



领科教育上海校区

Ulink Education-Shanghai

PreIB Chemistry

Workbook and Past Exam questions 2020-21



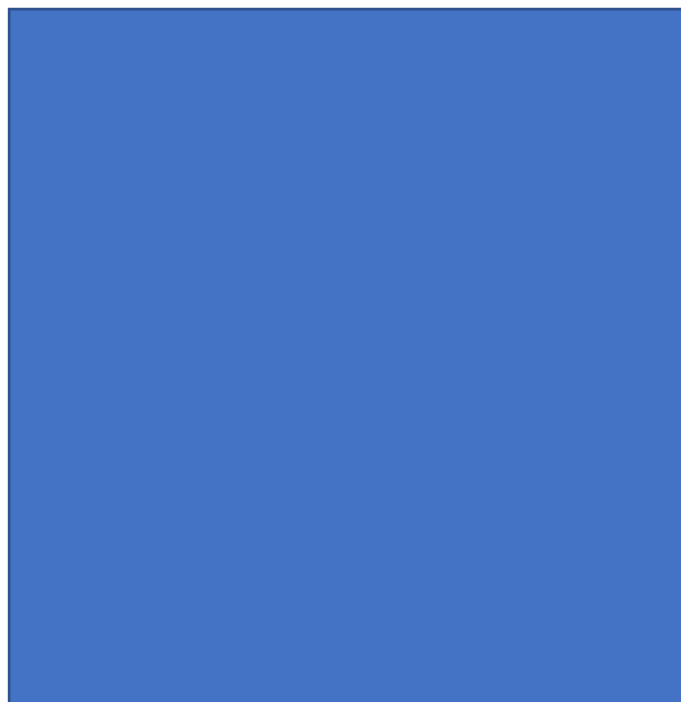
The world's first Chemistry textbook, written by a Babylonian woman called Tapputi 3300 years ago, to learn more, [click here](#).

NAME: _____ **English Name:** _____

Class: _____ **Teacher:** _____



PreIB Chemistry Workbook



Contents

1	Introduction to the Course and the Course Materials	9
1.1	FUNDAMENTAL – What the 4 different levels used here mean.....	9
1.2	FUNDAMENTAL – How to use this workbook.....	9
1.3	For Parents Section of Smashing Science	9
1.4	FUNDAMENTAL – Explaining the different sections of each chapter	10
1.5	FUNDAMENTAL Student Survey Introducing yourself.....	11
1.6	FUNDAMENTAL – Electronic Resources Available.....	13
1.7	FUNDAMENTAL – How Your Course Will be Assessed at Ulink College Shanghai.....	13
1.8	Fundamental Command Terms used in the questions taken from CAIE iGCSE Chemistry	14
1.9	ESSENTIAL How the PreIB Course Will be Assessed	15
1.10	FUNDAMENTAL Periodic Table of elements	16
1.11	FUNDAMENTAL Recording your scores and keeping track of your performance	17
1.12	FUNDAMENTAL School Calendar.....	18
1.13	ESSENTIAL Teaching order	20
1.14	EXCEPTIONAL Stretch and Challenge - Basics to delivering an effective presentation	22
1.15	EXTENSION How grade thresholds have changed across the years	24
1.15.1	Reflection:	24
1.16	ESSENTIAL Study Timetable – Use this to assign blocks of time to different subjects and regular activities	25
1.17	ESSENTIAL Revision Timetable –Use this to help you start to organise your revision time	26
2	Learning to learn	27



2.1	ESSENTIAL Critical reading techniques	27
2.2	FUNDAMENTAL Active Reading Advice	28
2.3	EXTENSION Active Reading Advice	28
2.4	How to get the most from your textbook	30
2.4.1	Important points to note about the textbook.....	30
2.5	EXTENSION Examples of active reading.....	32
2.6	ESSENTIAL Examples of Mind Maps	34
2.7	FUNDAMENTAL Glossary of Quizlet Library of Weblinks	38
3	The Cornel Note-Taking System	39
3.1	Introduction	39
3.2	The forgetting curve	41
3.3	Fundamental Cornell Notetaking Basics	42
3.3.1	Essential Cornell Notetaking for More Able Students.....	42
3.4	Extension Cornell Notetaking for Better Students	43
3.5	Exceptional Cornell Notetaking for the Best Students	44
3.6	Essential Note-Taking Tips and Examples.....	45
3.7	Cornel Notetaking Note Paper.....	48
3.8	Top Tips for Smashing! your Exams	69
4	IB Diploma.....	72
4.1	IB Learner Profile	73
4.2	Standard Level (SL) and Higher Level (HL) Group 4 Courses	74
4.3	Group 4 aims.....	74
4.4	IB SL and HL Chemistry Syllabus outline	75
4.5	IB Group 4 External Assessment Details SL Chemistry	76
4.1	IB Group 4 External Assessment Details HL Chemistry.....	77
4.2	IB Group 4 Internal Assessment (IA).....	78
4.3	Explaining the IB IA Assessment Criteria	78
5	Topic 1 Particulate Theory of Matter	83
5.1	End of Topic 1 Goals Checklist	83
5.2	Topic 1 Syllabus	84
5.1	ESSENTIAL Glossary for Keywords for this topic.....	85
5.1	ESSENTIAL EXAM QUESTIONS Paper 4 Topic 1 50marks	86
5.1.1	ESSENTIAL EXAM QUESTIONS Paper 4 Topic 1 50marks Mark Scheme	92
5.1	Essential End of Topic 1 Review and Reflection	94
6	Topic 2 Experimental Techniques	95
6.1	End of Topic 2 Goals Checklist	95
6.2	Topic 2 Syllabus	96
6.3	ESSENTIAL Glossary for Keywords for this topic.....	97
6.4	EXTENSION Keywords	98
6.5	EXTENSION Activity 1 WS Safety in the Lab.....	99



6.6	ESSENTIAL Activity 2 Hazard Symbols.....	100
6.7	ESSENTIAL Activity 3 Laboratory apparatus	100
6.8	ESSENTIAL EXAM QUESTIONS Paper 2 Topic 2 11marks	102
6.8.1	ESSENTIAL EXAM QUESTIONS Paper 2 T2 11marks Mark Scheme.....	106
6.9	ESSENTIAL EXAM QUESTIONS Paper 6 Labelling Equipment and Understanding Experiments.....	106
6.9.1	Mark Scheme iG Chem 2 EQ 18w to 16m Labelling Equipment.....	117
6.10	ESSENTIAL EXAM QUESTIONS Paper 6 Topic 2 Experimental Techniques 79 marks.....	120
6.10.1	ESSENTIAL EXAM QUESTIONS Paper 6 Topic 2 Experimental Techniques 79 marks Mark Scheme	131
6.11	EXTENSION EXAM QUESTIONS Paper 6 Topic 2 Long Answer Questions 53 marks	136
6.11.1	EXTENSION EXAM QUESTIONS Paper 6 Topic 2 Long Answer Questions 53 marks Mark Scheme	143
6.12	FUNDAMENTAL Assessed Activity 1 Keyword Test	145
6.13	ESSENTIAL Assessed Activity 2 –Which separation technique?	146
6.14	ESSENTIAL Assessed Activity 3 Labelling equipment	148
6.15	Extension Mind Map for Topic 2 Experimental Techniques and Separation	152
6.16	Essential End of Topic 2 Review and Reflection	153
6.17	Topic 2 EXCEPTIONAL Reading Magazines, Newspapers and Periodicals	154
7	Topic 3 Atoms, Elements and Compounds	155
7.1	End of Topic 3 Goals Checklist	155
7.2	Topic 3 Syllabus	156
7.3	ESSENTIAL Glossary for Keywords for this topic.....	159
7.4	ESSENTIAL EXAM QUESTIONS Paper 4 Topic 3 327marks	162
7.4.1	ESSENTIAL EXAM QUESTIONS Paper 4 Topic 3 327marks Mark Scheme	191
7.1	Essential End of Topic 3 Review and Reflection	203
8	Topic 4.1 Stoichiometry	204
8.1	End of Topic 4.1 Goals Checklist	204
8.2	Topic 4.1 Syllabus	205
8.3	ESSENTIAL Glossary for Keywords for this topic (4.1 Stoichiometry).....	206
8.3.1	Other Keywords that are needed for Topic 4.2 which will be covered later on in your studies:.....	207
8.4	EXTENSION Keywords	208
8.5	ESSENTIAL Active Learning Activity 1 Balancing chemical equations.....	208
8.5.1	Active Learning Activity Balancing chemical equations Mark Scheme	210
8.6	FUNDAMENTAL Active Learning Activity 2 Table of Common, and Not-So Common Ions	210
8.7	ESSENTIAL Active Learning Activity Naming Chemical Compounds	212
8.7.1	Naming Chemical Compounds Mark Scheme	213
8.8	EXCEPTIONAL INFORMATION Naming compounds (Nomenclature) – The Complete Set of Rules	213
8.9	Active Learning Activity 4 Word and Symbol Equations.....	218
8.9.1	Word and symbol equations mark scheme.....	222
8.10	FUNDAMENTAL EXAM QUESTIONS T4.1 Paper 1 12marks	223
8.10.1	FUNDAMENTAL EXAM QUESTIONS T4.1 Paper 1 12marks Mark Scheme	226
8.11	FUNDAMENTAL EXAM QUESTIONS Paper 2 9marks	227



8.11.1	FUNDAMENTAL EXAM QUESTIONS Paper 2 9marks mark Scheme	229
8.12	ESSENTIAL EXAM QUESTIONS T4.1 Paper 4 9marks.....	229
8.12.1	EXAM QUESTIONS T4.1 Paper 4 9marks Mark Scheme	230
8.13	FUNDAMENTAL Assessed Activity 1 Keyword Test	231
8.14	ESSENTIAL Assessed Activity 2 T4.1 Paper 1 (Core only material) 15marks.....	232
8.15	Extension Assessed Activity 3 T4.1 Stoichiometry 11marks.....	237
8.16	Extension Mind Map for Topic 4.1 Chemical equations.....	238
8.17	Essential End of Topic 4.1 Review and Reflection	239
8.18	Exceptional Stretch and Challenge Activities and Additional Reading The SI System	240
9	Topic 4.2 The Mole Concept	242
9.1	End of Topic 4.2 Goals Checklist	242
9.2	Topic 4.2 Syllabus	243
9.3	ESSENTIAL Glossary for Keywords for this topic.....	244
9.4	ESSENTIAL EXAM QUESTIONS Topic 4.2 Paper 3/4 148marks	246
9.4.1	ESSENTIAL EXAM QUESTIONS Topic 4.2 Paper 3/4 148marks Mark Scheme	262
9.1	Essential End of Topic 5 Review and Reflection	270
10	Topic 7.4 Redox	271
10.1	End of Topic 7.4 Goals Checklist	271
10.2	Topic 7.4 Syllabus	273
10.3	ESSENTIAL Glossary for Keywords for this topic.....	273
10.4	ESSENTIAL Classroom Active Learning Task 1 Assigning Oxidation States	274
10.4.1	ESSENTIAL Classroom Active Learning Task 1 Assigning Oxidation States Mark Scheme	275
10.1	ESSENTIAL Classroom Active Learning Task 2 Assigning Oxidation States	276
10.2	ESSENTIAL Classroom Active Learning Task 3 Oxidising and Reducing Agents	277
10.3	EXCEPTIONAL Active Learning Activity 4 Balancing Redox Reactions	278
10.3.1	ESSENTIAL Classroom Active Learning Task 2,3 &4 Mark Scheme.....	280
10.4	ESSENTIAL EXAM QUESTIONS Paper 3/4 48marks	281
10.4.1	Mark Scheme iG Chem 7.4 EQ Paper 3/4.....	286
10.5	ESSENTIAL EXAM QUESTIONS Paper 2 18marks.....	288
10.5.1	ESSENTIAL EXAM QUESTIONS T7.4 Paper 2 Mark Scheme	292
10.6	FUNDAMENTAL Assessed Activity 1 Keyword Test	293
10.7	FUNDAMENTAL Assessed Activity 2 Paper 1 17marks	293
10.8	Extension Assessed Activity 3 T7.4 P4 13marks	297
10.9	Extension Mind Map for Topic 7.4 Redox.....	300
10.10	Essential End of Topic 7.4 Review and Reflection	301
10.11	Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus.....	302
10.12	Topic 7.4 Exceptional Redox Reactions and the Origins of Life.....	302
11	Topic 5 Electrochemistry	303
11.1	End of Topic 6 Goals Checklist	303
11.2	Topic 5 Syllabus	304



11.3	ESSENTIAL Glossary for Keywords for this topic.....	305
11.4	ESSENTIAL Active Learning Tasks Electrolysis 1.....	306
11.5	Extension Classroom Active Learning Task 2 Voltaic & Electrolytic Cells Venn Diagram	307
11.6	Extension Classroom Active Learning Task 3	308
11.6.1	Extension Classroom Active Learning Task 3 Answers	311
11.7	ESSENTIAL EXAM QUESTIONS Paper 2 11marks.....	312
11.7.1	ESSENTIAL EXAM QUESTIONS Paper 2 T5 11marks MARK SCHEME	316
11.8	ESSENTIAL EXAM QUESTIONS T5 Paper 3/4 100 marks	317
11.9	ESSENTIAL EXAM QUESTIONS T5 Paper 3/4 Mark Scheme	330
11.10	FUNDAMENTAL Assessed Activity 1 Keyword Test	334
11.11	ESSENTIAL Assessed Activity 2 Multiple Choice T5 16marks.....	335
11.12	EXTENTION Assessed Activity 3 T5 Longer answer questions 21marks	340
11.13	Extension Mind Map for Topic 5 Electrochemistry	342
11.14	Essential End of Topic 5 Review and Reflection	343
11.15	Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus	344
12	Topic 6 Chemical Energetics.....	345
12.1	End of Topic 6 Goals Checklist	345
12.2	Topic 6 Syllabus	346
12.3	ESSENTIAL Glossary for Keywords for Topic 6	347
12.4	ESSENTIAL Classroom Active Learning Tasks 1 Drawing AND Interpreting Graphs for Paper 6.....	347
12.5	ESSNETIAL Classroom Active Learning Tasks 2 Endothermic or Exothermic?	351
12.6	ESSENTIAL EXAM QUESTIONS Topic 6 Paper 2 31marks Mark Scheme	353
12.6.1	ESSENTIAL EXAM QUESTIONS Topic 6 Paper 2 31marks Mark Scheme.....	363
12.7	ESSENTIAL EXAM QUESTIONS T6 Paper 3/4 29marks	364
12.7.1	ESSENTIAL EXAM QUESTIONS Paper 2 29marks Mark Scheme	367
12.8	ESSENTIAL EXAM QUESTIONS Topic 6 Paper 6 75marks	369
12.8.1	ESSENTIAL EXAM QUESTIONS Topic 6 Paper 6 75marks Mark Scheme.....	376
12.9	FUNDAMENTAL Assessed Activity 1 Keyword Test	378
12.10	ESSENTIAL Assessed Activity 2 Topic 6 Paper 2 14marks	379
12.11	Essential Assessed Activity 3 Topic 6 Paper 6 19marks	384
12.12	EXCEPTIONAL Assessed Activity 4 T6 13marks.....	388
12.13	ESSENTIAL End of Topic 6 Review and Reflection	390
12.14	Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus.....	391
12.15	EXCEPTIONAL Additional Activities, Further Reading and Exploring Beyond the Syllabus	391
12.16	EXCEPTIONAL EXAM QUESTIONS T6 From IB SL 31marks.....	392
12.16.1	EXCEPTIONAL EXAM QUESTIONS T6 From IB SL 31marks Mark Scheme.....	395
13	Topic 7.1 & 7.2 Chemical and Physical Reactions and Rate of Reactions	396
13.1	End of Topic 7.1 & 7.2 Goals Checklist	396
13.2	Topic 7.1 and 7.2 Syllabus.....	397
13.3	ESSENTIAL Glossary for Keywords for Topic 7.1 & 7.2	398



13.4	EXTENSION Keywords	398
13.5	ESSENTIAL Classroom Active Learning Tasks Drawing Graphs	398
13.6	Extension Classroom Active Learning Tasks Dealing with Multi-mark Questions	406
13.7	ESSENTIAL EXAM QUESTIONS Paper 2 Topic 7.1 & 7.2 12marks	414
13.8	ESSENTIAL EXAM QUESTIONS Paper 3/4 T7.1 & 7.2 139marks.....	418
13.8.1	ESSENTIAL EXAM QUESTIONS Paper 3/4 T7.1 & 7.2 139marks Mark Scheme	435
13.9	ESSENTIAL EXAM QUESTIONS Paper 6 Topic 7.1 and 7.2 151marks	440
13.9.1	ESSENTIAL EXAM QUESTIONS Paper 6 Topic 7.1 and 7.2 151marks Mark Scheme.....	469
13.10	FUNDAMENTAL Assessed Activity 1 Keyword Test	473
13.11	ESSENTIAL Assessed Activity 2 Topic 7.1 & 7.2 Paper 2 15marks	474
13.12	Extension Assessed Activity 3 Paper 3/4 17marks	479
13.13	ESSENTIAL End of Topic Review and Reflection	482
13.14	EXTENSION Mind Map For Topic 7.1 & 7.2	483
13.15	EXCEPTIONAL Additional Activities, Further Reading and Exploring Beyond the Syllabus	484
13.16	Exceptional Extra Credit Science in Context Topic 7.1 and 7.2	484
14	Topics 7.3 Reversible Reactions, 11.3 Nitrogen & Fertilisers & 12 Sulfur (Equilibria)	485
14.1	End of Topic 7.3, 11.3 and 12 Goals Checklist	485
14.2	Topics 7.3, 11.3 & 12 Equilibria Syllabus	486
14.3	ESSENTIAL Glossary for Keywords for this topic.....	487
14.4	ESSENTIAL Classroom Active Learning Tasks 1 The Haber Process	488
14.5	ESSENTIAL Classroom Active Learning Tasks 2 The Contact Process.....	489
14.6	Extension Classroom Active Learning Task 2 Concentrated and dilute sulfuric acid Venn Diagram.....	491
14.7	Extension Classroom Active Learning Tasks 3 Dealing with Multi-mark Questions about Equilibria 84marks.....	492
14.8	ESSENTIAL EXAM QUESTIONS Paper 2 Topic 7.3.....	505
14.8.1	ESSENTIAL EXAM QUESTIONS Paper 2 Topic 7.3 Mark Scheme	516
14.9	ESSENTIAL EXAM QUESTIONS Paper 3/4 Topic 7.3 56 marks.....	518
14.10	ESSENTIAL EXAM QUESTIONS Paper 3/4 Haber process and nitrogen chemistry (Topic 11.1) 63 Marks	526
14.10.1	ESSENTIAL EXAM QUESTIONS Paper 3/4 Contact Process and Sulfur Chemistry (Topic 12) 79 Marks	536
14.10.2	ESSENTIAL EXAM QUESTIONS Paper 3/4 Topic 7.3 56 marks Mark Scheme	548
14.11	FUNDAMENTAL Assessed Activity 1 Keyword Test	561
14.12	ESSENTIAL Assessed Activity 2 Topic 7.4, 11.3 and 12 Paper 2 15 marks	563
14.13	ESSENTIAL Assessed Activity 3 Topic 7.3 15 marks	570
14.14	EXTENSION Mind Map For Topics 7.3 Reversible Reactions, 11.3 Nitrogen & Fertilisers & 12 Sulfur (Equilibria) ..	572
14.15	ESSENTIAL End of Topic Review and Reflection	573
14.16	Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus.....	574
14.16.1	EXCEPTIONAL Active Learning Activity Can you think of why these molecules look wrong?	574
14.17	Exceptional Extra Credit Science in Context.....	575
15	APPENDIX	576
15.1	EXTENSION Keywords	576
15.2	APPENDIX EXCEPTIONAL Statistics Relating to the Course	578



15.3	Topics in Rank Order.....	578
15.4	Key Points about these graphs and data	579
15.4.1	Raw Data Info Used to Make the Graphs	582
15.4.2	.....	582
15.5	Words per topic statistics from the syllabus	583
15.6	Papers Used to create the revision resources I use.....	584
15.7	FUNDAMENTAL Periodic Table of elements	585



1 Introduction to the Course and the Course Materials

1.1 FUNDAMENTAL – What the 4 different levels used here mean

There are 4 different levels that each activity has been labelled as within this workbook. Learning about these 4 categories of activities is considered FUNDAMENTAL, so everyone is expected to read this :o)

FUNDAMENTAL – This is the most basic ideas and most important things to do before you try to do anything else. If you are struggling in this subject these FUNDAMENTAL activities are the most important things to concentrate on to allow you to progress on towards the higher grades. If you only do the fundamental parts of the course you are unlikely to get above a C grade.

ESSENTIAL – This refers to activities that you should do if you are aiming for a B or an A grade. These are the kinds of things that you should be doing before you attempt any of the harder activities.

EXTENSION – Anything that is marked with this is considered to be really important for those students who are on track for getting an A* and who intend to stay on track.

EXCEPTIONAL – These are things that you can do that are unlikely to have much impact on your final grade, so only the ablest students who regularly achieve over 90% in assessed activities should attempt these. They are important because they will help broaden your mind and give you a depth of understanding that will be particularly important if you are finding the work extremely easy and would like to stretch and challenge yourself. These kinds of experiences and ideas are especially important to help make a good application for the best universities.

1.2 FUNDAMENTAL – How to use this workbook

Each chapter of this book will have a Keyword list, or Glossary, a Classroom activities section, a Past Exam questions section, a Mark Scheme section, Assessed Activity section and a Stretch and Challenge Section. It is recommended that you read ahead in the textbook so that you already have answers, but most importantly, questions about the topic we are studying. This is what your textbook is for. **The Classroom Activities and the Assessed Activities SHOULD NOT be completed in advance**, but you can read through them if you would like. The Past Exam questions should only be attempted when you feel able to do them successfully, which may be after you have read through the textbook and already worked through the activities there, but often it will only be after you have been taught the material in class. It is better that you answer the questions well on your the first attempt and put all of your energy into doing as well as you can on the current topic, especially before the end of topic test. Only a very small number of students will benefit from getting too far ahead of the class, most will simply have covered more material less well and this will be reflected in disappointing grades and test scores.

1.3 For Parents Section of Smashing Science

There is a page dedicated to explaining the iGCSE course and the resources which is specifically to help your parents better understand what you are learning. You will need to get them to scan the QR codes below and then sign this page to show that they have seen this page and are aware of the additional online resources that have been created specifically for you.



Name of Parent or Guardian: _____

Signature: _____

Date: _____



1.4 FUNDAMENTAL – Explaining the different sections of each chapter

Section title	What is in it	How and why it can help you
Keywords	Keywords for the topic auto translated into Chinese. These words are essential to be able to understand and answer questions about the the science of the topic	If you are struggling with the language this is the most important section, you will not be able to do well in much else if you don't understand the keywords in English. For exceptional students I would be very appreciative of a better electronic translation.
Extension keywords	Keywords that are at the edges of the syllabus.	These are not essential to get an A grade, but they will help you to better understand where the syllabus ends. They are also useful in expanding your academic vocabulary and particularly useful for exceptional students .
Essential Exam Questions	Past exam questions from previous exam papers that assess the topic.	Understanding the science is only a part of being a successful science student, you also need to be able to read and answer exam questions in a way that will allow you to get enough marks. The best practice for anything nearly always is doing the thing you hope to become good at. The difference between and A* student and an A grade student often has very little to do with how much science they understand, but A* students understand very deeply good exam technique and the patterns in exam questions. This understanding takes a great deal of practice. Some students may not finish all of these questions. Exceptional students will not only finish these questions but will also go on the websites shown here and download and work on the additional exam questions.
Mark Schemes	The answers to the exam questions. This is not the mark scheme actually used by examiners when these questions were in real exams, however, but a simplified version.	Understanding the difference between a correct, but incomplete answer and a correct and complete answer is at the heart of excellent exam technique. Looking at how mark schemes change over time (they always get harder!) is also a useful exercise in understanding what the examiners think is the most important aspect of an idea. Exceptional students will make notes of the marks they have lost and work on other questions until the number of marks they lose in a given topic is reduced to a very small number, ideally 0.
Fundamental Assessed Activities	Test on the keywords for the course	These should only be attempted by those students who are struggling with the topic and the course. Most students are not expected to try these, but it is up to you to decide which assessed activity you try based on how you feel about the topic.
Essential Assessed Activities	Straightforward activities that test your progress in the course.	These are not going towards your GPA. You have access to all of them, but it is in your best interest to give them a fair go in class because the score is important: if you get very high scores on these, but very low scores on your End of Topic tests than it is obvious that you are not properly preparing for those tests because you have shown an ability already in this topic. It is far better to score badly in these, learn from those poor scores and revise properly for the end of topic tests, which sometimes will go towards your GPA.
Extension Assessed Activities	These are harder questions and there ar a lot more of them.	These will test your ability to work to tight timelines, which is essential for a good A*. You will complete these after you have completed the Essential Assessed Activities.
Stretch and Challenge Activities and Additional Reading	Questions, further reading and links to additional resources that go beyond the syllabus	You can use the advice and information in here to better understand the topic, but also there is an optional activity where you are able to give a presentation to the class about something loosely connected to this topic .



1.5 FUNDAMENTAL Student Survey Introducing yourself

Please complete this brief introduction to yourself and your background and what you hope to study later on and why.

Name, English and Chinese (in pinyin): _____ Class: _____

Email address: _____

iGCSE Subject	Target grade

iGCSE Subject	Target grade

Top 5's – What are your goals for the following

Rank	University course	University (& country it is in)	Career	How you want to be remembered by others
1				
2				
3				
4				
5				



Goals for your time at Ulink

Which activities (at school or outside of school, like music or sport) have you done before?

Which co-curricular activities do you intend to do, or would like to do?

What are your targets for the first few weeks of term?

Academic Targets for this term (and how will you achieve them?):

Life (non-academic) targets for this term (and how will you achieve them?):

If you have studied chemistry before, what do you think is easiest and hardest about the subject?

Easiest: _____

Hardest: _____

Most interesting: _____

Least interesting: _____

Can you think of anything that has happened in science recently in the news that you thought was amazing?



1.6 FUNDAMENTAL – Electronic Resources Available

An electronic version of this book is available by scanning the QR code below:



This book contains some past exam questions, but for even more practice go to one of the websites below, the larger of the two is the first one, but is only accessible through a VPN. Either website offers thousands of pages of resources to help you practice and learn about this subject as well as other subjects.

There is also advice on things you can do to [Expand your Mind](#) which will help broaden your horizons and give you ideas on things that might be of interest, especially to the ablest students. In addition, there is [advice and guidance on applying to university](#) and the kinds of things that the best universities tend to look for in students that they offer places to.

Videos explaining the science in the course in English can be found on this webpage here:

<https://www.smashingsciencecn.org/igcse-chem-videos>,

1.7 FUNDAMENTAL – How Your Course Will be Assessed at Ulink College Shanghai

For MOST topics you will have 2 Assessed Activities that will be carried out in the classroom. These **WILL NOT** go towards your Grade Point Average, but they will help you learn how you are progressing within the topic before the End of Topic Test. Some of your End of Topic Tests will go towards your GPA. This will be explained in advance. You will also have an End of Semester Exam in January, an End of Year Exam and your external iGCSE Exams in May.



1.8 Fundamental Command Terms used in the questions taken from CAIE iGCSE Chemistry (on which this course is based)

Command word	Meaning
Define	(the term(s) ...) is intended literally, only a formal statement or the same idea in slightly different language is acceptable. Often these questions lose marks over time, so the same answer is expected, but will carry fewer marks making it more difficult to get full marks.
What do you understand by/ What is meant by	(the term(s) ...) normally suggests that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.
State	implies a short and complete answer with little or no supporting information (e.g. a numerical answer that can readily be obtained 'by looking at it').
List	requires a number of points, generally each of one word, with no further information. Where a given number of points is specified only that number of points should be given, so don't give more answers than is required or they may not be counted, or they may, if they are incorrect, be used to deduct marks from your total.
Explain	may require reasoning or some reference to theory, depending on the context. It is another way of asking candidates to give reasons. The candidate needs to leave the examiner in no doubt why something happens. These questions will usually include the hardest mark, which is normally the 2nd or 3rd mark that will differentiate between A and A* students.
Give a reason/Give reasons	is another way of asking candidates to explain why something happens.
Describe	requires the candidate to state in words (using diagrams where appropriate) the main points. <i>Describe</i> and <i>explain</i> may be given in the same command, as may <i>state</i> and <i>explain</i> . Usually much easier than the <i>Explain</i> aspect of the question.
Discuss	requires the candidate to give the essential information of the points involved.
Outline	implies brevity, so a short response (i.e. limiting the answer to giving just the essentials).
Predict	implies that the candidate is expected to make a prediction not by remembering a fact (recall) but by making a logical connection between other pieces of information. For instance, predict the properties of a compound with unfamiliar elements, based on understanding lighter elements in the same group in the periodic table.
Deduce	implies that the candidate is not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Normally in chemistry this involves being shown a compound that contains unfamiliar elements, but which belong to a group of familiar elements, e.g. Deduce the formula of hydrogen selenide. Answer: Selenium is in the same group as oxygen, and hydrogen oxide is H ₂ O, so H ₂ Se is the expected response.
Suggest	is used in two main contexts, i.e. either to imply that there is no unique answer (e.g. in chemistry, two or more substances may satisfy the given conditions describing an 'unknown'), or to imply that candidates are expected to apply their general knowledge of the subject to a 'novel' situation, one that may be formally 'not in the syllabus' – many data response (for instance where information is given in a table about different substances) and problem solving questions are of this type.
Find	is a general term that may interpreted as <i>calculate</i> , <i>measure</i> , <i>determine</i> , etc.
Calculate	is used when a numerical answer is required. In general, working should be shown and clearly labelled especially where more than one step is involved.
Measure	implies that the quantity concerned can be directly obtained from a suitable measuring instrument (e.g. length using a rule, or mass using a balance).
Determine	often implies that the quantity concerned cannot be measured directly but can be worked out from a graph or by calculation.
Estimate	suggests that a statement that is only very roughly close to the real value (within a factor of 10) or calculation of the quantity concerned. Normally assumptions will need to be made based on points of principle and values of amounts not given in the question.
Sketch	when applied to graph work, implies that the shape and/or position of the curve need only be roughly (or qualitatively) correct, but candidates should be aware that, depending on the context, some quantitative aspects may be looked for (e.g. passing through the origin, having an intercept). In diagrams, <i>sketch</i> implies that simple, freehand drawing is acceptable; nevertheless, care should be taken over proportions and the clear labelling of important details or equipment.



1.9 ESSENTIAL How the PreIB Course Will be Assessed

All candidates take exam papers at the end of the year. These will be created base on questions taken from [Cambridge Assessment International Education](#) , which is a part of the [University of Cambridge](#).

You will NOT actually sit the CAIE exam in May!

You will complete a modified course that will allow us to focus on preparing you best for the IB which has a variety of unique aspects that are not found in the CAIE A Level program, but which need to be completed to allow you the best chance of success at IB Level.

Your exams will contain questions from these exam papers, but the course may not end with 3 exams (there's a chance that you will instead sit for fewer exams):

Extended candidates take:		and Extended candidates take:		or:	
Paper 2	45 minutes	Paper 4	1 hour 15 minutes	Paper 6	1 hour
Multiple Choice	30%	Theory	50%	Alternative to Practical	20%
40 marks		80 marks		40 marks	
40 four-choice multiple-choice questions		Short-answer and structured questions		Questions will be based on the experimental skills in Section 4	
Questions will be based on the Extended subject content (Core and Supplement)		Questions will be based on the Extended subject content (Core and Supplement)		Assessing grades A*–G	
Assessing grades A*–G		Assessing grades A*–G		Externally assessed	
Externally assessed		Externally assessed			



DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
																	4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4																20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12																35.5 Cl Chlorine 17
39 K Potassium 19	40 Ca Calcium 20																84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38																131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56																209 Po Polonium 84
226 Fr Francium 87	227 Ac Actinium 89																86 Rn Radon 86
*58-71 Lanthanoid series †90-103 Actinoid series																	
																	175 Lu Lutetium 71
																	102 No Nobelium 102
																	103 Lr Lawrencium 103

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

Key

a	X	a = relative atomic mass
b	X	X = atomic symbol
		b = proton (atomic) number



1.11

FUNDAMENTAL Recording your scores and keeping track of your performance

Target grade:_____

Target Score _____ %

[illegible][illegible]

1.12 FUNDAMENTAL School Calendar

Week #	Monday starting	Contents	Your Notes
	10-Aug	Mon 10 to 14 G1 & PreA Students Orientation Week <u>Tue 11th All teachers back in office</u> Fri 14th Full staff meeting/Department meeting Welcome Buffet Sun 16th C6 AS & A2 students registration <u>Sun 16th UCS Opening Ceremony All Staff</u> <u>am: G1, G2 & PreA, pm AS, A2 & IB1/2</u>	
1	17-Aug	Mon 17th Teaching Begins	
2	24-Aug	<u>Fri 28th Dead Line for G1, ASD and IB1 to change options</u> Tue 26th Activities Fair Wed 26th-30th Student Union Elections	
3	31-Aug		
4	7-Sep	Fri 11th G1 and PreA Parents consultation day <u>Fri 11th Dead Line for A2 Students to drop options</u>	
5	14-Sep	<u>Fri 18th Dead Line for A2 Predicted grades</u> Fri 18th IB2 Parents' consultation day Fri 11th Open day for G1 and PreA parents	
6	21-Sep	<u>Sat 26th Make up day (Tuesday)</u>	
7	28-Sep	Thur 1st Oct First day of National Holiday	
	5-Oct	10th Oct Last day of National Holiday <u>Sun 11th Make-up Day (Friday's timetable)</u>	
8	12-Oct	<u>SAT 17 Make-up Day (Sports Day) (or Wednesday if weather is bad)</u>	
9	19-Oct	Fri 23rd International Mole day	
10	26-Oct	Wed 28th Alternative sports day 26th-30th Art Week	
11	2-Nov	<u>Fri 6th Deadline for 1st observation for returning teachers</u>	
12	9-Nov	Mon 9th to Fri 13th IB2 MS EXAMS Wed 11th Physics Day Fri 13th CAIE Winter Session Begins <u>Fri 13th DeadLine for inputting marks for Mid Semester Reports</u>	
13	16-Nov		
14	23-Nov	Mon 23rd G1,2 PreA, AS and A2 Reports Fri 27th AS, A2 and IB1 Parents Consultation Fri 27th Completion of the first Student Survey <u>Sat 28th Makeup day G1, G2, PreA and Pre IB</u> <u>Parents Consultation day</u>	
15	30-Nov		
16	7-Dec		
17	14-Dec	13th CAIE Winter session ends	
18	21-Dec		
	28-Dec		

Week #	Monday starting	Contents	Your Notes
19	4-Jan	Sun 3rd Jan Last day of Xmas holiday Mon 4th to Sat 9th End of Semester Exams Sat 9th Jan make up day	
20	11-Jan		
21	18-Jan	Mon 18th Deadline for input of all marks in SIMS for EOS Reports Fri 22nd Annual Party & Long Service Awards Celebration	
22	25-Jan	Mon 25th G1,2, PreA, AS and A2 reports issued Thur 28th IB1, AS and A2 Parents Consultation Day (PM only) Fri 29th G1,2 PreA, PreIB Parents Consultation Day (Whole day) Sat 30th Spring Festival Holiday begins	
	1-Feb	Chinese New Year Holiday	
	8-Feb	Chinese New Year Holiday	
	15-Feb	Chinese New Year Holiday Sat 20th Winter Holiday ends Sun 21st AM All students and form tutors in school for registration Sun 21st PM Students Assembly	
23	22-Feb	Mon 22nd Semester 2 Teaching begins Sun 28th New spring classes in school for registration	
24	1-Mar	Tue 2nd to Fri 12th IB2 Mock Exam Wed 3rd Graduation Picture Day (Weather permitting)	
25	8-Mar	Fri 12th End of IB2 Mock Fri 12th G2 and preA Optional Course Information Day Fri 12th Completion of 2nd Student survey	
26	15-Mar	Mon 15th Deadline for G2, PreA, AS and A2 End of Year Exam Papers to AAO for printing	
27	22-Mar	Mon 22nd Guided Revision Starts Wed 24 UCS Spring Concert Fri 26th Teaching of G2, PreA AS, A2 syllabi completed Fri 26th Deadline for all Observations	
28	29-Mar	Mon 29th- Thur 1st April CAIE Oral English Exam Thur 1st Guided Revision Ends Fri 2nd April QingMing Holiday Begins (3 days) Wed 31st Drama Class End of Year Performance	
29	5-Apr	Mon 5th EOY (G2, PreA, AS & A2) begins	
30	12-Apr	Fri 16th EOY ends	
31	19-Apr		
32	26-Apr	Thur 29th IB External Exams Begin	



Week #	Monday starting	Contents	Your Notes
33	3-May	Mon 3rd CAIE Summer Session Begins Deadline All marks G3, PreA, AS and A2 into SIMS	
34	10-May	Fri 14th G1 Syllabus Completed	
35	17-May	Mon 17th to Fri 21st PreIB EoY exams Fri 21st IB External Exams End	
36	24-May	Mon 24th to Fri 28th G1 EoY Exams	
37	31-May	Mon 31st Deadline for payment of student tuition and dormitory fees Fri 4th G2, PreA, AS and A2 reports issued Fri 4th Deadline for inputting G1 marks into SIMS Fri 4th PreIB Parents consultation day	
38	7-Jun	Wed 9th IB Parents Consultation Day Fri 11th CAIE summer session ends Sat 12th A2 & IB2 Graduation Ceremony Mon 7th-9th G1 Students Social Studies Wed 9th G1 Reports issues Fri 11th G1 Parents Consultation Day	
39	14-Jun	Mon 14th-16th EoY Reflection Days (All staff must attend) Thur 17th Ulink Family Day Fri 18th -20th Annual Summer Trip Mon 21st Summer Holiday Begins	

1.13 ESSENTIAL Teaching order

This is the approximate order that these topics will be taught and if they are going to be taught by me. There may be changes depending on special events or lessons that are missed for other reasons, especially because this is the first year that this course has been offered

Notice that the textbook that is used, Complete Chemistry for Cambridge IGCSE (3rd Edition, Oxford 2014) follows a different order than the CAIE topic order, which we will follow almost exactly, with some slight changes. **Exceptional students** will not only be following the topic being taught outside of class but also preparing for the next topic.

The main difference between our course and CAIE is that we will cover about 20% less of the course than the iGCSE due to time restrictions (we have fewer lessons per week than PreA level classes) and to allow us to better prepare for the IB group 4 subject you chose to do (which may be Chemistry either HL or SL).

CAIE Topic ID	My topic ID	Textbook Chapter	PhysC OrgC?	Teaching Week #	Topic name
1	Heading				The particulate nature of matter
1.1	1.1	1	OrgC	1	The particulate nature of matter
2	Heading				Experimental techniques
2.1	2.1&2	19	PhysC	1	Measurement
2.2.1	2.2.1&2	2	PhysC	2	Criteria of purity
2.2.2	2.2.1&2	2	PhysC	2	Methods of purification
2.2	Heading				Purity
3	Heading				Atoms, elements and compounds
3.1	3.1	3	OrgC	4	Atomic structure and the Periodic Table
3.2	Heading				Structure and bonding
3.2.1	3.2.1&2	4	OrgC	4	Bonding: the structure of matter
3.2.2	3.2.1&2	4	OrgC	5	Ions and ionic bonds



CAIE Topic ID	My topic ID	Textbook Chapter	PhysC OrgC?	Teaching Week #	Topic name
3.2.3	3.2.3&4	4	OrgC	6	Molecules and covalent bonds
3.2.4		4	OrgC	6	Macromolecules
3.2.5	3.2.5	4	OrgC	6	Metallic bonding
4	Heading				Stoichiometry
4.1	4.1	5	PhysC	7	Stoichiometry
4.2	4.2	6	OrgC	8	The mole concept
5					Electricity and chemistry
5.1	5.1	8	PhysC	9	Electricity and chemistry
6	Heading				Chemical energetics
6.1	6.1&2	9	PhysC	12	Energetics of a reaction
6.2	6.1&2	9	PhysC	12	Energy transfer
7	Heading				Chemical reactions
7.1	7.1&2	4	OrgC	13	Physical and chemical changes
7.2	7.1&2	10	PhysC	14	Rate (speed) of reaction
7.3	7.3	9	PhysC	15	Reversible reactions
7.4	7.4	7	PhysC	11	Redox
8	Heading				Acids, bases and salts
8.1	8.1&2	11	PhysC	21	The characteristic properties of acids and bases
8.2	8.1&2	11	PhysC	22	Types of oxides
8.3	8.3	11	PhysC	22	Preparation of salts
8.4	8.4	19	PhysC	23	Identification of ions and gases
9	Heading				The Periodic Table
9.1	9.1&2	12	OrgC	25	The Periodic Table
9.2	9.1&2	12	OrgC	25	Periodic trends
9.3	9.3	12	OrgC	26	Group properties
9.4	9.4	12	OrgC	26	Transition elements
9.5	9.5	12	OrgC	26	Noble gases
10	Heading				Metals
10.1	10.1	13	PhysC	27	Properties of metals
10.2	10.2	13	PhysC	27	Reactivity series
10.3	10.3	14	PhysC	28	Extraction of metals
10.4	10.4	14	PhysC	28	Uses of metals
11	Heading				Air and water
11.1	11.1	15	OrgC	29	Water
11.2	11.2	15	OrgC	29	Air
11.3	11.3	16	OrgC	15	Nitrogen and fertilisers
11.4	11.4	16	OrgC	30	Carbon dioxide and methane
12	Heading				Sulfur
12.1	12.1	16	PhysC	15	Sulfur
13	13				Carbonates
13.1	13.1	16	OrgC	31	Carbonates



1.14 EXCEPTIONAL Stretch and Challenge - Basics to delivering an effective presentation

At the end of each topic there will be a chance for the most interested students to give a presentation about anything they found particularly interesting. It can be about anything, but it will help develop your public speaking skills, your confidence and allow you to demonstrate subject passion, which is the most important quality that the best universities in the UK are interested in.

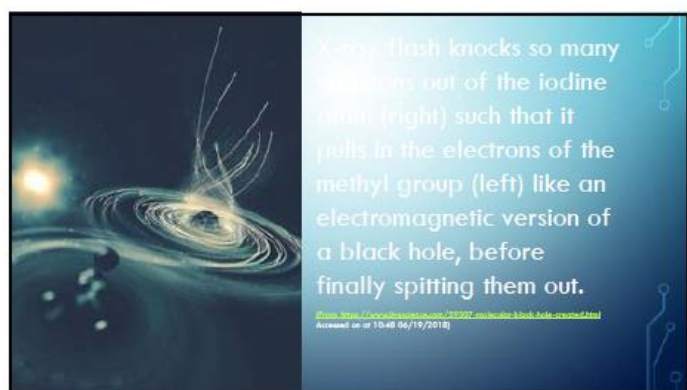
This exercise is voluntary but open to all students.



1



2



3



4



5



6



[illegible]

7

TRY NOT TO SIMPLY REPEAT FROM YOUR POWER POINT

- Your slides should be used to show *visual information*
- And KEY POINTS ONLY



POWERPOINT IS BORING!

8

OR YOUR WEBSITE

For the version available everywhere

<https://www.analyticalscience.org/ncse-chemistry-con-0000/>

For the version available only with a VPN

<https://www.analyticalscience.org/ncse-chemistry.html>

A large QR code is positioned on the right side of the slide. In the center of the QR code is a small, stylized portrait of a man with glasses and a mustache, wearing a suit. Above the portrait is the text 'Cn' and below it is 'SMASHING!!!' in a bold, red, sans-serif font.

9

OR ANYTHING ELSE WITH YOUR AUDIENCE

- For a range of online course providers that includes the world's best universities, like Harvard and Yale
- <https://www.classcentral.com/providers>

A square QR code with a white background and black modules, located in the bottom right corner of the slide. It is framed by a white border.

10

- Try alternatives to PowerPoint, like Prezi
- <https://www.youtube.com/watch?v=UW08tYDkz6I>

11

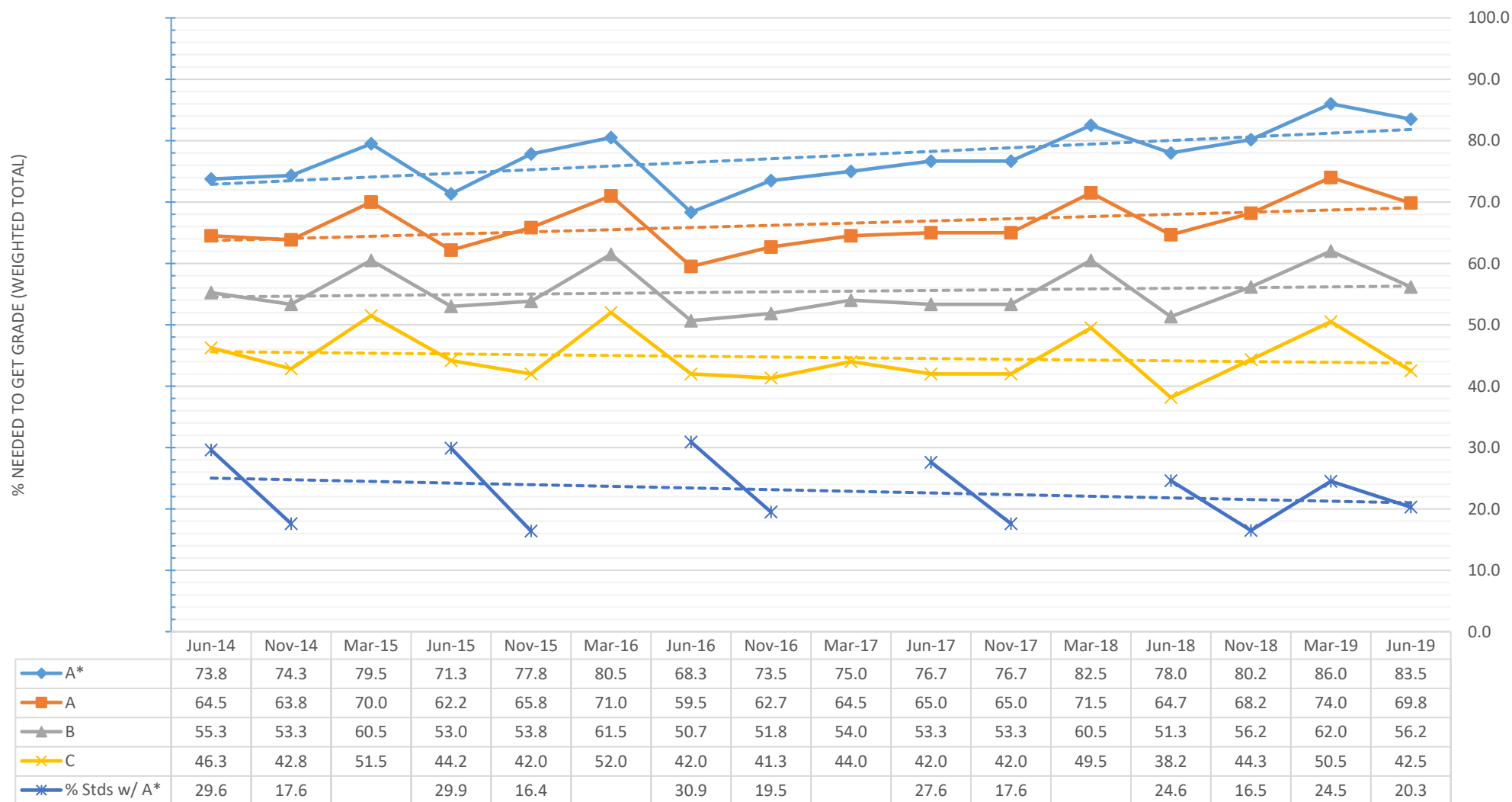
A composite image with a blue background and white circuit-like lines on the left. On the left, a smiling baby is shown. On the right, a kitten is hanging from a branch with the text "HANG IN THERE" above it. The text "© 2012 by Kristin Weir" is at the bottom.

12



1.15 EXTENSION How grade thresholds have changed across the years

GRADE THRESHOLDS FOR EXTENDED CHEMISTRY 0620 FROM JUN2019 TO JUN2014 A*-C WITH THE PROPORTION OF STUDENTS AWARDED AN A*



1.15.1 Reflection:

What do you think this graph shows? How can you use this information to make sure you achieve the A*?

1.16 ESSENTIAL Study Timetable – Use this to assign blocks of time to different subjects and regular activities

Period	Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	5:00 AM							
	5:30 AM							
	6:00 AM							
	6:30 AM							
	7:00 AM							
Regstn	7:45 AM							
1	8:00 AM							
2	8:50 AM							
Break	9:35 AM							
3	9:45 AM							
4	10:35 AM							
Lunch 5	11:25 AM							
Lunch 6	12:10 PM							
7	1:00 PM							
8	1:55 PM							
9	2:45 PM							
10	3:30 PM							
	4:20 PM							
	5:00 PM							
	5:30 PM							
	6:00 PM							
	6:30 PM							
	7:00 PM							
	7:30 PM							
	8:00 PM							
	8:30 PM							
	9:00 PM							
	9:30 PM							
	10:00 PM							
	10:30 PM							

1.17 ESSENTIAL Revision Timetable –Use this to help you start to organise your revision time

Period	Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	5:00 AM							
	5:30 AM							
	6:00 AM							
	6:30 AM							
	7:00 AM							
Regstn	7:45 AM							
1	8:00 AM							
2	8:50 AM							
Break	9:35 AM							
3	9:45 AM							
4	10:35 AM							
Lunch 5	11:25 AM							
Lunch 6	12:10 PM							
7	1:00 PM							
8	1:55 PM							
9	2:45 PM							
10	3:30 PM							
	4:20 PM							
	5:00 PM							
	5:30 PM							
	6:00 PM							
	6:30 PM							
	7:00 PM							
	7:30 PM							
	8:00 PM							
	8:30 PM							
	9:00 PM							
	9:30 PM							
	10:00 PM							
	10:30 PM							

2 Learning to learn

2.1 ESSENTIAL Critical reading techniques

1. [Critical reading techniques](#)
2. [Use an efficient approach](#)
3. Active reading

4. [How to take notes](#)
5. [Critically processing what you read](#)
6. [Coping with difficult content](#)

Active reading simply means reading something with a determination to understand and evaluate it for its relevance to your needs.

Simply reading and re-reading the material isn't an effective way to understand and learn. Actively and critically engaging with the content can save you time. Most OU study books and websites include in-text questions and self-assessed questions. Use these as built-in cues to make your study active.¹

PREDICT
Use clues to think about what will happen.
■ *I think/predict _____ because _____.*

QUESTION
What questions come up about the text, character, plot, detail, or action?
■ *Who, what, when, where, how, or why did the character...*

CLARIFY
Clear up any confusion or reaffirm what is already known.
■ *I think the passage means...*

INFER
Use clues from the text and what is known to figure out what the text means.
■ *Because _____ I think that...*

SUMMARIZE
Explain what the text is mainly about.
■ *In my words, this is about...*

COMPARE
Identify similarities seen in the text between characters or situations.
■ *I see how _____ is similar to _____ because _____.*

CONNECT
Make connections in the text by explaining how one can relate, or how the text relates to something else.
■ *I can relate to this because...*
■ *This reminds me of...*
■ *This is similar to ...because...*

VISUALIZE
Pause to imagine what the setting or action must be like.
■ *When I was reading, I pictured...*

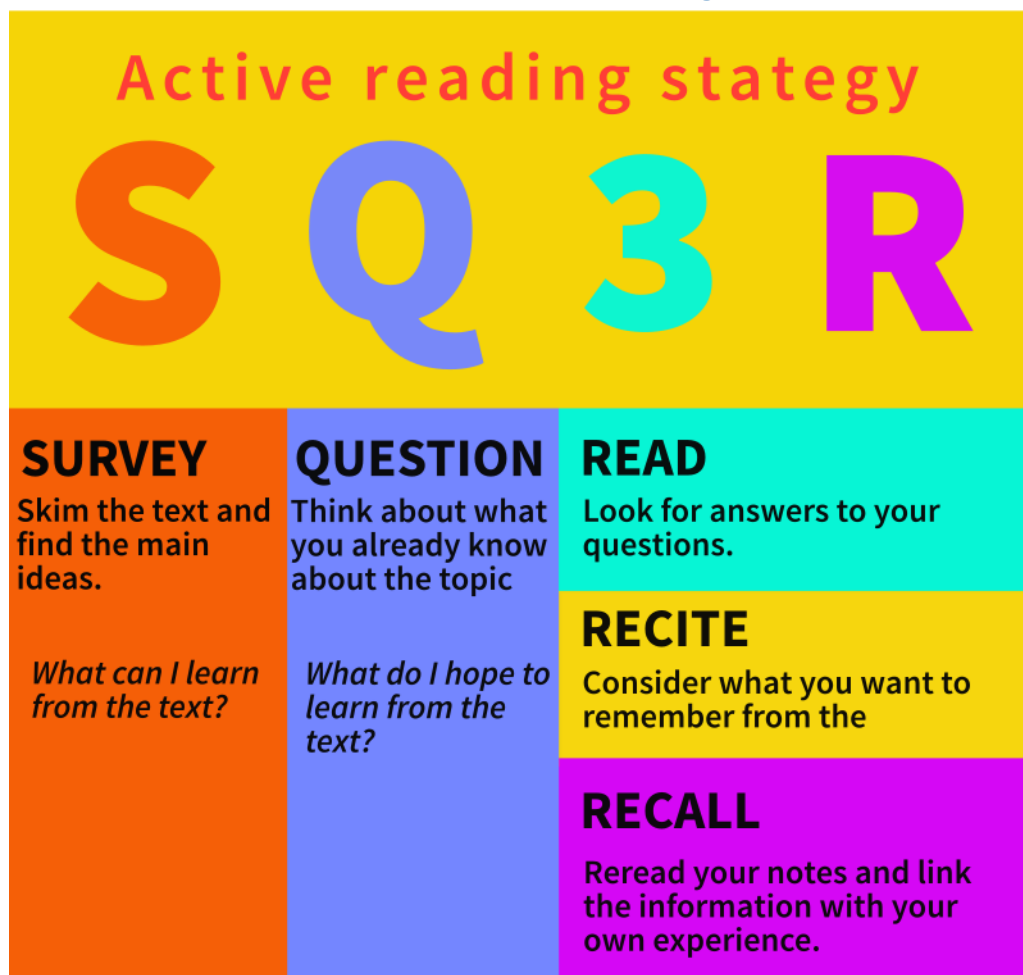
EVALUATE
Form an idea or judgement about the text.
■ *This is good/bad because...*
■ *I would have done _____ differently because...*
■ *I liked/didn't like the way the writer...*

SYNTHESIZE
Put the pieces together to see them in a new way.
■ *All these details lead me to believe...*
■ *Based on _____, the author wants me to think...*

GERÅRD AFLÅGUE COLLECTION Copyright 2018. All rights reserved. Proudly designed in the United States. Teacher approved.

¹ <https://help.open.ac.uk/active-reading>





2.3 EXTENSION Active Reading Advice

From: <https://mcgraw.princeton.edu/sites/mcgraw/files/media/active-reading-strategies.pdf>



Active Reading Strategies

Choose the strategies that work best for you or that best suit your purpose.

- **Ask yourself pre-reading questions.** For example: What is the topic, and what do you already know about it? Why has the instructor assigned this reading at this point in the semester?
- **Identify and define any unfamiliar terms.**
- **Bracket the main idea or thesis of the reading, and put an asterisk next to it.** Pay particular attention to the introduction or opening paragraphs to locate this information.
- **Put down your highlighter. Make marginal notes or comments instead.** Every time you feel the urge to highlight something, write instead. You can summarize the text, ask questions, give assent, protest vehemently. You can also write down key words to help you recall where important points are discussed. Above all, strive to enter into a dialogue with the author.



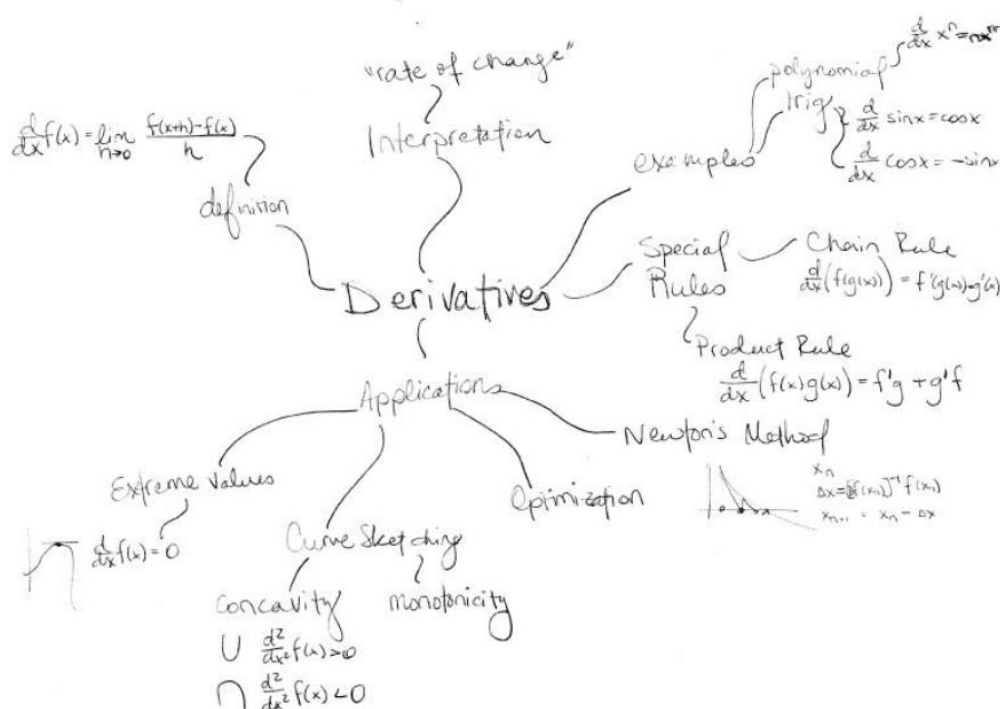
- **Write questions in the margins, and then answer the questions in a reading journal or on a separate piece of paper.** If you're reading a textbook, try changing all the titles, subtitles, sections and paragraph headings into questions. For example, the section heading "The Gas Laws of Boyle, Charles, and Avogadro" might become "What are the gas laws of Boyle, Charles, and Avogadro?"
- **Make outlines, flow charts, or diagrams that help you to map and to understand ideas visually.** See the reverse side for examples.
- **Read each paragraph carefully and then determine "what it says" and "what it does."** Answer "what it says" in only one sentence. Represent the main idea of the paragraph in your own words. To answer "what it does," describe the paragraph's purpose within the text, such as "provides evidence for the author's first main reason" or "introduces an opposing view."
- **Write a summary of an essay or chapter in your own words.** Do this in less than a page. Capture the essential ideas and perhaps one or two key examples. This approach offers a great way to be sure that you know what the reading really says or is about.
- **Write your own exam question based on the reading.**
- **Teach what you have learned to someone else!** Research clearly shows that teaching is one of the most effective ways to learn. If you try to explain aloud what you have been studying, (1) you'll transfer the information from short-term to long-term memory, and (2) you'll quickly discover what you understand — and what you don't.

See other side of page for sample diagrams →

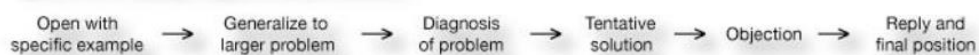
McGraw for Undergraduates: <https://mcgraw.princeton.edu/undergraduates>

©2016

Sample diagrams:



Sketch of a reading's argumentative structure:



2.4 How to get the most from your textbook

The best way to learn most efficiently is the most important thing that you will learn about yourself and about learning. To discover better ways of learning will need you to try them out. Hopefully you have already started to notice certain patterns in all textbooks, like the way they are set out. Normally one idea or concept is covered in either a single page or a double page spread, helping to break down a larger topic into smaller parts which are easier to manage. They will also have questions after idea has been explained which are designed to reinforce your learning and require you to think about the ideas and make use of what you have just learnt. This is a part of a process known as [Active Learning](#)². Solving past exam questions is another way to learn by activity. Also effective is teaching another student who is struggling with a particular part of the course.

[Active reading](#)³ requires you to really think about what you are reading and make notes, underline and reflect on the ideas. If you follow the instructions that follow when you are working through the textbook, especially if you are reading ahead of the classes (use the calendar and ask your teacher to find out which topic or Chapter is next)

2.4.1 Important points to note about the textbook

Like any textbook it will contain information that is relevant, but not always necessary for the topic it covers. For instance, some of the uses of chemicals it lists are accurate, they really are used in those processes, but they are not always included in mark schemes for CAIE iGCSE Chemistry, which in addition to valuing what is true, also requires from it's A* students what is most relevant. E.g. if you got hit by a car walking across the street there are lots of things that you might notice like it's colour, shape, size and the direction it was travelling, but really only it's speed would matter if you hoped to survive. Not all things that are accurate (close to being the "true"⁴ value) are equally relevant, and this exam board sometimes requires you to understand and list the most relevant factors, properties or characteristics first.

Activity	What you should do	Why it helps	When you should do it
FUNDAMENTAL 1. Translation	Translate ALL new words, especially the ones in bold , ideally next to the text. Use the glossary at the back to help you.	The most important words to translate are the non-scientific words you already know in Chinese.	As you are reading.
FUNDAMENTAL 2. Underlining	Underline, highlight circle , put a *star or symbol 😊 next to the biggest new ideas. But remember, if you highlight everything, you've actually highlighted nothing 😞.	Completing the in the Key Points task becomes quicker but most importantly, it is a form of ACTIVE READING.	As you are reading.
FUNDAMENTAL 3. Answers	Answer the Summary Questions about the material at the end of the double page spread.	Here you are shown what is most important about the ideas of this 2-page spread and forced to think about it in a new way.	After you have finished reading both pages
FUNDAMENTAL 4. Checking Answers	Check your answers with the answers provided at the end the textbook (pages 286 to 301)	Any major misunderstandings or confusions you have are likely to be discovered doing this.	After you've finished your answers
ESSENTIAL 5. Key Points	Main ideas, equations and diagrams for both pages. It's the idea that you are trying to describe to your self, so try to make it as visual and colourful as possible! Make sure whatever you write is in your own words!!! Include any notes you have from lessons here!	At this point you are now starting to own the information you are processing. This task will force your brain to think about what is most important because space is limited and writing is work. After you have thought about it in a new way, you'll need to remember your thoughts long enough to write them out, helping your long-term memory. This will also help to write out better que questions.	After you have finished the going through the questions and answers, but before you start the next two pages.

² <https://teachingcommons.stanford.edu/resources/learning-resources/promoting-active-learning> & <https://www.smartsparrow.com/what-is-active-learning/>

³ <https://help.open.ac.uk/active-reading>

⁴



Activity	What you should do	Why it helps	When you should do it
ESSENTIAL 6. Cue Questions v1.0	Write out, in your own words, questions and bullet points that will force you to think about the essential ideas. Links to other parts of the topic and syllabus should also be included (e.g. half-equations are also covered in Topic 5 (Electrochemistry), so a note like: T5 $2\text{Cl}^-(\text{aq}) \rightarrow \text{Cl}_2(\text{g}) + 2\text{e}^-$ [conc only!] Might be a good idea if you've missed a mark on this before.	If you covered up the notes section of the page, answering these questions should allow you revise the whole page simply by answering a few questions and thinking about a few core ideas. If this is done carefully and thoughtfully not only will it make revision quicker later on, but also because it helps long term memories form, it'll mean less revision is needed to get the highest grade.	After you've finished the next 2-page spread.
ESSENTIAL 7. Summary	Write one or two sentences, in your own words that contain only the most important ideas.	Another way of thinking about it is: what's the least useful or important 80% content here? Give a thoughtful person 2 tasks and the first thing they'll do is create a third task which they'll do first and prioritize which of the two is most important.	After you've finished the section
EXCEPTIONAL 8. Cue Questions v2.0	Write out, in a different colour, or in any other way to identify it, any new questions or details that you've discovered are important to getting full marks on questions assessing material covered in this 2 page spread. After you've worked on the past exam questions you should understand this section as well as the quality of the work you have put in deserves. You should also know in detail which marks are the hardest and this information needs to go into your Cue section so the work you've put in to discover this information isn't abandoned or forgotten.	The tricky marks and the slippery explanations (especially that 2 nd or 3 rd mark) are most obvious now, but unless you make a decent effort to write them down, not only will you have lost the value of the work you have done because you'll be less likely to remember them, you'll also have no record to use later on. This is essentially saving your hard work for later when you'll need it most.	After you've finished the past exam questions
EXCEPTIONAL 9. Top tips	Any new tough mark or detail that you have overlooked.	This level of attention to detail will help you become a person who is far less likely to make a mistake, but if you do, is far more likely to learn from it. It's your capacity to learn effectively and efficiently that will get you into a good university in the short term; in the long term it will allow you to do more interesting things with your work and your life.	Any time after you've finished the topic, but before the iGCSE exam



2.5 EXTENSION Examples of active reading

Feel free to tape additional pieces of paper onto the edges of your textbook to increase the space you have for making additional notes while you are reading. Another option is to digitise your textbook as has been done below.

A6 (&A8). Cue questions

Fill this in AFTER finishing the section

Alkali metals are metals with low densities, melting and boiling points, and all with very high reactivity. They are generally soft and can be cut with a knife to reveal a silvery white section.

13.5 Thermal decomposition

LEARNING OUTCOMES

- Describe the action of heat on selected hydroxides and nitrates
- Link the thermal decomposition of nitrates to the reactivity of the metals



Nitrates can decompose explosively to cause a large amount of damage, as shown by the remains of this fertiliser factory.

Activities To Do

(complete as you are reading)

A1. Translating - 翻译

A2. Underlining

A5. Key Points

(in space below)

EXAMINER SAYS...

You need to remember the products from the thermal decomposition of nitrates. If you don't know these, you won't be able to write equations for thermal decomposition.

When we heat some carbonates, nitrates and hydroxides, they break down to form two or more different products. We call this type of reaction **thermal decomposition**. For example, the equation:



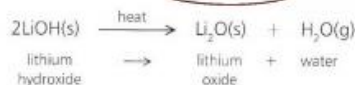
represents the thermal decomposition of calcium carbonate.

Thermal decomposition of metal hydroxides

Most metal hydroxides decompose when heated. A metal oxide and water are formed. For example:



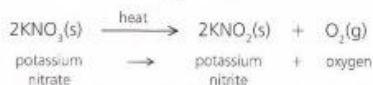
All Group II hydroxides decompose in a similar way. Most alkali metal hydroxides, however, do not decompose. They are stable to heat. There is one exception to this: lithium hydroxide.



Lithium is the least reactive of the alkali metals. So does thermal decomposition depend on the reactivity of the metal? We shall look at the decomposition of nitrates and carbonates to answer this question.

Thermal decomposition of nitrates

All nitrates decompose when heated. But there are some differences in how they decompose. The alkali metal nitrates decompose to form a nitrite and oxygen. You can see that the nitrite ion is similar to the nitrate ion but has one fewer oxygen atom:



Nitrates of other metals decompose on heating to form an oxide, nitrogen dioxide and oxygen. For example:



Lithium nitrate, a compound of the least reactive alkali metal, decomposes in this way too.

- ★ Thermal decomposition means the breakdown of a compound into two or more different products by heat.
- ★ The more reactive the metal, the more stable its nitrate, hydroxide or carbonate
- ★ Metal hydroxides decompose to oxides and water
- ★ Most nitrates decompose to either nitrites and oxygen or to oxides, nitrogen dioxide and oxygen.
- ★ We could observe how long does the compound need to

A7. Summary Section- Do this after you have answered the past exam questions and write, in your own words, only one or two sentences that sums up the important points on this page

The more reactive the metal, the more stable its nitrate, carbonate or hydroxide is.



A6 (&A8). Cue questions part 2

Fill this in AFTER finishing the section

When alkali metal hydroxide is heated strongly, it will melt, but not nothing.

When metal nitrate (except alkali metal) is heated.

Brown gas will form. (NO₂)

When copper nitrate is heated, blue solid will turn into black, and brown gas will form.

Nitrates of very unreactive metals, such as silver, decompose to form the metal when they are heated:



DEMONSTRATION

The decomposition of Group II nitrates

This experiment is demonstrated using a fume cupboard because nitrogen dioxide is poisonous.

We start a stopwatch when we begin to heat the magnesium nitrate. The nitrate is heated until we see dark brown fumes of nitrogen dioxide in the tube. We record the time taken to see these fumes. Then we repeat the experiment using other nitrates. In this experiment we must keep the amount of nitrate and the rate of heating the same.

The longer it takes for the nitrate to decompose, the more stable the nitrate is.



Figure 13.5.1

Magnesium nitrate decomposes at 402 °C but barium nitrate decomposes at 865 °C. So it appears that barium nitrate is more stable than magnesium nitrate. Barium is more reactive than magnesium. So the more reactive the metal, the more stable to thermal decomposition its compound is. This is well demonstrated if we look at the temperatures at which carbonates decompose when heated.

Thermal decomposition of carbonates

The table shows the temperatures at which the Group II carbonates decompose.

Group II carbonate	Reactivity →			
	magnesium carbonate	calcium carbonate	strontium carbonate	barium carbonate
decomposition temperature/°C	540	900	1280	1360

The reactivity of the Group II metals increases down the group. You can see from the table that as you go down the group it gets more difficult to decompose the carbonates. So the more reactive the metal, the more stable its nitrate, carbonate or hydroxide is.

KEY POINTS

- 1 Thermal decomposition is the breakdown of a compound into two or more different products by heat.
- 2 The more reactive the metal, the more stable its nitrate, hydroxide or carbonate.
- 3 Metal hydroxides decompose to oxides and water when heated.
- 4 Most nitrates decompose to either nitrites and oxygen or to oxides, nitrogen dioxide and oxygen when heated.

SUMMARY QUESTIONS

- 1 Copy and complete using the words below:

alkali, dioxide, heated, less, nitrite, oxygen

Nitrates of the _____ metals decompose when _____ to form the metal _____ and oxygen. Nitrates of _____ reactive metals form metal oxides, nitrogen _____ and _____ when heated.

- 2 Write equations for the thermal decomposition of:
 - a copper(II) hydroxide, Cu(OH)₂
 - b calcium nitrate, Ca(NO₃)₂
- 3 Suggest why lithium nitrate decomposes in a similar way to a Group II nitrate rather than a Group I nitrate.

A3. Answers to Summary Questions (& Activity 4 Checking answers)

1. alkali, heated, nitrite, less, dioxide, oxygen ✓

2. a) Cu(OH)₂ → CuO + H₂O ✓

b) 2Ca(NO₃)₂ → 2CaO + 4NO₂ + O₂ ✓

3. Because it's the least reactive reactive alkali metal. X
Lithium has a much smaller ion than the other group I metals so has a higher charge density. The charge density

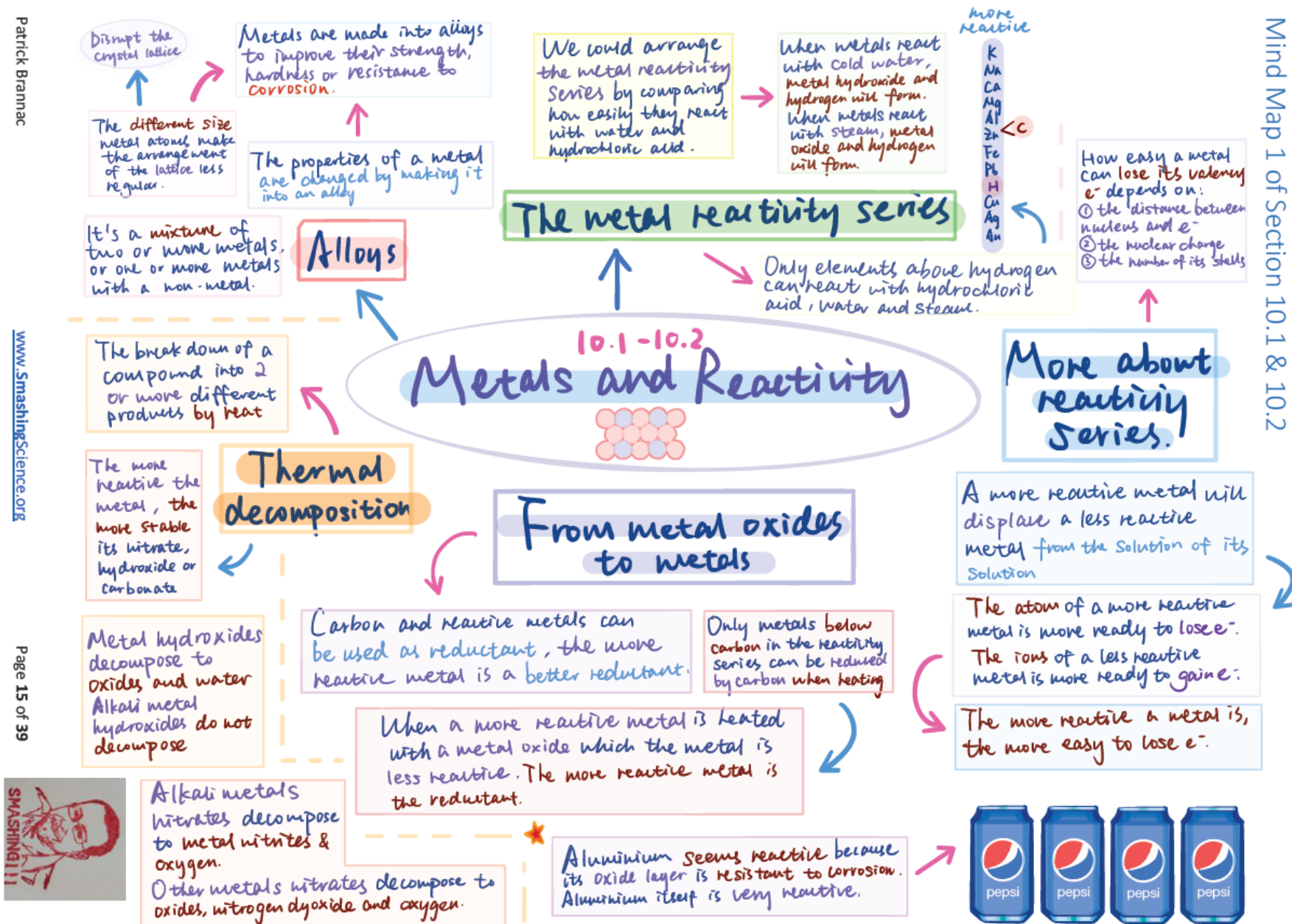
A9 Top Tips - Do this after you've taken the end of topic test. Write any difficult, odd or unexpected marks you come across from your tests and revision and especially from working through past exam questions

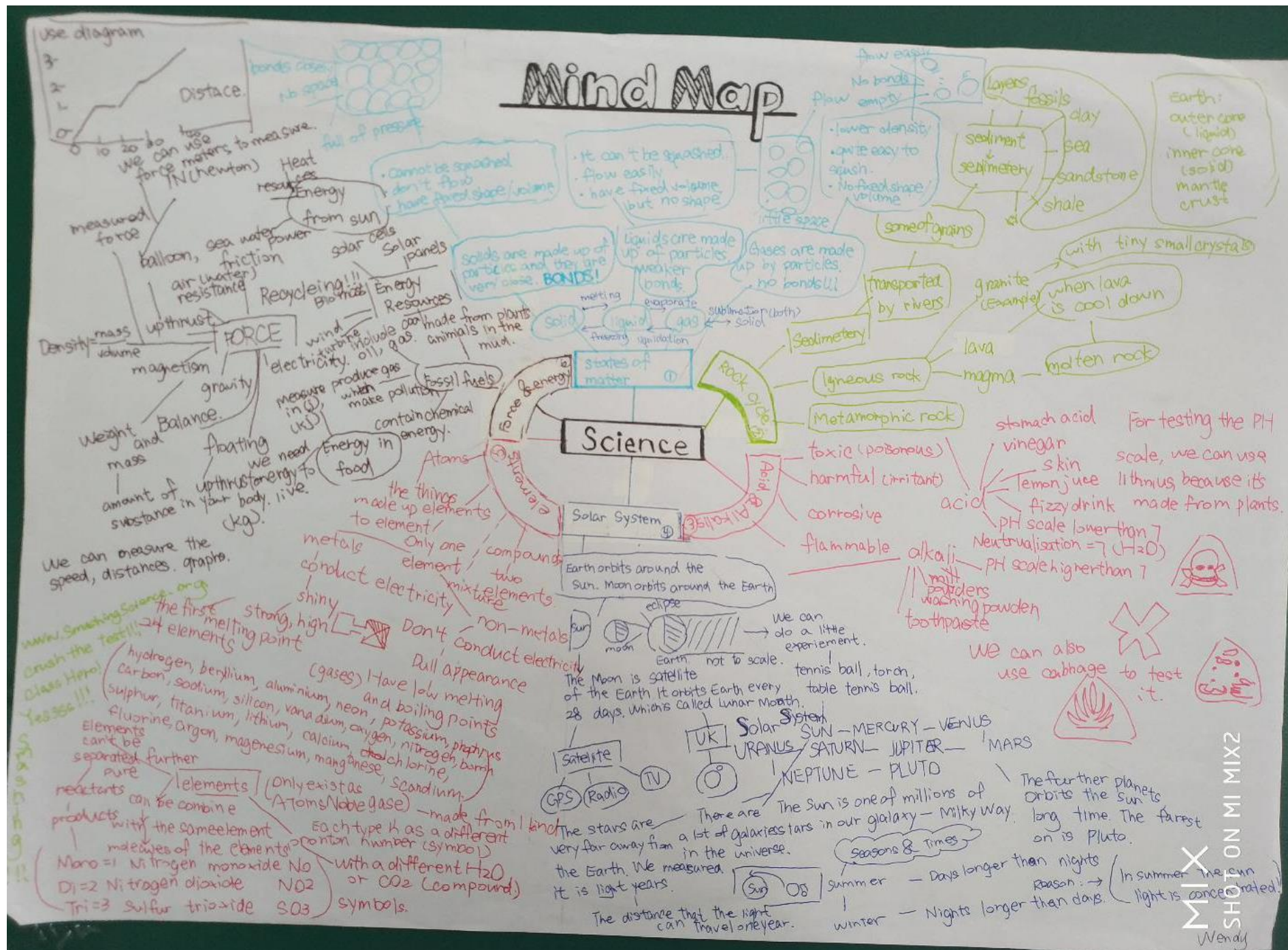
★ Only alkali metal nitrates decomposed to form metal nitrites and oxygen. Other metals don't.

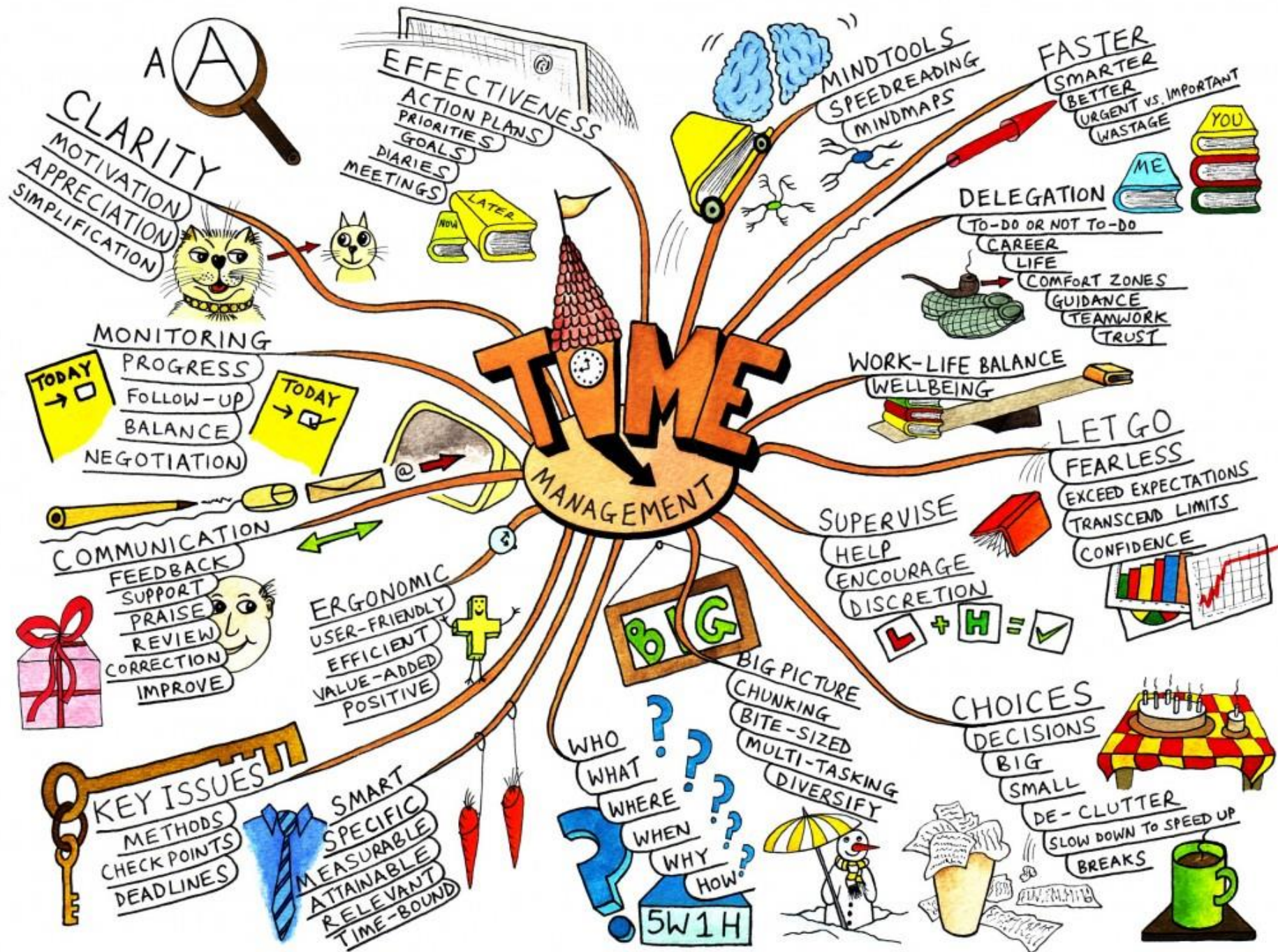
★ Most of the alkali metal hydroxide (except LiOH) don't decompose.

is more similar to those of group II metals









TOPIC 1

ATOMIC STRUCTURE AND THE PERIODIC TABLE

Atom radius = 0.1 nm or 1×10^{-10} m

NUCLEUS
in middle of atom, radius = 1×10^{-14} m, positively charged, where mass of atom is concentrated

1869 ← Periodic table
ordered mostly by A_r , but some by properties

1897 form columns
Elements with similar properties

1909 → Bohr: fixed electron shells

NUCLEAR MODEL!

more reactive & more energy released
metal hydroxides hydrogen gas

WATER
forms metal oxide & water

OXYGEN
forms metal oxide

CHLORINE
white metal chloride salts

DIFFERENT properties of compound
increasing A_r highest BP

Flammable → non-flammable gases (noble gases)

all inert, colourless
gases (noble gases)

Cl₂ gas
solution of potassium iodide if salt decomposes when heated: iodine forming in solution

More reactive halogens will displace less reactive ones

Crystallisation > Evaporation
separate solutions

Simple distillation
"methane to hydrogen → carbon dioxide + water"

Chemical equation:
mass number - atomic # = neutrons

Compounds = neutrons
2 of more ele.

Particle table:

Particle	r mass	r charge
P	1	+1
N	1	0
E	tiny	-1

Chadwick proved for neutral particles in the nucleus

Chromatography:
Pencil line 1cm from bottom of chromatography paper filter paper. Add small spot of ink (0.5cm²) to line and add solvent to beaker of solvent (water or ethanol). Ink must touch solvent or it will dissolve into it.

High BP
1 spot per dye in ink

Insoluble stays on baseline

Near top → leave to dry

SOLUBLE = goes HIGHER

end result = chromatogram

John Dalton: solid spheres 19th C → JJ Thomson: Plum Pudding model (electrons) →

VERY reactive, soft with low density
1e⁻ in outer shell

Fr lowest BP + MP
Fr most reactive

conductors
not gas

more brittle
nonmetals

metals
good conductors

metals
strong + hard than T-metals, lower BP

fractional distillation
different boiling points

increasing A_r
highest BP

Flammable → non-flammable gases (noble gases)

all inert, colourless
gases (noble gases)

Cl₂ gas
solution of potassium iodide if salt decomposes when heated: iodine forming in solution

More reactive halogens will displace less reactive ones

Crystallisation > Evaporation
separate solutions

Simple distillation
"methane to hydrogen → carbon dioxide + water"

Chemical equation:
mass number - atomic # = neutrons

Compounds = neutrons
2 of more ele.

Particle table:

Particle	r mass	r charge
P	1	+1
N	1	0
E	tiny	-1

Chadwick proved for neutral particles in the nucleus

2.7 FUNDAMENTAL Glossary of Quizlet Library of Weblinks

. If you are struggling with the vocabulary and English in this course here's a whole library of resources including games, puzzles and tests that are based on the Quizlet website that will help you get up to speed with the keywords.

Note: Words from Topic 1 and 2 are combined and found in Topic 1. The same is also true for words from 12 and 13 which are both in Topic 13.

Topic Quizlet word list hyperlink

1. English word to English definition: https://quizlet.com/_4lta54
English word & translation to Chinese google translate https://quizlet.com/_4ltg2p
2. **This topics word list is grouped with topic 1**
3. English word to English definition: https://quizlet.com/_4ltaf5
English word & translation to Chinese google translate https://quizlet.com/_4ltgdp
4. English word to English definition: https://quizlet.com/_4ltdjc
English word & translation to Chinese google translate https://quizlet.com/_4ltggk
5. English word to English definition: https://quizlet.com/_4ltdnw
English word & translation to Chinese google translate https://quizlet.com/_4ltgl9
6. English word to English definition: https://quizlet.com/_4ltdgg
English word & translation to Chinese google translate https://quizlet.com/_4ltgnd
7. English word to English definition: https://quizlet.com/_4lteab
English word & translation to Chinese google translate https://quizlet.com/_4ltgph
8. English word to English definition: https://quizlet.com/_4ltede
English word & translation to Chinese google translate https://quizlet.com/_4ltgr8
9. English word to English definition: https://quizlet.com/_4ltejh
English word & translation to Chinese google translate https://quizlet.com/_4ltgsv
10. English word to English definition: https://quizlet.com/_4ltem0
English word & translation to Chinese google translate https://quizlet.com/_4ltgux
11. English word to English definition: https://quizlet.com/_4lteoy
English word & translation to Chinese google translate https://quizlet.com/_4ltgwq
12. **This topics word list is grouped with topic 13**
13. English word to English definition: https://quizlet.com/_4lterb
English word & translation to Chinese google translate https://quizlet.com/_4ltgy5
14. English word to English definition: https://quizlet.com/_4lt3b5
English word & translation to Chinese google translate https://quizlet.com/_4lth0u

All my English to Chinese by topic word lists:

https://quizlet.com/Patrick_Brannac4/folders/igcse-chemistry-cie-0620-glossary



All my English keyword to English meaning by topic word lists:

https://quizlet.com/Patrick_Brannac4/folders/igcse-chemistry-cie-0620-glossary-english-words-by-topic



3 The Cornell Note-Taking System

3.1 Introduction

The main task your brain does is forgetting things. It is constantly, quietly and relentlessly erasing everything you see, hear and feel during both your conscious and unconscious (e.g. whilst sleeping) sense of being, including the single moment it takes for you look at this next full stop.

But if you have ever fallen off a bike or had an accident your brain stops deleting everything and instead stores as much of the information as it is able. Time slows down and your memory becomes almost photographic. Some things are therefore more memorable than others. The trick with learning is to make your brain think that what you are trying to learn matters to your brain.

It is designed to only remember the things that it is programmed to think are important. It's programming comes from culture, but some is also hard-wired into the system itself, like our shared interest in learning a language when we are babies, or our ability to process visual images or our ability to control our body temperature. This hard wiring is created by our genes, which we inherit from our parents. Our genes were created and adapted to survive and persist tens of thousands of years ago in a totally different world to the one your brain finds itself in a classroom.

Current understanding of the human brain is extremely basic, no-one knows what the smallest part of an idea might be in terms of brain cells. But we do know that brain cells make connections and we think that those connections are where the mind, and memory, is created. We also know that the brain is more likely to make connections, and therefore memories, from events we are emotionally attached to, like an accident or a totally awesome movie. If we feel emotions about something, either good or bad, than our brain thinks that thing is something it needs to keep for later.

If you keep returning to the same idea over time, but you make your brain think about it differently, for instance by taking notes using your own words, or making a summary, or writing out key questions raised by that idea, forces it to make new connections in order to enable this different kind of thinking. Not only will the brain be better able to use this new idea in a new situation, like in an exam, but these connections make the memory more stable. If the brain really thinks something is important, like your name or where you live, it will store these essential bits of information into what is called the Long Term Memory.

The goal of learning is not only to make as many interesting and important connections within the brain as possible, but also to put as much information into the long term storage area as possible. The goal of education, especially in the better universities is not fill a student's brain with specific facts and ideas, or to test how intelligent someone is, but to train a students brain with skills and techniques to learn faster, better and longer. The more you know, for instance about the Avengers and the MCU, the more interesting and exciting watching Avengers Endgame for the first time was as a movie. But it was still kinda disappointing, unfortunately.

Learning how to learn better than before is the most valuable and important thing you will take away from any lesson. Luckily, you are not the first person to ever be taught. There are thousands of years of history and tens of thousands of years of culture that you can use to your advantage. Some systems of learning work better than others.

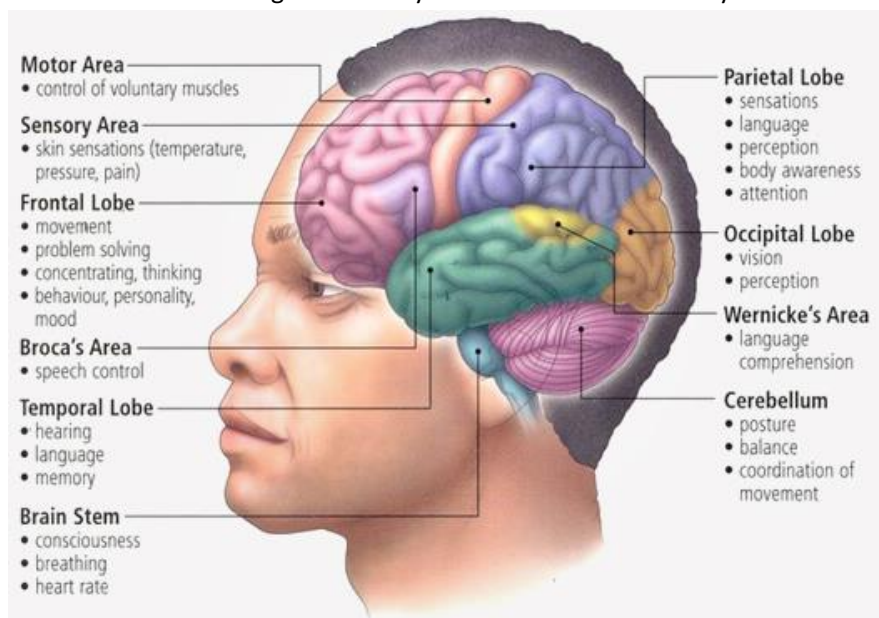


Figure 1 The brain as a biological organ



In the 1940s a professor of law at Cornell University called Walter Pauk realised his students, who were supposed to be some of the best of their generation, weren't that good and he wondered what they could do to learn better. He invented the Cornell Notetaking system, which is widely considered to be the best way to learn difficult things in any subject.

If you imagine using this system gives you a token that allows you to have to revise less later. If you follow this system properly, that token has tremendous value and will not only allow you to aim for the highest grade, but allow you to do so with much less stress, challenge and negativity that often surrounds big exams for disorganised students. You are effectively being kinder to your future self by putting the work in earlier when it matters more. If you skip this, and just wait until the end of year exam you'll more likely be learning instead of revising, which takes much longer and produces much poorer results. Even if you end up with the exact same grade, you'll have failed to progress as a student, and that lack of progress eventually, maybe not even at A Level, but at a world leading university, will cause all kinds of calamities and challenges. You may even be so disappointed in how little you learnt about learning that you decide to become a teacher. It happens.

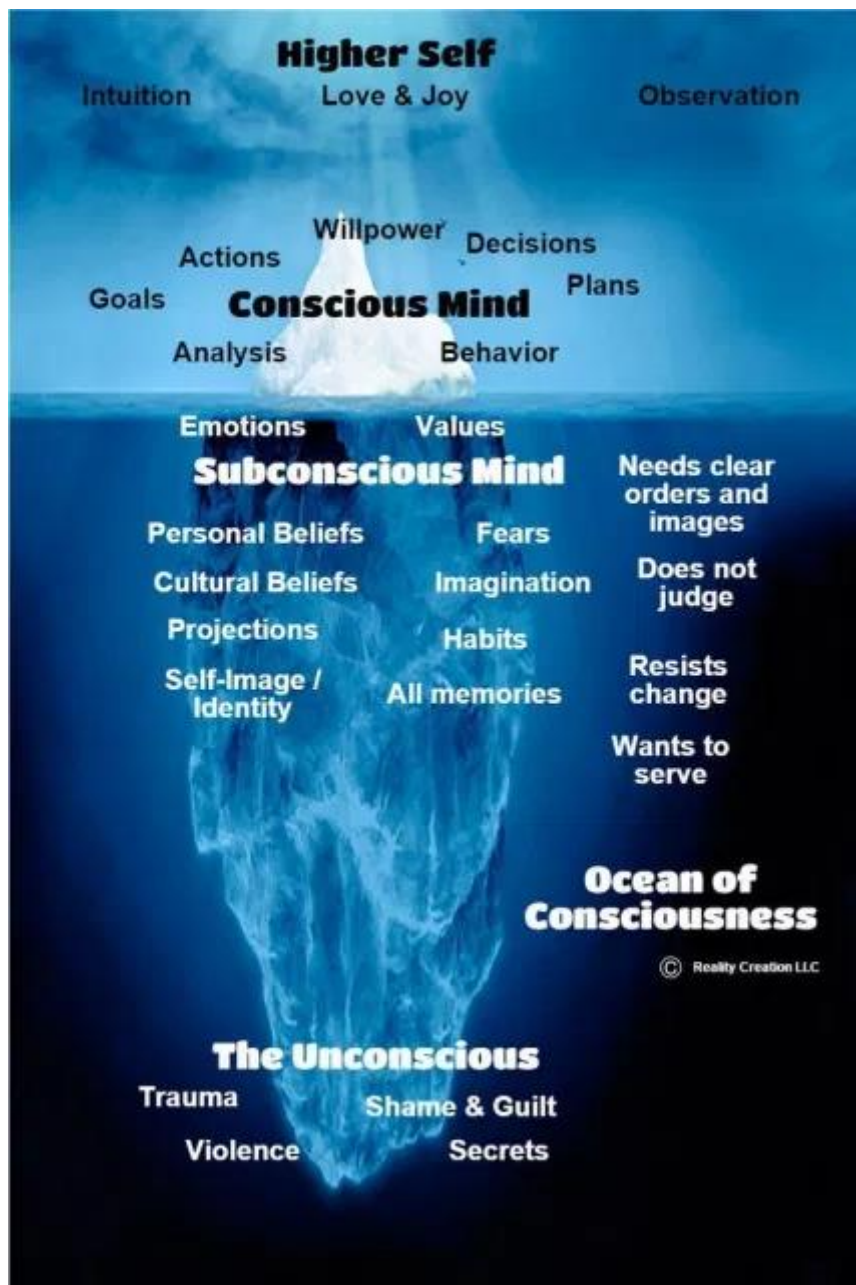
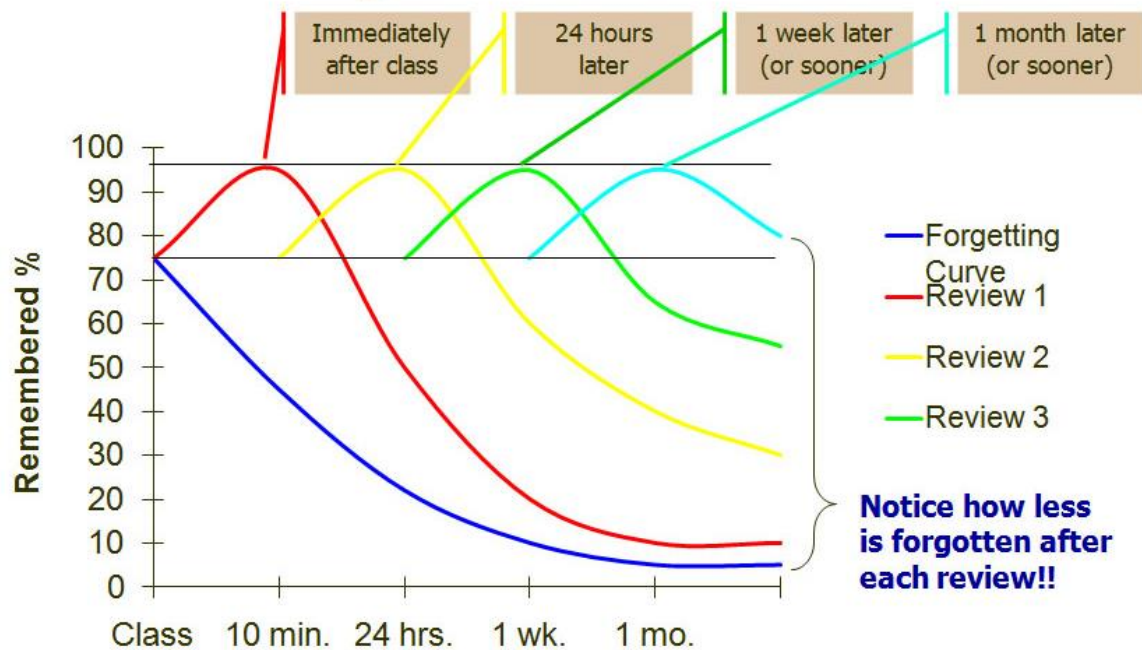


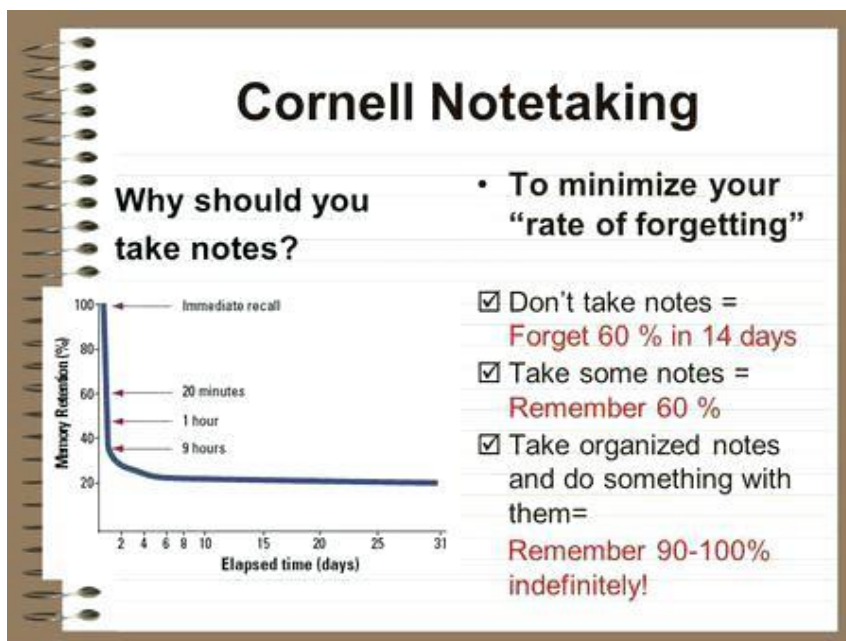
Figure 2 One way of thinking about the mind. Most of it involves aspects of the self that are hard to understand and even harder to change, but with enough work it is possible for anyone to nurture and grow the habits of an outstanding student, but it takes time and especially commitment.



Overcoming the Curve



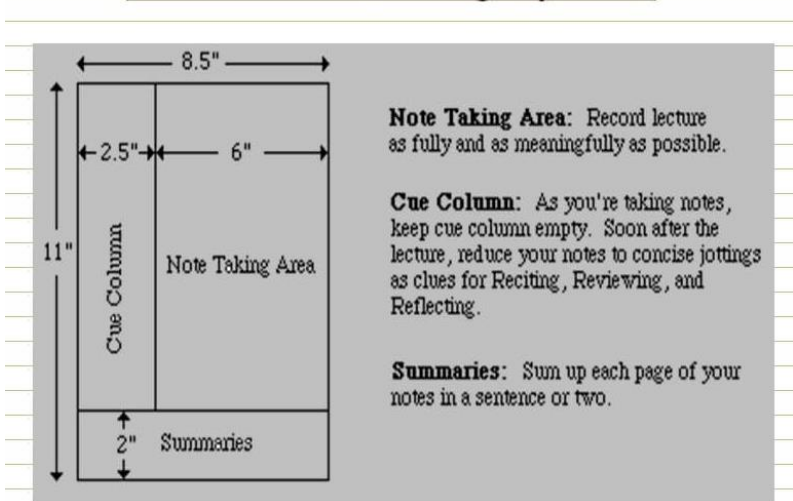
<https://psychology.stackexchange.com/questions/8377/how-are-these-review-forgetting-curve-calculated>



The quicker you return to a lesson to review it, the less time you will need to gently nudge it into your long term memory, so 5 minutes within 24 hours can be as effective as an hour or more a month later. Remember, your brain does not understand what you are trying to do, but if you try to work with it, and help it along, remind it that this stuff matters to you (and it), it will be more likely respond in the way that you want and learn what you need it to.



Cornell Note-taking System



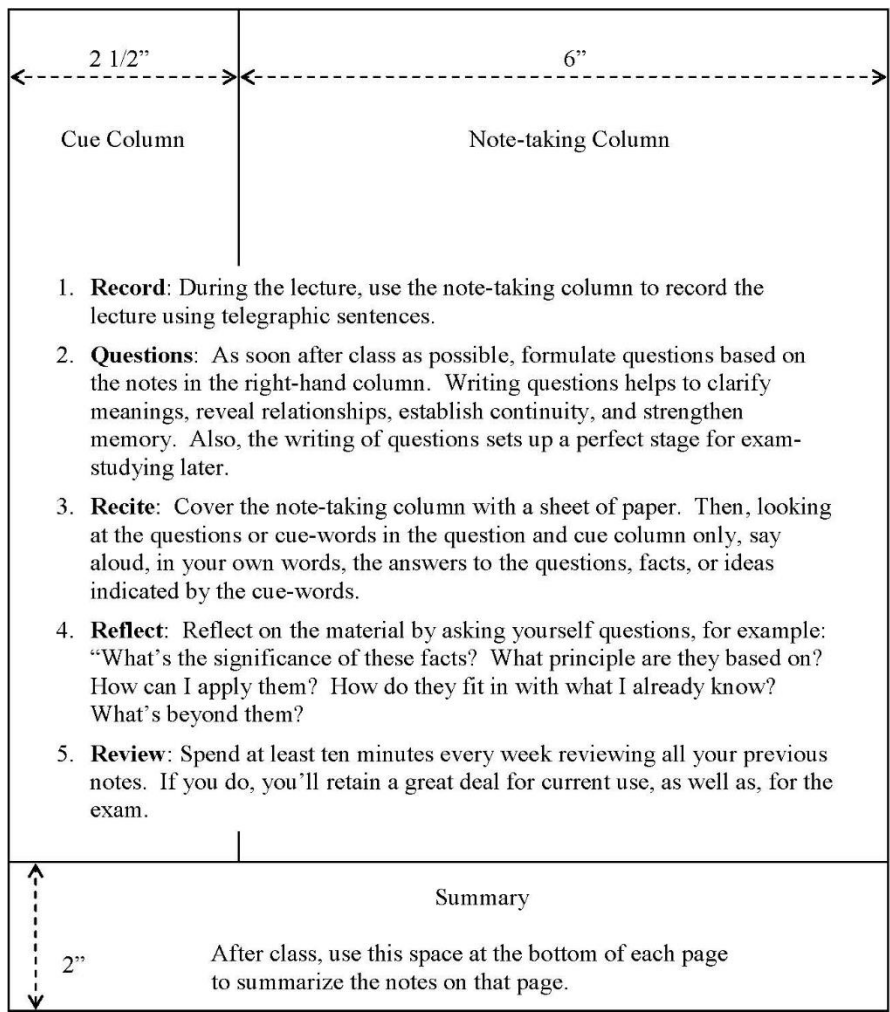
3.3.1 Essential Cornell Notetaking for More Able Students



Cornell University
Learning Strategies Center

420 CCC
Garden Ave Extension
Ithaca, New York 14853-4203
t. 607.255.6310
f. 607.255.1562
www.lsc.cornell.edu

The Cornell Note-taking System



2.5"

CORNELL NOTE TAKING

CUE COLUMN

This section is to be completed after the lesson/lecture, and should include key words or phrases as well as vocabulary, people or case studies you may need to research, and potential exam questions. I guess you could say this column is for the

WHAT'S
WHO'S
WHEN'S and
WHERE'S

6"

Name, Date, Subject, Topic...

NOTE TAKING COLUMN

This section of your page is dedicated to lesson time and in class note taking. You might want to include:

- Main points and lesson objectives
- Diagrams, graph sketches, drawings or charts
- Bullet points/numbered processes
- Concise sentences
- Shorthand symbols/paraphrases/abbreviations

Also, try to leave lines between points so you can go back in and add any brief notes you may have missed. This extra space will also give you a sense of clarity.

You don't have to use a ruled line version- try one with a blank note taking section to experiment with mindmaps, tables or whatever takes your fancy - make it personal to you.

You might say this column is for the **WHY'S** and **HOW'S** with some of these guys thrown in.

←

ALSO
If you really run out of space, add a post-it, but do try to summarise on just one page!

↑

2"

↓

SUMMARY SECTION

This section should be written last, after class. It should also only really contain a basic, condensed summary of your notes in the Cue column, and important details of your main notes. It is used to quickly find & digest info later.

3.5 Exceptional Cornell Notetaking for the Best Students

The advice and ideas here are not needed for most students but include further ideas that can help develop your notetaking skills, which is at the heart of the most successful students (and intellectuals).

The Five R's:

1. **RECORD** your notes in the right-hand column.
2. **REDUCE** your notes into the recall column on the left
3. **RECITE** out loud from the recall column.
4. **REFLECT** on the information that you are studying.
5. **REVIEW** your notes immediately and regularly

Topic:	Name:	Date:
	Class:	Period:
Step 2: Cues (Reduce) When: During class but after the lecture, activity or discussion What: Reduce learning to the essential facts & ideas How (make lists): • Facts • Key ideas • Important words • Pivotal phrases • Questions Why: Students can not recall everything and need to filter out the most important ideas, concepts and questions.	Step 1: Notes (Record) When: During class lecture, discussion or activity What: Record as many facts and ideas from the lesson as possible How: • Bullets, phrases and pictures • Avoid sentences and paragraphs • develop abbreviations and symbols • leave space between points to add information later Why: Students need to record the learning in a method that is meaningful to them before they can do anything with it.	
Step 3: Summary (Reflect & Review) When: At the end of class, after class for homework or as a warmup at the start of the next class What: Synthesis that reviews and summarizes the main ideas from the lesson How (in complete sentences, answer questions such as the following): • "Why is this information important?" • "What conclusions can I make from this information?" • "How can this information be applied?" Why: Summarizing and reviewing information after it is learned is one of the best research based strategies for ensuring long term retention of any content or skill.		

Step 1: Record

Write main ideas and supporting material in the right column

Use signals from the lecture

Titles & keywords= topics

main ideas

Use abbreviations to get the full idea.

Leave spaces between ideas so you can fill in more later. see how ideas relate to one another

Step 2: Reduce

Write the topics and vocabulary words, in the left column of your notes Write questions to quiz yourself on the material.

–Write a question for each new topic, main idea, or significant detail.

–Write questions on the material which you think your teacher will test you.

Step 3: Recite

This will help transfer ideas to your long-term memory!

Study the information by answering your questions in the left column.

–Cover the Record Column.



- Read your vocabulary words and questions in the left Column
- Using your own words, define the words and answer your questions out loud.
- You can also define the words and answer your questions on the paper you are using to cover the Record Column.
- Uncover your notes and check what you have said against the facts.

Step 4: Reflect

After the lecture, write a summary at the bottom of your notes.

- Use complete sentences in the summary.
- Choose the key points.
- Organize ideas.
- Link ideas together.

Step 5: Review

Improve your memory.

–If you spend 10 minutes after every class in a quick review of your notes, you will retain most of what you have studied you won't have to cram during an "all-nighter" you will relate the facts and ideas to present lectures or readings.

3.6 Essential Note-Taking Tips and Examples

Develop a code system of note-marking to indicate questions, comments, important points ...for example,

- Mark unfamiliar vocabulary & unclear ideas in unique ways, such as with a star or asterisk.
- Highlight vocabulary terms and important people.
- Circle ideas that are still unclear.
- Make sure you can understand what you have written and if needed, make corrections.
- Use drawings, arrows or other organizers to help you see concepts and relationships between them.
- Use abbreviations and symbols wherever possible in the notes portion (but try to keep your abbreviations simple to understand, if you forget later your system then your notes lose their meaning)
- If you completely don't understand an idea, leave a blank space and ask your teacher for help on

For a more detailed and involved exploration and explanation of notetaking download document attached to this QR code (30 pages):



How To Illustrate

Your Notes

By Revise or Die

YOU CAN DO IT!

YES. I CAN DO IT!

IT'S ALL ABOUT PIC N' MIX Y'KNOW

① CHOOSE YOUR 'BAG'... (TYPE OF NOTES)

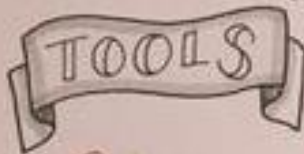
MINDMAP? POSTER? THE CORNELL METHOD?
THE OUTLINING METHOD? THE CHARTING METHOD?



② CHOOSE YOUR 'SCOOP'... (FONTS/TOOLS/COLOURS)



{ THERE are SO **MANY** kinds
(O)F **FONTS** TO choose FROM }
to find inspo go to dafont.com!



PENS

BIRD

FINELINER

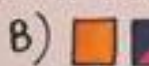
PENCILS

GEL

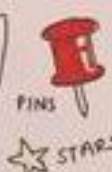
FELT TIP

HIGHLIGHTER

Colours - if you're feeling really snazzy, choose a colour palette for your work! Here's some suggested ones I use...



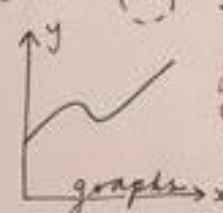
③ CHOOSE YOUR 'SWEETS'... (TWIDDLY BITS)



DASHED LINES

STARS

ARROWS...



+ anything specific to the subject - don't be afraid to draw it!

how i write outlines//take notes

ROMAN NUMERAL METHOD: (outline)

required
format by
my bio
teacher

I. Main Topic

A. Section Name (pg. #)

I usually
jot notes
down in
the
margins

1. } Important facts,
 2. } concepts,
 3. } examples, etc.
 4. }
 5. }
- and so on...

B. Section Name (pg. #)

Highlight
key points/
definitions/
things the
teacher
goes over

1. Important fact/concept/etc.
 - a. Expansion/going into details
2. Important fact/concept/etc.
 - a. Expansion, details,
 - b. } more examples, etc.
 - c. }

II. Main Topic

and so on...

EXAMPLE

I. Energy and the Cell

A. Cells transform energy as they perform work (pg. 80)

1. Energy is the capacity to cause change or to perform work. The 2 types of energy are kinetic and potential.

a. Kinetic energy is the energy of motion. Moving objects transfer motion to other matter. Heat is a type of kinetic energy associated with the random movement of atoms/electrons.

measured
in temp

b. Potential energy is energy that is a result of its location or structure. Chemical energy is the potential energy available for release in a chemical reaction.

potential to
be kinetic
energy

MY USUAL OUTLINE METHOD:

[Section #] Section Name

→ summary from textbook

Heading

{MAIN IDEA}

- info (important dates/ events/ people/ concepts/etc.)

SUBHEADING

- info
- event
- ↳ effect

- info
- (Ex.) examples

I usually write
the headings
and subheadings
in a different
color

EXAMPLE

[Section 1] The Road to World War I

→ 1914, summer: Crisis in the Balkans led to conflict when a Serbian terrorist assassinated Archduke Francis Ferdinand...

Causes of the War

{MAIN IDEA} Nationalism, militarism, and a system of alliances contributed to the start of World War I.

- system of nation-states that were formed led to competition

NATIONALISM AND ALLIANCES

- Europe's greatest powers were divided into 2 alliances: the ~~Triples Alliance~~ (1882) AND the ~~Triples Alliance~~ (1907)

- Germany
- Austria-Hungary
- Italy

- France
- Great Britain
- Russia



3.7 Cornell Notetaking Note Paper

Questions & Translations

Fill this in AFTER lesson

Date:

Summary Section- Do this a week later and write, in your own words, only one or two sentences that sums up the important points on this page



Questions & Translations*Fill this in AFTER lesson***Date:**

Summary Section- Do this a week later and write, in your own words, only one or two sentences that sums up the important points on this page



Questions & Translations*Fill this in AFTER lesson***Date:**

Summary Section- Do this a week later and write, in your own words, only one or two sentences that sums up the important points on this page



Questions & Translations

Fill this in AFTER lesson

Date:

Summary Section- Do this a week later and write, in your own words, only one or two sentences that sums up the important points on this page



Questions & Translations*Fill this in AFTER lesson***Date:**

Summary Section- Do this a week later and write, in your own words, only one or two sentences that sums up the important points on this page



Questions & Translations

Fill this in AFTER lesson

Date:

Questions & Translations*Fill this in AFTER lesson***Date:**

Questions & Translations

Fill this in AFTER lesson

Date:



Date:

[illegible]

Questions & Translations*Fill this in AFTER lesson***Date:**

Questions & Translations

Fill this in AFTER lesson

[illegible]

Date:

[illegible]

Questions & Translations*Fill this in AFTER lesson***Date:**

Summary Section- Do this a week later and write, in your own words, only one or two sentences that sums up the important points on this page



Date:

[illegible]

Questions & Translations*Fill this in AFTER lesson***Date:**

Summary Section- Do this a week later and write, in your own words, only one or two sentences that sums up the important points on this page



Questions & Translations*Fill this in AFTER lesson***Date:**

Summary Section- Do this a week later and write, in your own words, only one or two sentences that sums up the important points on this page



Questions & Translations

Fill this in AFTER lesson

Date:

Summary Section- Do this a week later and write, in your own words, only one or two sentences that sums up the important points on this page



Questions & Translations*Fill this in AFTER lesson***Date:**

Summary Section- Do this a week later and write, in your own words, only one or two sentences that sums up the important points on this page



Date:

[illegible]

Questions & Translations

Fill this in AFTER lesson

Date:

Summary Section- Do this a week later and write, in your own words, only one or two sentences that sums up the important points on this page





Idea	Why it matters
Adding to your answers at the end	For most students. The harder explain questions, or other multi-mark questions often will require details that may not be the first ones you include. After you have given the question roughly the right amount of time per mark, MOVE ON to the next part of the exam. Return later if you have made the time to do so, after you have checked through the exam and add whatever else you can think might be relevant AND correct. If you are not sure if it's relevant, but you are sure that it is correct, then add it anyways, but only if you have the time!
Annotating your multiple-choice questions	For ALL students! Although the examiner will not see you question paper for multiple choice questions, you should still make notes on the question paper itself. This will help you break the question down, which will often require you to have one idea that follows another, if this is written down inside the question you are more likely to see this second step. Also important, at the end you can see your own thinking when you check through your exam at the end, which will make checking your work easier and more effective
Annotating your questions	For ALL students! You should be writing out what you know about the compounds and ideas as you are reading the question. Underline numbers, these are usually only ever given to you because they are necessary in a calculation. For questions involving unknowns, try to write what X is if that is possible. This way you break down a larger problem in to more manageable parts helping you see more clearly the answer.
Checking your exam paper	For most students try to allow at least 10% of the exam time to check your exam paper at the end, for Paper 2 this is about 5 minutes, Paper 4 it is 8 minutes, for Paper 6 it is 6 minutes. As you move through the paper, you should have already marked the hardest questions with a star or other symbol, these should be checked the most carefully. For the most able students who are aiming for a good A* you ought to have about 20 to 30% of the time left at the end for checking which will allow you to thoroughly check all of the exam and locate every mark. For less able students you may need to ignore the later parts of a tough topic to ensure you are able to check through the easiest questions at the end to correct any easy mistakes you may have made.
Chemical equations	For most students. A good answer ought to try to include at least one balanced chemical equation, even if you feel you have just explained the same thing in words, because you may have missed something out or not explained properly the idea that you had in your mind which the chemical equation will provide evidence to the examiner that will allow you to get the mark. It is an example of REDUNDENCY or a FAIL-SAFE
Crossing out mistakes	Never cross out work that you think is a mistake unless you have already provided another answer, so draw a box around what you intend to replace, then write your new answer, THEN write a neat cross through that box. Your crossed-out work should always be readable to the examiner. If it contradicts your new work, it will not be considered, but if it helps to clarify your new answer, than it ought to be considered by the examiner. For instance, in a recent exam students were expected to describe a difference and explain it; many students simply explained the difference, without saying if the value would be larger or smaller, one student suggested that it would be smaller in their crossed out work, but only different in their final answer, but they had shown they understood how it would be different and got the mark.
Diagrams	For ALL students! A picture is worth a 1000 words. A good LABELLED diagram even if there is not there is no blank space for a diagram, can sometimes be acceptable and can help give a fuller answer to allow you to pick up the hardest marks or prevent silly mistakes where you have accidentally not included enough information.
Drawing graphs	In pencil!!! If you make a mistake in the real exam in pen it your answer may not be clear enough for you to be awarded really easy marks, you cannot ask for another exam paper, so mistakes that are made in pen are permanent! For ALL students!
Eliminating the wrong answers in multiple choice questions	For ALL students! Usually two of the 4 answers are more easily seen as incorrect. Finding these two will give you a 50/50 chance of getting the right answer with less understanding, so even though you don't fully understand the question, you have at least managed to increase your odds of guessing correctly. If you can't easily and quickly find these 2 answers, mark the question, make a guess IN PENCIL, then move on, this question is obviously a difficult question therefore.
Exam Questions	For ALL students! Almost none of the marks are awarded for answering actual questions (you will almost never see a question mark!?!). What are commonly referred to as exam questions, even by Mr Paddy, are in fact commands: calculate this, or explain that or state how etc. This is to reduce confusion so that you know exactly what is expected from the language of the command (which is why the command terms exist and why they are so important to properly understand!!)



Idea	Why it matters
FAIL SAFE or REDUNDENCY	For most students. If you really want to make sure you pick up every single mark you should be aiming to include additional information in a slightly different format, including labelled diagrams and balanced chemical equations with state symbols. This level of attention to detail means that if your first attempt at the hardest marks in the exam paper fails, it fails into a safe position, because you have a backup plan. This is an essential idea in engineering and research science.
Give <i>some</i> properties/etc	For the most able students. Give about 40 to 100% more properties or conditions than there are marks: irrelevant answers, or incomplete answers will not go against you, so to ensure you include all of the answers that the examiner requires you need to be very cautious. Answers acceptable one year may not be acceptable in another exam session, they are not incorrect, just not enough to get a mark. This is essential for a candidate to hope for a good A*!!! For the least able students. Make sure that you are at least giving as many answers as there are marks, if you are not sure, give your best guess, never leave an answer blank!
Give <u>x</u># properties/conditions/etc	For ALL Students! Give exactly and only x number of properties, any more will either not be marked, so if one of your answers is irrelevant, and you are supposed to give 3 answers, but you give 4 and the 4th is correct, you could lose the mark. If one of the answers is wrong, then you will most likely lose the mark. They do not reward candidates who try to use ambiguity to increase their score, and in fact actively penalise it.
Name	For most students. Give the name, in English, for the chemical compound, ion or element. Only the name is acceptable, and if you misspell it, especially if it is a negative ion, like chloride, you will not be awarded the mark.
Plurals	For ALL students! If a question requires more than one answer, it will have ALWAYS indicated this with the use of plurals. If only one answer is needed than again, the statement will indicate this grammatically. PAY ATTENTION TO THIS!!!
Showing your working in calculations	For ALL students! The space given for your working for a calculation should not be considered as 'rough paper' or include incomplete numbers or ideas. The space for your response should be considered as a place for you to communicate with the examiner what you are doing, and especially thinking, in each step, even if it seems obvious to you what you are doing, each step should be clearly labelled and written in a way that can be easily followed. Sometimes the final answer is only worth one mark, and the other marks can only be achieved with carefully laid out working. Another important reason for good, systematic working, even for easy questions that involve more than one step is that they allow you at the end of the exam to check your thinking quickly, efficiently and effectively.
Spelling	For ALL students! It is only really in the naming of a specific process or compound that spelling is vital. Otherwise anything that is spelt well enough for the word to be clear and the meaning to be understood is acceptable. Your written response is used by the exam board to measure your level of understanding, some students with certain disabilities may not be able to write, but they could still get an A* in this subject if they could show, e.g. through speech, that they are able to understand the ideas. If you think of Stephen Hawking, a world famous scientist, who was also a professor at the University of Cambridge, he could not write, but he was still extremely well respected.
State or identify	For ALL Students! In this case you can use either the chemical formula or the full English name of the compound, ion or element. If you give the formula and the name and one of them is incorrect, you will lose the mark, so you are better off only identifying the substance by the way you are most confident in. For instance, if you say that it is "Bromine (Br)" when it is in fact Br ₂ , you will likely lose the mark. Or "Bromine (Br ⁻)" when it is the bromide ion, you will also lose the mark.
State symbols	For most students. Always include these in your diagrams where you can, even if you are not able to include all of them for the whole equation (e.g. the electrolysis of aluminium). This is another example of a FAIL SAFE .
The order you answer questions	For ALL students! This should be organised at the start of the exam. Take 2 minutes to skim through the exam paper and find the hardest questions and the easiest ones. The hardest questions should be answered last, these are the least efficient use of your time (in terms of marks achieved versus time spent). The easiest questions are the most efficient use of your time, unless you have run out of time and are forced to leave them unanswered, or poorly answered. DON'T ANSWER EXAM QUESTIONS IN THE ORDER THEY APPEAR ON THE EXAM PAPER!!!



Idea	Why it matters
Time management in exams	For ALL students! You should know how long you have for each mark (normally it is around 1 mark a minute). You should also have a watch that you are familiar with that is not a smart watch or a smart band. A simple, cheap classic Casio watch would be best, and you can use this same watch throughout your academic career making sure to replace the battery before every exam session. Some questions you should be able to make time up on, others will take considerably longer, for those harder questions, stop after about 1 minute a mark and return to them at the end to ensure the easiest marks have been answered fully and carefully.
Understanding the distracter answer in a multiple-choice question	For the most able students. After you have eliminated the 2 easily incorrect answers there will be two very similar answers that will differ in a fundamental way, hopefully, that will allow you to find the correct answer. Sometimes, however, neither will be easily identified as correct, so you will need to find the most incorrect answer and chose the other one. These questions tend to be the hardest marks in the exam.
Units	For ALL students! Always include units in your answer! Often, they will not be enough to allow you to get a mark, but if they are not there you will lose a mark.
Writing in the mathematics formula booklets	For ALL maths students. Nothing to do with chemistry, but I find it really unnecessary. DO NOT TO THIS! At best rough work which should have been included in your answer booklet, then neatly crossed out, will not be seen by an examiner, so you could very pointlessly drop marks. At worst the handwriting is yours in this booklet, so you could be accused of writing the answers in there before the exam and therefore cheating. It is CAIE policy (and all exam boards, actually) that everything a candidate does in the exam is sent to them, which is again related to exam security which they take extremely seriously. Most likely however, the booklets are just thrown away for no good reason which is a waste of paper.
Wrong answer + Right Answer	= No marks! If you are unsure go with your best guess, but don't give two answers if only one answer is acceptable. For ALL Students!



4 IB Diploma

The Diploma Programme is a rigorous pre-university course of study designed for students in the 16 to 19 age range. It is a broad-based two-year course that aims to encourage students to be knowledgeable and inquiring, but also caring and compassionate. There is a strong emphasis on encouraging students to develop intercultural understanding, open-mindedness, and the attitudes necessary for them to respect and evaluate a range of points of view.

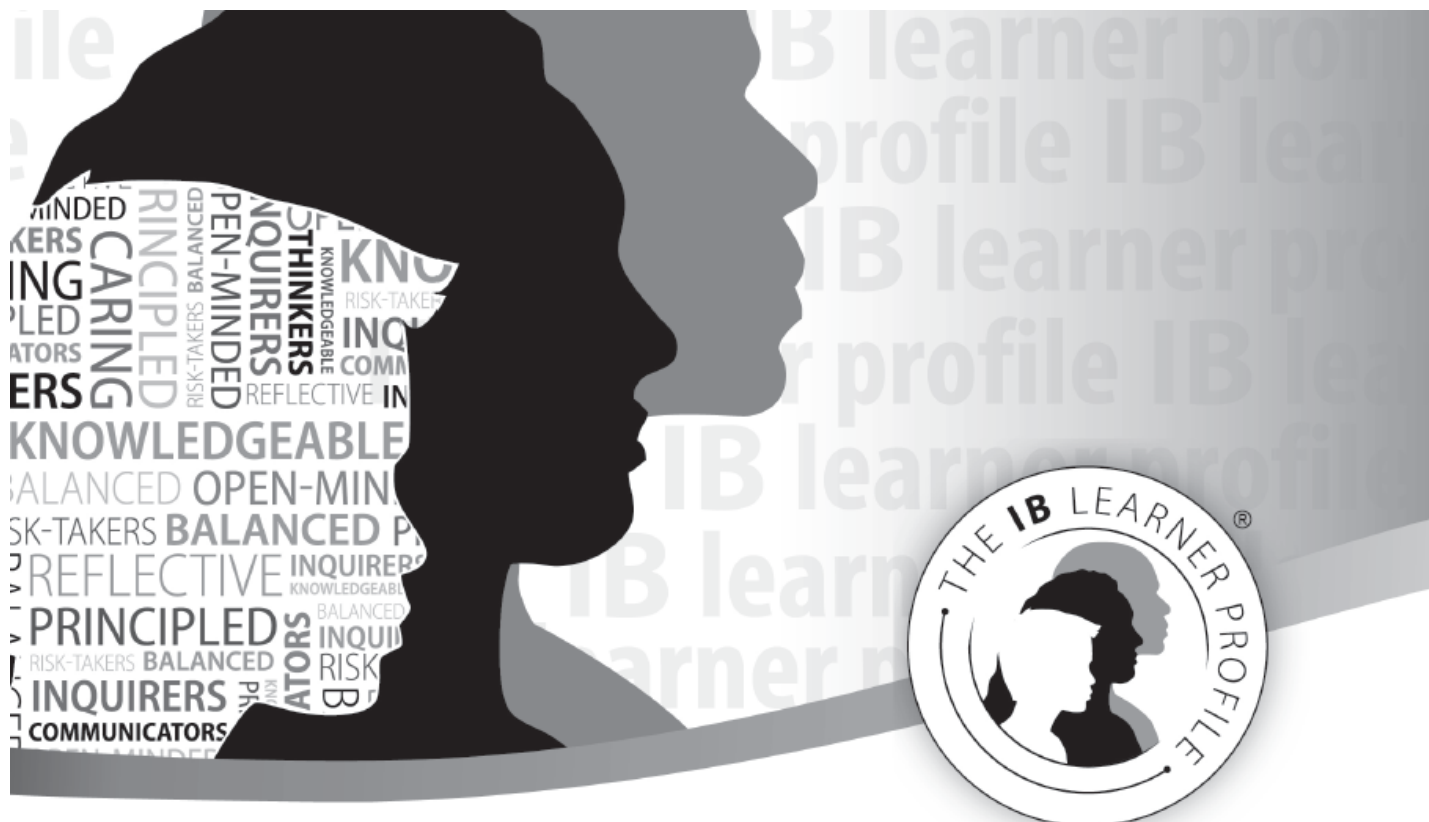
The Diploma Programme model

The course is presented as six academic areas enclosing a central core (see figure 1). It encourages the concurrent study of a broad range of academic areas. Students study two modern languages (or a modern language and a classical language), a humanities or social science subject, a science, mathematics and one of the creative arts. It is this comprehensive range of subjects that makes the Diploma Programme a demanding course of study designed to prepare students effectively for university entrance. In each of the academic areas students have flexibility in making their choices, which means they can choose subjects that particularly interest them and that they may wish to study further at university.



Figure 1
Diploma Programme model





IB learner profile

The aim of all IB programmes is to develop internationally minded people who, recognizing their common humanity and shared guardianship of the planet, help to create a better and more peaceful world.

As IB learners we strive to be:

INQUIRERS

We nurture our curiosity, developing skills for inquiry and research. We know how to learn independently and with others. We learn with enthusiasm and sustain our love of learning throughout life.

KNOWLEDGEABLE

We develop and use conceptual understanding, exploring knowledge across a range of disciplines. We engage with issues and ideas that have local and global significance.

THINKERS

We use critical and creative thinking skills to analyse and take responsible action on complex problems. We exercise initiative in making reasoned, ethical decisions.

COMMUNICATORS

We express ourselves confidently and creatively in more than one language and in many ways. We collaborate effectively, listening carefully to the perspectives of other individuals and groups.

PRINCIPLED

We act with integrity and honesty, with a strong sense of fairness and justice, and with respect for the dignity and rights of people everywhere. We take responsibility for our actions and their consequences.

OPEN-MINDED

We critically appreciate our own cultures and personal histories, as well as the values and traditions of others. We seek and evaluate a range of points of view, and we are willing to grow from the experience.

CARING

We show empathy, compassion and respect. We have a commitment to service, and we act to make a positive difference in the lives of others and in the world around us.

RISK-TAKERS

We approach uncertainty with forethought and determination; we work independently and cooperatively to explore new ideas and innovative strategies. We are resourceful and resilient in the face of challenges and change.

BALANCED

We understand the importance of balancing different aspects of our lives—intellectual, physical, and emotional—to achieve well-being for ourselves and others. We recognize our interdependence with other people and with the world in which we live.

REFLECTIVE

We thoughtfully consider the world and our own ideas and experience. We work to understand our strengths and weaknesses in order to support our learning and personal development.

The IB learner profile represents 10 attributes valued by IB World Schools. We believe these attributes, and others like them, can help individuals and groups become responsible members of local, national and global communities.



© International Baccalaureate Organization 2013

International Baccalaureate® | Baccalauréat International® | Bachillerato Internacional®



4.2 Standard Level (SL) and Higher Level (HL) Group 4 Courses

The PreIB Chemistry Course is designed to prepare you for the SL or HL Chemistry IB Diploma courses, however, regardless of what course you chose for group 4 (the Sciences, including Chemistry, Physics or Biology), they all have common ideas behind their organisation and are assessed using a similar format.

4.3 Group 4 aims

Through studying biology, chemistry or physics, students should become aware of how scientists work and communicate with each other. While the scientific method may take on a wide variety of forms, it is the emphasis on a practical approach through experimental work that characterizes these subjects.

The aims enable students, through the overarching theme of the Nature of science, to:

1. Appreciate scientific study and creativity within a global context through stimulating and challenging opportunities
2. Acquire a body of knowledge, methods and techniques that characterize science and technology
3. Apply and use a body of knowledge, methods and techniques that characterize science and technology
4. Develop an ability to analyse, evaluate and synthesize scientific information
5. Develop a critical awareness of the need for, and the value of, effective collaboration and communication during scientific activities
6. Develop experimental and investigative scientific skills including the use of current technologies
7. Develop and apply 21st century communication skills in the study of science
8. Become critically aware, as global citizens, of the ethical implications of using science and technology
9. Develop an appreciation of the possibilities and limitations of science and technology
10. Develop an understanding of the relationships between scientific disciplines and their influence on other areas of knowledge.

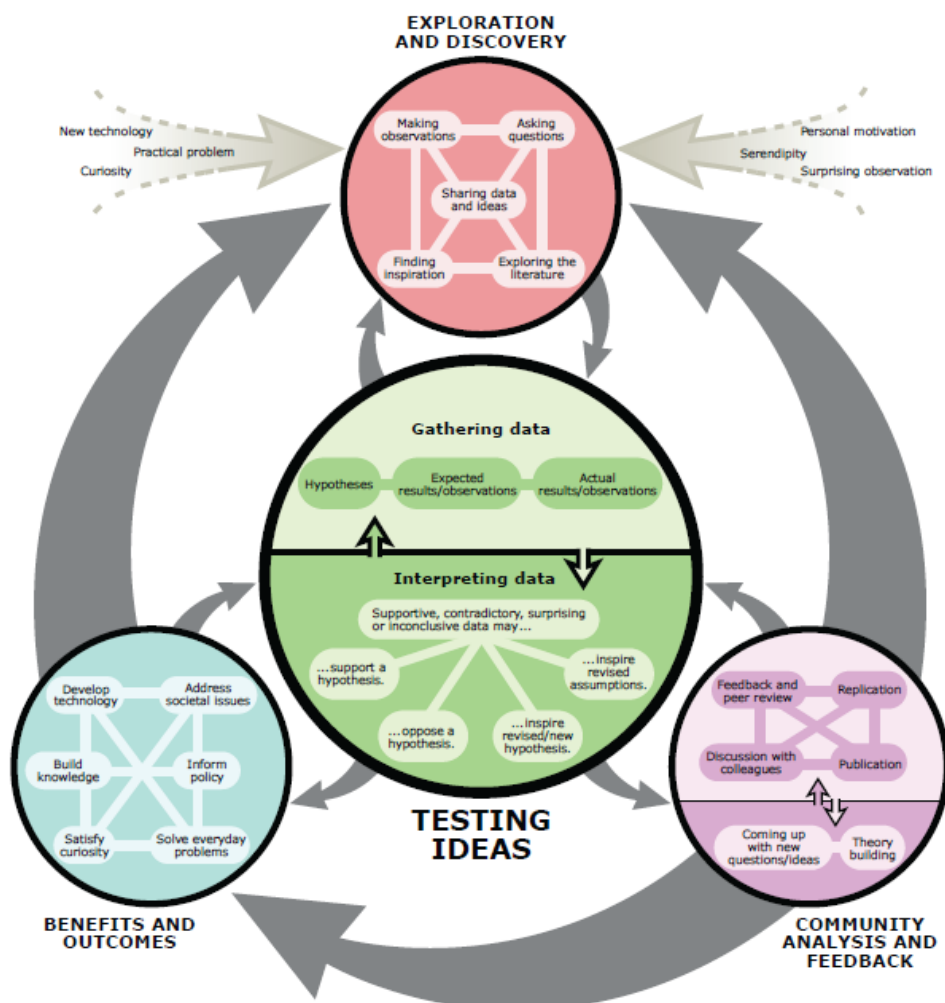


Figure 2
Pathways to scientific discovery



Group 4 covers all of the sciences, but only the main sciences (Chemistry, Biology and Physics) are offered at most schools, including this one.

4.4 IB SL and HL Chemistry Syllabus outline

The last topic is the Organic topic, which will be covered in the second year, IB2, which is why it has been removed from the PreIB course

Syllabus component	Recommended teaching hours	
	SL	HL
Core	95	
1. Stoichiometric relationships	13.5	
2. Atomic structure	6	
3. Periodicity	6	
4. Chemical bonding and structure	13.5	
5. Energetics/thermochemistry	9	
6. Chemical kinetics	7	
7. Equilibrium	4.5	
8. Acids and bases	6.5	
9. Redox processes	8	
10. Organic chemistry	11	
11. Measurement and data processing	10	
Additional higher level (AHL)		60
12. Atomic structure		2
13. The periodic table—the transition metals		4
14. Chemical bonding and structure		7
15. Energetics/thermochemistry		7
16. Chemical kinetics		6
17. Equilibrium		4
18. Acids and bases		10
19. Redox processes		6
20. Organic chemistry		12
21. Measurement and analysis		2
Option	15	25
A. Materials	15	25
B. Biochemistry	15	25
C. Energy	15	25
D. Medicinal chemistry	15	25



Syllabus component	Recommended teaching hours	
	SL	HL
Practical scheme of work	40	60
Practical activities	20	40
Individual investigation (internal assessment—IA)	10	10
Group 4 project	10	10
Total teaching hours	150	240

The recommended teaching time is 240 hours to complete HL courses and 150 hours to complete SL courses as stated in the document *General regulations: Diploma Programme* (2011) (page 4, Article 8.2).

Distinction between SL and HL

Group 4 students at standard level (SL) and higher level (HL) undertake a common core syllabus, a common internal assessment (IA) scheme and have some overlapping elements in the option studied. They are presented with a syllabus that encourages the development of certain skills, attributes and attitudes, as described in the "Assessment objectives" section of this guide.

While the skills and activities of group 4 science subjects are common to students at both SL and HL, students at HL are required to study some topics in greater depth, in the additional higher level (AHL) material and in the common options. The distinction between SL and HL is one of breadth and depth.

4.5 IB Group 4 External Assessment Details SL Chemistry

Paper 1

Duration: 3/4 hour

Weighting: 20%

Marks: 30

- 30 multiple-choice questions on core, about 15 of which are common with HL.
- The questions on paper 1 test assessment objectives 1, 2 and 3.
- The use of calculators is not permitted.
- Students will be provided with a periodic table.
- No marks are deducted for incorrect answers.

Paper 2

Duration: 1¼ hours

Weighting: 40%

Marks: 50

- Short-answer and extended-response questions on core material.
- The questions on paper 2 test assessment objectives 1, 2 and 3.
- The use of calculators is permitted. (See calculator section on the OCC.)
- A chemistry data booklet is to be provided by the school.



Paper 3

Duration: 1 hour

Weighting: 20%

Marks: 35

- This paper will have questions on core and SL option material.
- Section A: one data-based question and several short-answer questions on experimental work.
- Section B: short-answer and extended-response questions from one option.
- The questions on paper 3 test assessment objectives 1, 2 and 3.
- The use of calculators is permitted. (See calculator section on the OCC.)
- A chemistry data booklet is to be provided by the school.

4.1 IB Group 4 External Assessment Details HL Chemistry

Paper 1

Duration: 1 hour

Weighting: 20%

Marks: 40

- 40 multiple-choice questions on core and AHL, about 15 of which are common with SL.
- The questions on paper 1 test assessment objectives 1, 2 and 3.
- The use of calculators is not permitted.
- Students will be provided with a periodic table.
- No marks are deducted for incorrect answers.

Paper 2

Duration: 2¼ hours

Weighting: 36%

Marks: 95

- Short-answer and extended-response questions on the core and AHL material.
- The questions on paper 2 test assessment objectives 1, 2 and 3.
- The use of calculators is permitted. (See calculator section on the OCC.)
- A chemistry data booklet is to be provided by the school.

Paper 3

Duration: 1¼ hours

Weighting: 24%

Marks: 45

- This paper will have questions on core, AHL and option material.
- Section A: one data-based question and several short-answer questions on experimental work.
- Section B: short-answer and extended-response questions from one option.
- The questions on paper 3 test assessment objectives 1, 2 and 3.
- The use of calculators is permitted. (See calculator section on the OCC.)
- A chemistry data booklet is to be provided by the school.



4.2 IB Group 4 Internal Assessment (IA)

If you add up all of the percentages for the External Assessment (which is the main exam at the end of 2 years) you will find that they only add up to 80%. The remainder, 20% for BOTH HL and SL, of your grade comes from an Internally Assessed component, which you complete during the 2 years in class and is graded by your teacher. It follows a very specific pattern of assessment that is easy once you are experienced in it, but can be very challenging if you haven't been given enough practice.

Duration: 10 hours

Weighting: 20%

- Individual investigation
- This investigation covers assessment objectives 1, 2, 3 and 4.

Internal assessment criteria

The new assessment model uses five criteria to assess the final report of the individual investigation with the following raw marks and weightings assigned:

Personal engagement	Exploration	Analysis	Evaluation	Communication	Total
2 (8%)	6 (25%)	6 (25%)	6 (25%)	4 (17%)	24 (100%)

Each of the above criteria will be explored this year through practicals which will contribute towards your final PreIB grade.

4.3 Explaining the IB IA Assessment Criteria

Personal engagement

This criterion assesses the extent to which the student engages with the exploration and makes it their own. Personal engagement may be recognized in different attributes and skills. These could include addressing personal interests or showing evidence of independent thinking, creativity or initiative in the designing, implementation or presentation of the investigation.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1	The evidence of personal engagement with the exploration is limited with little independent thinking, initiative or creativity. The justification given for choosing the research question and/or the topic under investigation does not demonstrate personal significance, interest or curiosity . There is little evidence of personal input and initiative in the designing, implementation or presentation of the investigation.
2	The evidence of personal engagement with the exploration is clear with significant independent thinking, initiative or creativity. The justification given for choosing the research question and/or the topic under investigation demonstrates personal significance, interest or curiosity . There is evidence of personal input and initiative in the designing, implementation or presentation of the investigation.



Exploration

This criterion assesses the extent to which the student establishes the scientific context for the work, states a clear and focused research question and uses concepts and techniques appropriate to the Diploma Programme level. Where appropriate, this criterion also assesses awareness of safety, environmental, and ethical considerations.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1–2	The topic of the investigation is identified and a research question of some relevance is stated but it is not focused. The background information provided for the investigation is superficial or of limited relevance and does not aid the understanding of the context of the investigation. The methodology of the investigation is only appropriate to address the research question to a very limited extent since it takes into consideration few of the significant factors that may influence the relevance, reliability and sufficiency of the collected data. The report shows evidence of limited awareness of the significant safety, ethical or environmental issues that are relevant to the methodology of the investigation*.
3–4	The topic of the investigation is identified and a relevant but not fully focused research question is described. The background information provided for the investigation is mainly appropriate and relevant and aids the understanding of the context of the investigation. The methodology of the investigation is mainly appropriate to address the research question but has limitations since it takes into consideration only some of the significant factors that may influence the relevance, reliability and sufficiency of the collected data. The report shows evidence of some awareness of the significant safety, ethical or environmental issues that are relevant to the methodology of the investigation.*

Mark	Descriptor
5–6	The topic of the investigation is identified and a relevant and fully focused research question is clearly described. The background information provided for the investigation is entirely appropriate and relevant and enhances the understanding of the context of the investigation. The methodology of the investigation is highly appropriate to address the research question because it takes into consideration all, or nearly all, of the significant factors that may influence the relevance, reliability and sufficiency of the collected data. The report shows evidence of full awareness of the significant safety, ethical or environmental issues that are relevant to the methodology of the investigation.*



Analysis

This criterion assesses the extent to which the student's report provides evidence that the student has selected, recorded, processed and **interpreted** the data in ways that are relevant to the research question and can support a conclusion.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1-2	The report includes insufficient relevant raw data to support a valid conclusion to the research question. Some basic data processing is carried out but is either too inaccurate or too insufficient to lead to a valid conclusion. The report shows evidence of little consideration of the impact of measurement uncertainty on the analysis. The processed data is incorrectly or insufficiently interpreted so that the conclusion is invalid or very incomplete.
3-4	The report includes relevant but incomplete quantitative and qualitative raw data that could support a simple or partially valid conclusion to the research question. Appropriate and sufficient data processing is carried out that could lead to a broadly valid conclusion but there are significant inaccuracies and inconsistencies in the processing. The report shows evidence of some consideration of the impact of measurement uncertainty on the analysis. The processed data is interpreted so that a broadly valid but incomplete or limited conclusion to the research question can be deduced.
5-6	The report includes sufficient relevant quantitative and qualitative raw data that could support a detailed and valid conclusion to the research question. Appropriate and sufficient data processing is carried out with the accuracy required to enable a conclusion to the research question to be drawn that is fully consistent with the experimental data. The report shows evidence of full and appropriate consideration of the impact of measurement uncertainty on the analysis. The processed data is correctly interpreted so that a completely valid and detailed conclusion to the research question can be deduced.



Evaluation

This criterion assesses the extent to which the student's report provides evidence of evaluation of the investigation and the results with regard to the research question and the accepted scientific context.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1–2	A conclusion is outlined which is not relevant to the research question or is not supported by the data presented. The conclusion makes superficial comparison to the accepted scientific context. Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are outlined but are restricted to an account of the practical or procedural issues faced. The student has outlined very few realistic and relevant suggestions for the improvement and extension of the investigation.
3–4	A conclusion is described which is relevant to the research question and supported by the data presented. A conclusion is described which makes some relevant comparison to the accepted scientific context. Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are described and provide evidence of some awareness of the methodological issues* involved in establishing the conclusion. The student has described some realistic and relevant suggestions for the improvement and extension of the investigation.
5–6	A detailed conclusion is described and justified which is entirely relevant to the research question and fully supported by the data presented. A conclusion is correctly described and justified through relevant comparison to the accepted scientific context. Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are discussed and provide evidence of a clear understanding of the methodological issues* involved in establishing the conclusion. The student has discussed realistic and relevant suggestions for the improvement and extension of the investigation.



Communication

This criterion assesses whether the investigation is presented and reported in a way that supports effective communication of the focus, process and outcomes.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1–2	The presentation of the investigation is unclear, making it difficult to understand the focus, process and outcomes. The report is not well structured and is unclear: the necessary information on focus, process and outcomes is missing or is presented in an incoherent or disorganized way. The understanding of the focus, process and outcomes of the investigation is obscured by the presence of inappropriate or irrelevant information. There are many errors in the use of subject specific terminology and conventions*.
3–4	The presentation of the investigation is clear. Any errors do not hamper understanding of the focus, process and outcomes. The report is well structured and clear: the necessary information on focus, process and outcomes is present and presented in a coherent way. The report is relevant and concise thereby facilitating a ready understanding of the focus, process and outcomes of the investigation. The use of subject specific terminology and conventions is appropriate and correct. Any errors do not hamper understanding.



5 Topic 1 Particulate Theory of Matter

5.1 End of Topic 1 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTENSION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTENSION
	Scored over 95%		SMASHING!!!



Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book <u>you enjoy</u> (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book <u>you enjoy</u> in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book <u>you enjoy</u> in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

5.2 Topic 1 Syllabus

1 The particulate nature of matter

1.1 The particulate nature of matter

Core

- State the distinguishing properties of solids, liquids and gases
- Describe the structure of solids, liquids and gases in terms of particle separation, arrangement and types of motion
- Describe changes of state in terms of melting, boiling, evaporation, freezing, condensation and sublimation
- Describe qualitatively the pressure and temperature of a gas in terms of the motion of its particles
- Show an understanding of the random motion of particles in a suspension (sometimes known as Brownian motion) as evidence for the kinetic particle (atoms, molecules or ions) model of matter
- Describe and explain diffusion

Supplement

- Explain changes of state in terms of the kinetic theory
- Describe and explain Brownian motion in terms of random molecular bombardment
- State evidence for Brownian motion
- Describe and explain dependence of rate of diffusion on molecular mass



5.1 ESSENTIAL Glossary for Keywords for this topic

Many words used in science have a meaning that is slightly different to their common everyday English meaning, for instance a salt is the product of an acid and base reacting together in chemistry, but normally thought of as table salt (NaCl) in common use.

The keywords have been auto translated into Chinese, so the translations will not be perfect but they should hopefully make sense. If there is a better translation you can simply write it out yourself on a Post-it note and stick it over the printed one.

Topic #	English	Chinese
1	boiling a condition under which gas bubbles are able to form within a liquid – gas molecules escape from the body of a liquid, not just from its surface	沸腾在液体中能够形成气泡的条件下–气体分子从液体体内逸出，而不仅仅是从其表面逸出
1	boiling point the temperature at which a liquid boils, when the pressure of the gas created above the liquid equals atmospheric pressure	沸点，当在液体上方产生的气体压力等于大气压时，液体沸腾的温度
1	condensation the change of a vapour or a gas into a liquid; during this process heat is given out to the surroundings	将蒸气或气体的变化冷凝成液体；在此过程中，热量散发到周围环境中
1	diffusion the process by which different fluids mix as a result of the random motions of their particles	扩散由于粒子的随机运动而导致不同流体混合的过程
1	evaporation a process occurring at the surface of a liquid, involving the change of state from a liquid into a vapour at a temperature below the boiling point	蒸发一种在液体表面发生的过程，包括在低于沸点的温度下从液体状态转变为蒸气状态
1	fluid a gas or a liquid, they are able to flow	流体是气体或液体，它们能够流动
1	melting point the temperature at which a solid turns into a liquid – it has the same value as the freezing point; a pure substance has a sharp melting point	熔点固体变成液体的温度，它与凝固点的值相同；纯物质具有尖锐的熔点
1	physical change a change in the physical state of a substance or the physical nature of a situation that does not involve a change in the chemical substance(s) present	物理变化不涉及所存在化学物质变化的物质的物理状态变化或情况的物理性质变化
1	states of matter solid, liquid and gas are the three states of matter in which any substance can exist, depending on the conditions of temperature and pressure	固体，液体和气体的物质状态是可以存在任何物质的三种物质状态，具体取决于温度和压力的条件
1	sublimation the direct change of state from solid to gas or gas to solid: the liquid phase is bypassed	升华状态从固体到气体或从气体到固体的直接变化：绕过液相



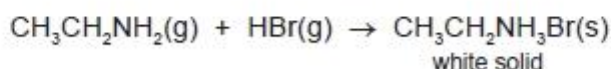
(c) Gases diffuse, which means that they move to occupy the total available volume.

(i) Explain, using kinetic particle theory, why gases diffuse.

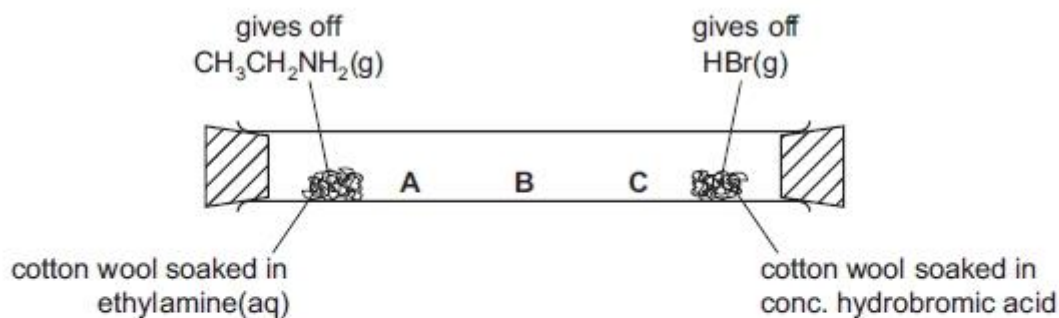
.....

 [2]

(ii) When the colourless gases hydrogen bromide and ethylamine come into contact, a white solid is formed.



The following apparatus can be used to compare the rates of diffusion of the two gases ethylamine and hydrogen bromide.



Predict at which position, A, B or C, the white solid will form. Explain your choice.

.....

 [3]

Q# 2/ iGCSE Chemistry/2014/s/Paper 31/Q3 (c)

(iii) Suggest another method, other than diffusion, by which helium could be separated from the mixture of gases in natural gas.

..... [1]

Q# 3/ iGCSE Chemistry/2014/s/Paper 31/

3 (a) Different gases diffuse at different speeds.

(i) What is meant by the term *diffusion*?

.....
 [1]

(ii) What property of a gas molecule affects the speed at which it diffuses?

..... [1]



- (b) Helium is a gas used to fill balloons. It is present in the air in very small quantities. Diffusion can be used to separate it from the air.

Air at 1000 °C is on one side of a porous barrier. The air which passes through the barrier has a larger amount of helium in it.

- (i) Why does the air on the other side of the barrier contain more helium?

..... [1]

- (ii) Why is it an advantage to have the air at a high temperature?

.....
..... [1]

Q# 4/ iGCSE Chemistry/2012/w/Paper 31/

- 7 Both strontium and sulfur have chlorides of the type XCl_2 . The table below compares some of their properties.

	strontium chloride	sulfur chloride
appearance	white crystals	red liquid
formula	SrCl_2	SCl_2
melting point/°C	874	-120
boiling point/°C	1250	59
conductivity of liquid	good	poor
solubility in water	dissolves to form a neutral solution	reacts to form a solution of pH 1

- (a) (i) Use the data in the table to explain why sulfur chloride is a liquid at room temperature, 25 °C.

.....
..... [2]

Q# 5/ iGCSE Chemistry/2010/s/Paper 31/

- 2 Ozone is a form of oxygen. Ozone is present in the upper atmosphere and it prevents dangerous solar radiation from reaching the Earth's surface. Some of the chemicals that diffuse into the upper atmosphere decompose ozone. Chemicals that have this effect are methane (CH_4), chloromethane (CH_3Cl) and an oxide of nitrogen (NO_2).

- (i) Which of these three chemicals diffuses the most slowly? Give a reason for your choice.

.....
.....
..... [2]



- 2 The table shows the melting points, boiling points and electrical properties of the six substances A to F.

substance	melting point / °C	boiling point / °C	electrical conductor at room temperature	electrical conductor of substance dissolved in water
A	961	2193	good	does not dissolve
B	113	444	does not conduct	does not dissolve
C	0	100	very poor	very poor
D	803	1465	does not conduct	good
E	-5 to -10	102 to 105	good	good
F	-85	-60	does not conduct	does not dissolve

- (i) Which **three** substances are solids at room temperature?

..... [1]

- (iii) Which **one** is a gas at room temperature?

..... [1]

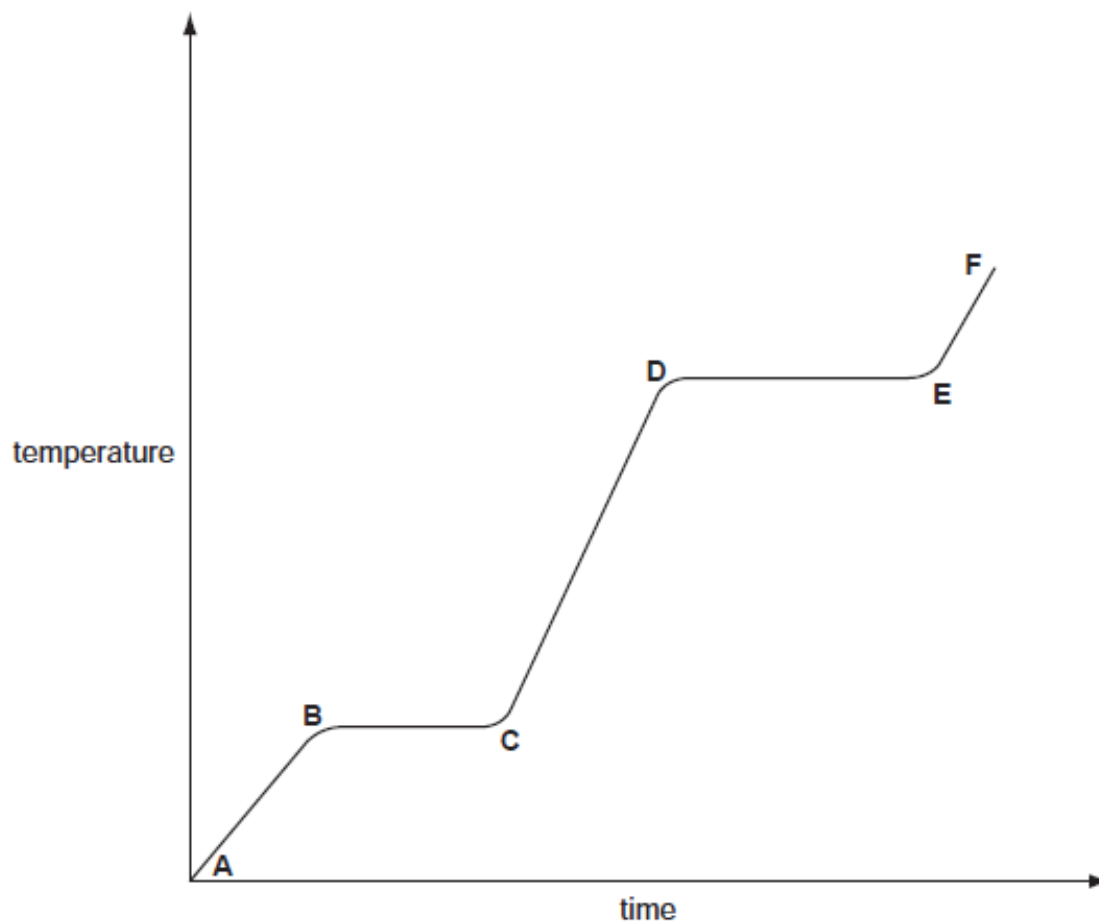
- (iv) Which **two** substances are liquids at room temperature?

..... [1]



2 Ethanoic acid is a colourless liquid at room temperature. It has the typical acid properties and forms compounds called ethanoates.

(a) A pure sample of ethanoic acid is slowly heated from 0°C to 150°C and its temperature is measured every minute. The results are represented on the graph below.



(i) Name the change that occurs in the region **D** to **E**.

..... [1]

(ii) What would be the difference in the region **B** to **C** if an impure sample had been used?

..... [1]

(iii) Sketch on the graph how the line would continue if the acid was heated to a higher temperature. [1]



- (iv) Complete the following table that compares the separation and movement of the molecules in regions **C** to **D** with those in **E** to **F**.

	C to D	E to F
separation (distance between particles)	.....	.....
movement of particles	random and slow	..... .....
Can particles move apart to fill any volume?	.....	.....

[5]

Q# 8/ iGCSE Chemistry/2005/s/Paper 3/ QIGCSE Chemistry/201

- (d) Traces of chlorine can be separated from bromine vapour by diffusion.
Which gas would diffuse the faster and why?

.....
..... [2]

Q# 9/ iGCSE Chemistry/2003/w/Paper 3/

- 4 Esters occur naturally in plants and animals. They are manufactured from petroleum. Ethyl ethanoate and butyl ethanoate are industrially important as solvents.

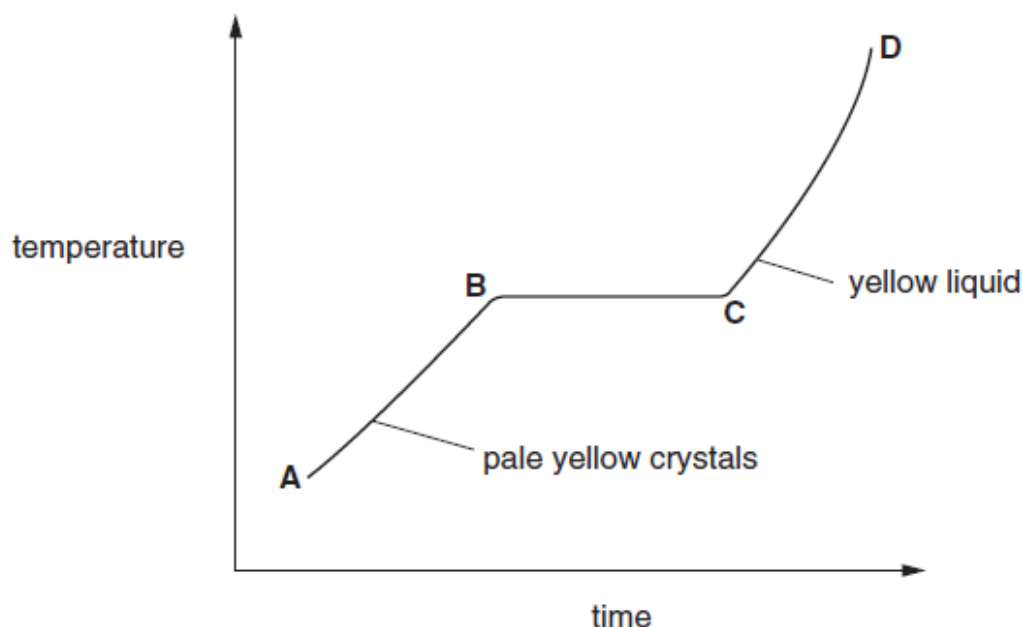
- (a) (i) Explain the term *solvent*.

.....[1]

Q# 10/ iGCSE Chemistry/2003/s/Paper 3/ Q4

- (b) When nitrogen dioxide is cooled, it forms a yellow liquid and then pale yellow crystals. These crystals are heated and the temperature is measured every minute. The following graph can be drawn.





(i) Describe the arrangement and movement of the molecules in the region A–B.

.....

.....

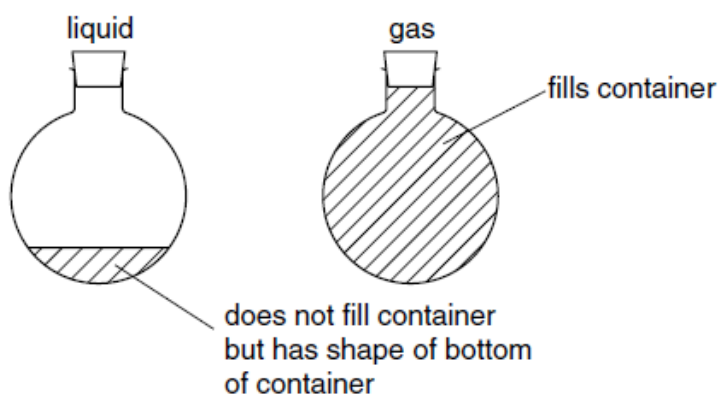
(ii) Name the change that occurs in the region B–C

.....[4]

Q# 11/ iGCSE Chemistry/2002/s/Paper 3/

- 5 (a) The Kinetic Theory explains the properties of solids, liquids and gases in terms of the movement of particles.

Liquids and gases both take up the shape of the container but a gas always fills the container. Explain this, using the ideas of the Kinetic Theory.



.....

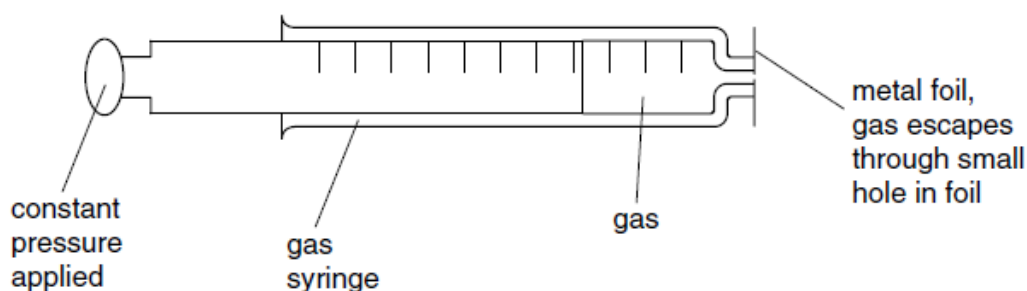
.....

.....

.....[4]



(b) The following apparatus can be used to measure the rate of diffusion of a gas.



(i) What measurements would need to be taken to calculate the rate of diffusion of a gas?

.....[2]

(ii) Which gas, carbon dioxide or sulphur dioxide, would diffuse faster? Explain your choice.

.....

[3]

5.1.1 ESSENTIAL EXAM QUESTIONS Paper 4 Topic 1 50marks Mark Scheme

Q# 1/ iGCSE Chemistry/2015/s/Paper 31/

6(c)(i)	Any two from: (particles move in) random motion; (particles) collide; (particles) move from a region of high concentration to low concentration;		-----
			A alternative phrases for collide
		2	A down a concentration gradient
6(c)(ii)	C; M2 it has a lower (relative) molecular mass (than HBr); M3 ethylamine diffuses faster (than HBr);		
		3	A ethylamine is less dense A ethylamine is a lighter molecule but I 'ethylamine is lighter' I ethylamine is a smaller molecule A ethylamine molecules or particles move faster A ECF for M2 and M3 if A is given e.g. HBr diffuses faster for M3 because it is a lighter molecule for M2 A ECF for M2 if B is given e.g. they diffuse at same rate for M3 because molecules weigh the same for M2

Q# 2/ iGCSE Chemistry/2014/s/Paper 31/Q3c

(iii) fractional distillation (1) [1]

Q# 3/ iGCSE Chemistry/2014/s/Paper 31/

3 (a) (i) (particles) spread to fill total available volume / move from high concentration to low concentration / moves down a concentration gradient (1) [1]

(ii) mass or M_r (1) [1]

(b) (i) helium atoms / molecules are lighter than molecules in air or N_2 and O_2
 or helium is less dense than air or N_2 and O_2 .
 or helium diffuses (through the porous barrier) faster than air or N_2 and O_2 . (1) [1]

(ii) faster rate of diffusion / molecules move faster (at high temperatures). (1) [1]



(iii) fractional distillation (1)

[1]

Q# 4/ iGCSE Chemistry/2012/w/Paper 31/

- 7 (a) (i) melting point is below 25°C; [1]
boiling point above 25°C; [1]
accept: argument based on actual values
note: 25°C is between mp and bp = [2]

Q# 5/ iGCSE Chemistry/2010/s/Paper 31/

- 2 (i) chloromethane [1]
cond biggest molecular mass / biggest mass of one mole / its molecules
move slowest / heaviest molecule / highest density [1]
accept atomic mass if correct numerical value given
ignore it is the heaviest (gas) / biggest molecule
accept particles or molecules
not atoms

Q# 6/ iGCSE Chemistry/2006/w/Paper 3/

- 2 More than required number of answers – [0]
(i) A, B, D [1]
(ii) D [1]
(iii) F [1]
(iv) C and E [1]
(v) A [1]
(vi) E [1]
(a)(i) boiling [1]
(ii) lower temperature **or**
over temperature range or no plateau [1]
(iii) direct continuation of E to F [1]
(iv) close **or** touching far apart [2]
fast and random [1]
cannot move apart can move apart [2]

Q# 7/

Q# 8/ iGCSE Chemistry/2005/s/Paper 3/ QiGCSE Chemistry/201

- (d) chlorine [1]
COND lower M_r **or** lower density **or** lighter molecules **or** molecules move faster [2]
OR lighter **or** based on A_r MAX [1]
smaller with no additional comment **or** sieve idea [0]
N.B. a total of [3] not [2]

Q# 9/ iGCSE Chemistry/2003/w/Paper 3/

- 4 (a) (i) in which something dissolves [1]

Q# 10/ iGCSE Chemistry/2003/s/Paper 3/ Q4

- (b) (i) close **or** tightly packed [1]
ordered **or** lattice [1]
vibrational [1]
NOT forces
(ii) melting **or** freezing **or** fusion **or** solidification [1]

Q# 11/ iGCSE Chemistry/2002/s/Paper 3/Q5 (a)

Particles are free to move in both liquids and gases,
so they can change their shape;

In a gas, there are no bonds between particles, so they are free to assume the volume of the container

In a liquid the particles are connected together by bonds, so can only change their shape, not their volume

Total 4 marks

5 (b) (i)



Time taken
For volume to decrease 2 marks

(ii) Carbon dioxide
Because it has a Mr of 44, SO₂ has an Mr of 64
Molecules with smaller mass diffuse more quickly
3 marks

5.1 Essential End of Topic 1 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?



6 Topic 2 Experimental Techniques

6.1 End of Topic 2 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTENSION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTENSION
	Scored over 95%		SMASHING!!!



Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book <u>you enjoy</u> (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book <u>you enjoy</u> in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book <u>you enjoy</u> in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

6.2 Topic 2 Syllabus

2 Experimental techniques

2.1 Measurement

Core

- Name appropriate apparatus for the measurement of time, temperature, mass and volume, including burettes, pipettes and measuring cylinders

2.2 Purity

2.2.1 Criteria of purity

Core

- Demonstrate knowledge and understanding of paper chromatography
- Interpret simple chromatograms
- Identify substances and assess their purity from melting point and boiling point information
- Understand the importance of purity in substances in everyday life, e.g. foodstuffs and drugs

Supplement

- Interpret simple chromatograms, including the use of R_f values
- Outline how chromatography techniques can be applied to colourless substances by exposing chromatograms to substances called locating agents. (Knowledge of *specific* locating agents is **not** required.)

2.2.2 Methods of purification

Core

- Describe and explain methods of purification by the use of a suitable solvent, filtration, crystallisation and distillation (including use of a fractionating column). (Refer to the fractional distillation of petroleum in section 14.2 and products of fermentation in section 14.6.)
- Suggest suitable purification techniques, given information about the substances involved



6.3 ESSENTIAL Glossary for Keywords for this topic

Many words used in science have a meaning that is slightly different to their common everyday English meaning, for instance a salt is the product of an acid and base reacting together in chemistry, but normally thought of as table salt (NaCl) in common use.

The keywords have been auto translated into Chinese, so the translations will not be perfect but they should hopefully make sense. If there is a better translation you can simply write it out yourself on a Post-it note and stick it over the printed one.

English	Chinese
chromatogram the result of a paper chromatography run, showing where the spots of the samples have moved to	纸质色谱分析结果的色谱图，显示了样品斑点移至的位置
chromatography a technique employed for the separation of mixtures of dissolved substances, which was originally used to separate coloured dyes	色谱法一种用于分离溶解物质混合物的技术，该技术最初用于分离有色染料
crystallisation the process of forming crystals from a saturated solution	结晶从饱和溶液中形成晶体的过程
decanting the process of removing a liquid from a solid which has settled or from an immiscible heavier liquid by careful pouring	通过仔细倾倒，倾析从沉降的固体或不混溶的较重液体中除去液体的过程
distillation the process of boiling a liquid and then condensing the vapour produced back into a liquid: used to purify liquids and to separate liquids from solutions	蒸馏过程：将液体煮沸，然后将产生的蒸气冷凝回液体中：用于纯化液体并将液体与溶液分离
downward delivery a method of collecting a gas which is denser than air by passing it downwards into a gas jar	向下输送一种向下收集气体的方法，该方法将比空气更浓的气体向下传送到一个煤气罐中
filtrate the liquid that passes through the filter paper during filtration	过滤在过滤过程中通过滤纸的液体
filtration the separation of a solid from a liquid, using a fine filter paper which does not allow the solid to pass through	使用不允许固体通过的细滤纸过滤从液体中分离出的固体
fractional distillation a method of distillation using a fractionating column, used to separate liquids with different boiling points	分馏通过分馏塔进行蒸馏的方法，用于分离沸点不同的液体
insoluble term that describes a substance that does not dissolve in a solvent	不溶性术语，描述了不溶于溶剂的物质
locating agent a compound that reacts with invisible, colourless spots separated by chromatography to produce a coloured product which can be seen	定位剂一种化合物，它与色谱分离的无色无色斑点反应，生成有色产物，可以看到
mixture a system of two or more substances that can be separated by physical means	混合两种或多种可以通过物理方式分离的物质的系统
pure substance a single chemical element or compound – it melts and boils at definite temperatures	纯物质是一种化学元素或化合物—在一定温度下会熔化并沸腾
residue the solid left behind in the filter paper after filtration has taken place	过滤后残留在滤纸中的固体残留物
R_f value in chromatography, the ratio of the distance travelled by the solute to the distance travelled by the solvent front	色谱中的R _f 值，溶质行进距离与溶剂前沿行进距离之比
risk assessment an evaluation of the methods and chemical substances used in a particular experiment to see what safety issues may be involved	风险评估：对特定实验中使用的的方法和化学物质的评估，以了解可能涉及的安全问题
saturated solution a solution which contains as much dissolved solute as possible at a particular temperature	饱和溶液在特定温度下包含尽可能多的溶解溶质的溶液



English	Chinese
solubility a measure of how much of a solute dissolves in a solvent at a particular temperature	溶解度，用于衡量在特定温度下有多少溶质溶解在溶剂中
soluble term that describes a solute that dissolves in a particular solvent	可溶术语，描述了溶解在特定溶剂中的溶质
solute the solid substance that has dissolved in a liquid (the solvent) to form a solution	溶解溶解在液体（溶剂）中的固体物质以形成溶液
solution formed when a substance (solute) dissolves into another substance (solvent)	当一种物质（溶质）溶于另一种物质（溶剂）时形成的溶液
solvent front the moving boundary of the liquid solvent that moves up the paper during chromatography	溶剂在色谱分析过程中沿纸向上移动的液体溶剂的移动边界的前面
solvent the liquid that dissolves the solid solute to form a solution; water is the most common solvent but liquids in organic chemistry that can act as solvents are called organic solvents	溶解溶解固体溶质形成溶液的液体；水是最常见的溶剂，但有机化学中可以用作溶剂的液体称为有机溶剂
upward delivery a method of collecting a gas that is lighter than air by passing it upwards into an inverted gas jar	向上输送一种向上收集气体的方法，该方法是将比空气轻的气体向上传递到倒置的煤气罐中

6.4 EXTENSION Keywords

Using your textbook find out what each of these words means and write it in English, then give an example and translate

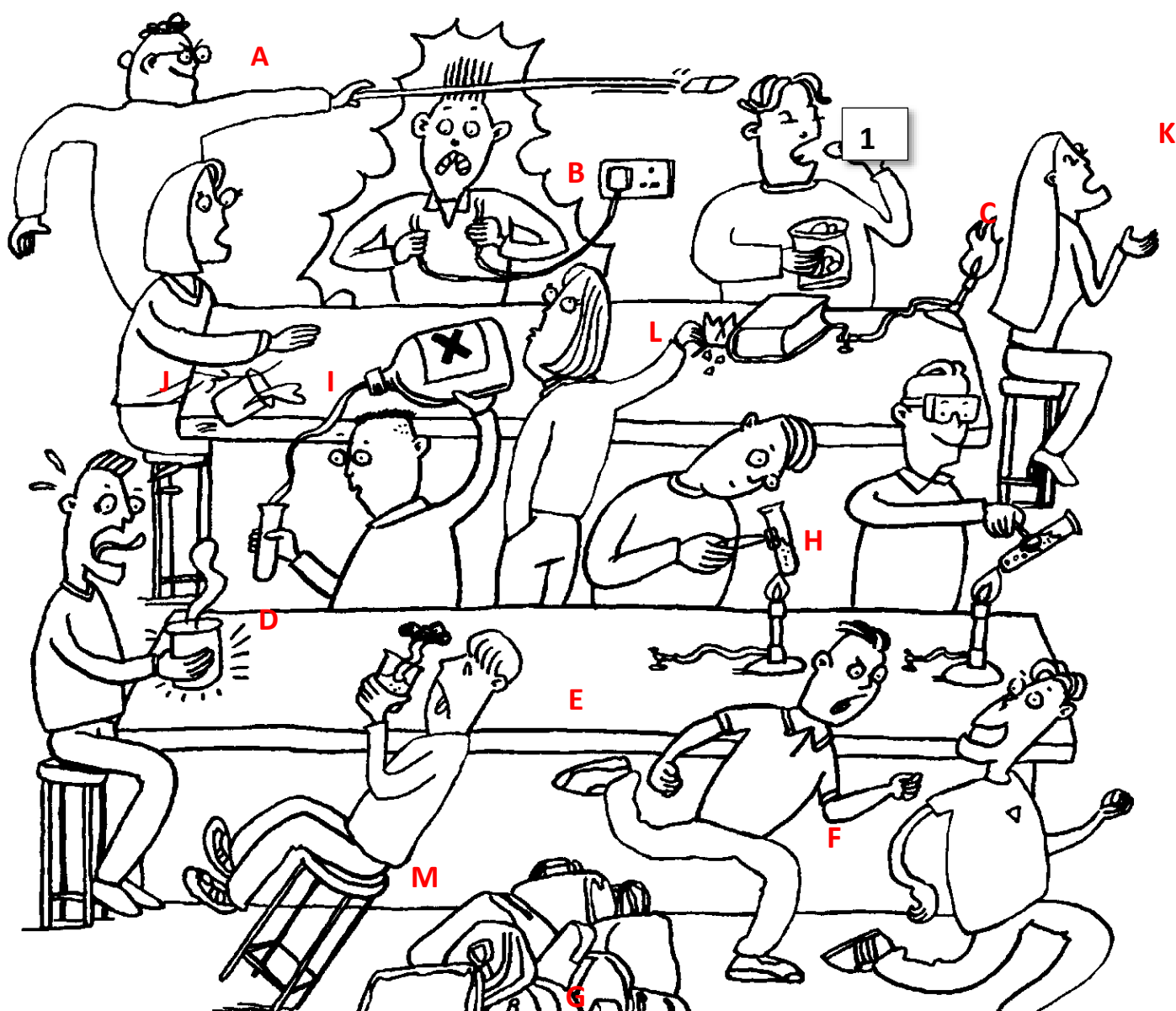
Topic #	English	Example	Chinese Translation
2	Hazard any situation or practical that includes risks that need to be carefully managed to perform that experiment safely for you and your classmates		
2	Corrosive		
2	Irritant		
2	Harmful		
2	Flammable		
2	Poisonous		
2	Explosive		

Extension activity: State and explain which of these hazards is most dangerous in the space below



6.5 EXTENSION Activity 1 WS Safety in the Lab

Find the danger and create a rule to stop it



Where the problem is	What could happen as a result?	Write a rule to prevent this danger from causing harm
1	Student could transfer harmful chemicals on the bench to his food with his hands	Never eat or drink in a lab!
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		
K		
L		
M		

6.6 ESSENTIAL Activity 2 Hazard Symbols

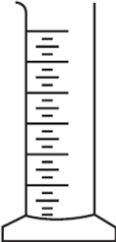
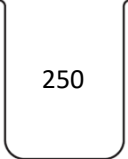
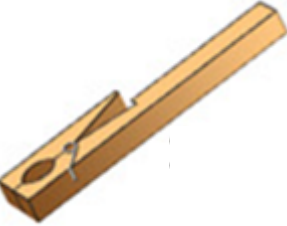
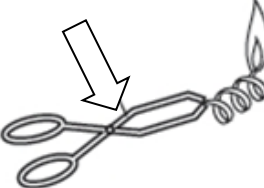
Hazard symbols are used across the world as a way to keep everyone safer. They use pictures instead of words so they can be understood by everyone, but **before you can be safe in a lab you MUST learn these.**

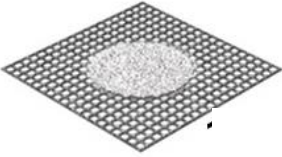
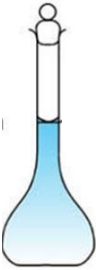
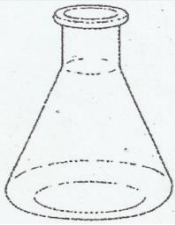
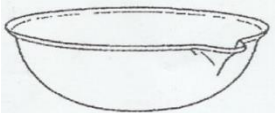
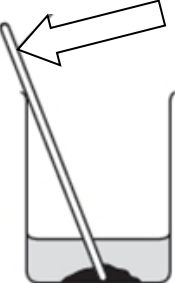
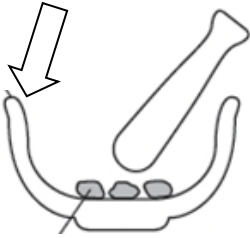
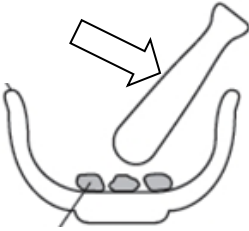
Link the hazard symbols to the correct label and description.

Old hazard symbol	New hazard symbol	Name	Description
1 		Corrosive	This may dissolve or burn materials, including skin
2 		Health hazard (Harmful)	This includes irritants, harmful substances, and some low-hazard substances
3 		Explosive	This contains dangerous organisms such as bacteria
4 		Flammable	This can be poisonous and possibly deadly
5 		Toxic	This may explode
6 		Caution (Irritant)	This can catch fire easily

6.7 ESSENTIAL Activity 3 Laboratory apparatus

Apparatus is a scientific name for equipment. Use the list below to label this equipment.

			
			 magnesium burning

(Round bottom) flask

Burette

Clamp stand

Conical flask

Evaporating basin

Funnel

Glass beaker

Heat proof gauze

Measuring cylinder

Mortar

Pistil

Spatula

Stirring rod

Teat pipette

Test tube brush

Test tube holder

Test tube rack

Thermometer

Tongs

Tripod and Bunsen burner

Volumetric flask

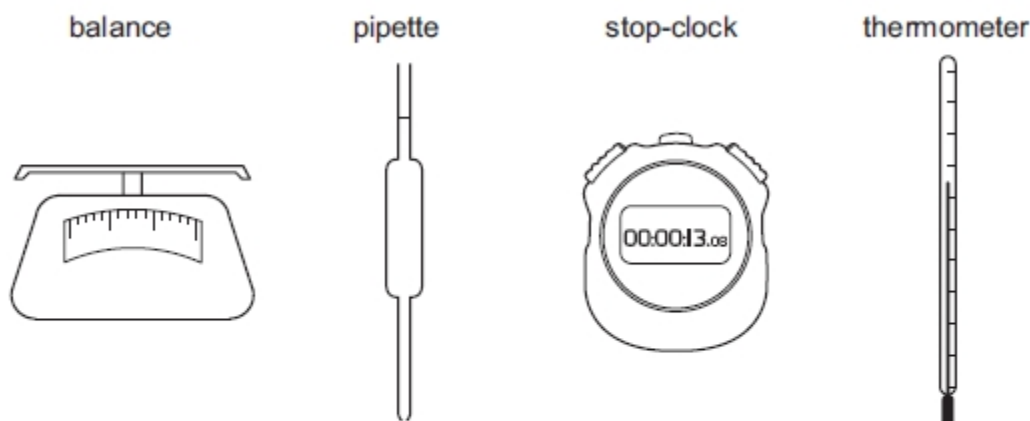
Volumetric pipette

Wash bottle (filled with distilled water)

6.8 ESSENTIAL EXAM QUESTIONS Paper 2 Topic 2 11marks

Q# 1/ iGCSE Chemistry/2018/w/Paper 21/

2 The diagrams show four pieces of laboratory equipment.



Which equipment is essential to find out if dissolving a salt in water is an exothermic process?

	balance	pipette	stop-clock	thermometer
A	x	x	x	✓
B	✓	x	x	✓
C	x	✓	x	✓
D	✓	x	✓	x

Q# 2/ iGCSE Chemistry/2018/s/Paper 23/

2 Paper chromatography is done in the same way with three different mixtures of dyes. Each mixture contains at least one of the dyes W, X, Y and Z.

The R_f values of the dyes in the three mixtures are shown.

dye	R_f values from mixture 1	R_f values from mixture 2	R_f values from mixture 3
W	0.15	0.15	0.15
X	0.00	0.00	0.00
Y	0.50	0.50	0.50
Z	0.00	0.91	0.91

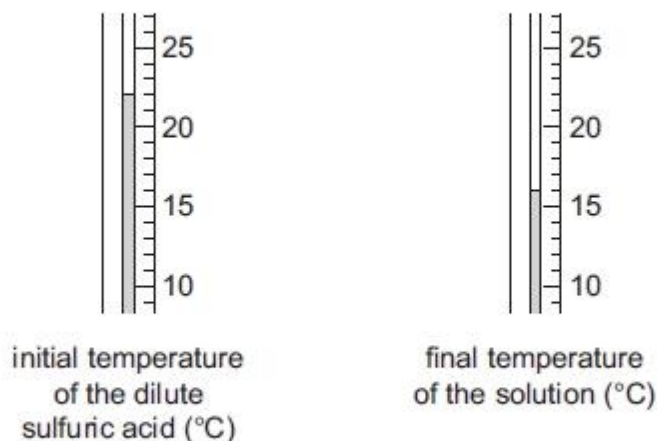
Which conclusion is correct?

- A Dye W is nearest the solvent front and is present only in mixture 1 and mixture 3.
- B Dye X has travelled furthest up the chromatography paper.
- C Dye Y is the only dye present in all three mixtures.
- D Dye Z is nearest the solvent front and is found in only two of the mixtures.



3 Solid R reacted with dilute sulfuric acid.

The initial temperature of the dilute sulfuric acid and the final temperature of the solution are shown.



What was the change in temperature in °C?

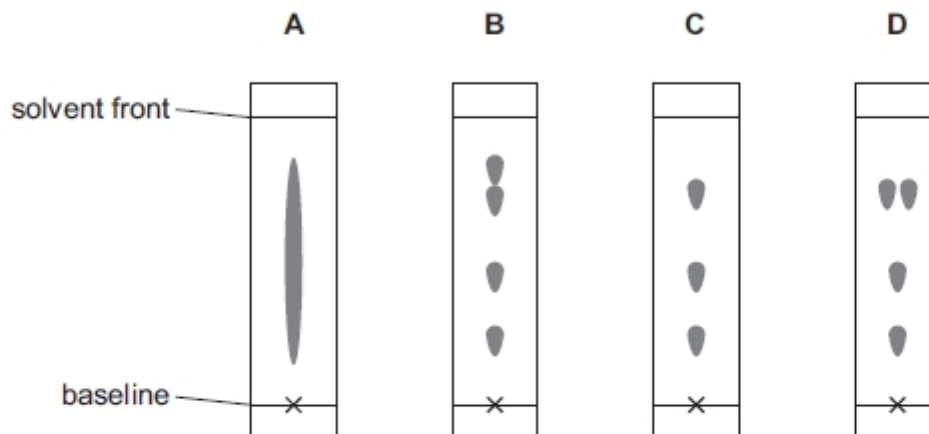
- A -6 B -4 C 4 D 6

Q# 3/ iGCSE Chemistry/2018/s/Paper 22/

2 A chromatography experiment was done to separate a mixture of four substances.

The R_f values measured for these substances were 0.3, 0.5, 0.8 and 0.8.

Which diagram shows the chromatogram obtained?



3 Which piece of apparatus **cannot** be used to collect and measure the volume of gas produced in an experiment?

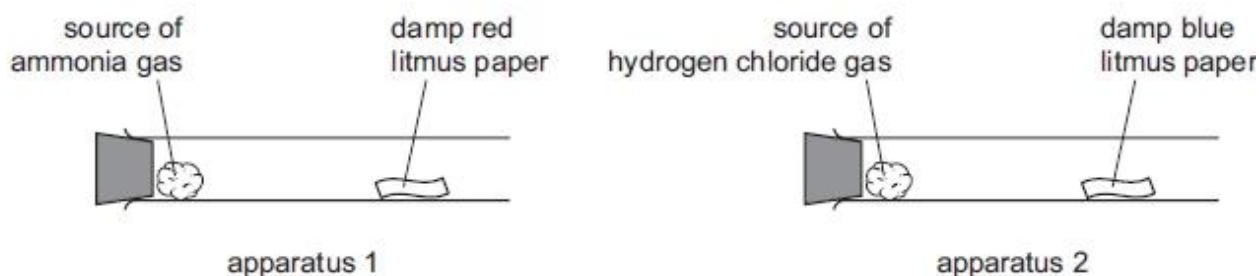
- A burette
B gas syringe
C measuring cylinder
D pipette



Q# 4/ iGCSE Chemistry/2018/s/Paper 21/

1 A student investigated the diffusion of ammonia gas, NH_3 , and hydrogen chloride gas, HCl .

Two sets of apparatus were set up as shown at room temperature and pressure.



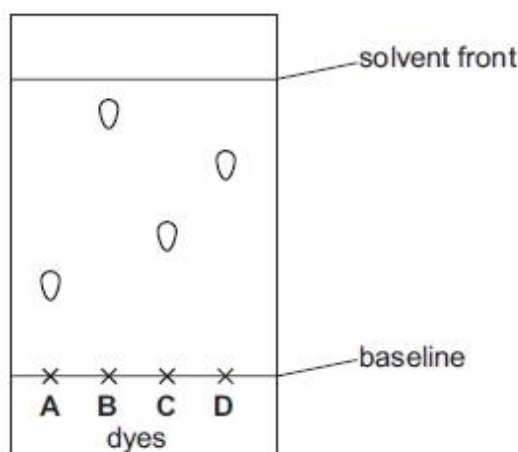
The damp red litmus paper in apparatus 1 changed colour after 30 seconds.

How long does it take for the damp blue litmus paper to change colour in apparatus 2?

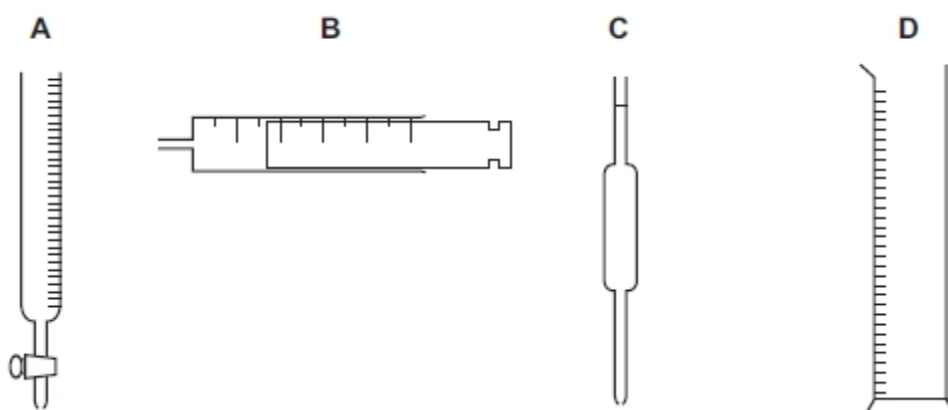
- A** 64 seconds
- B** 30 seconds
- C** 21 seconds
- D** The blue litmus paper would not change colour.

2 Chromatography is a technique used to separate coloured dyes.

Which dye has an R_f value of 0.7?



3 Which piece of apparatus is used to measure exactly 26.3 cm^3 of a liquid?



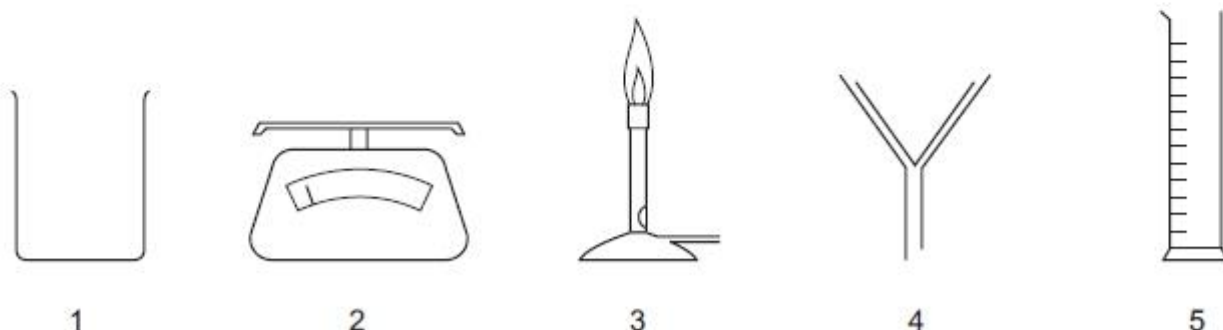
2 Which method should be used to separate a mixture of two liquids?

- A crystallisation
- B electrolysis
- C filtration
- D fractional distillation

3 Lead(II) iodide is insoluble in water.

Lead(II) iodide is made by adding aqueous lead(II) nitrate to aqueous potassium iodide.

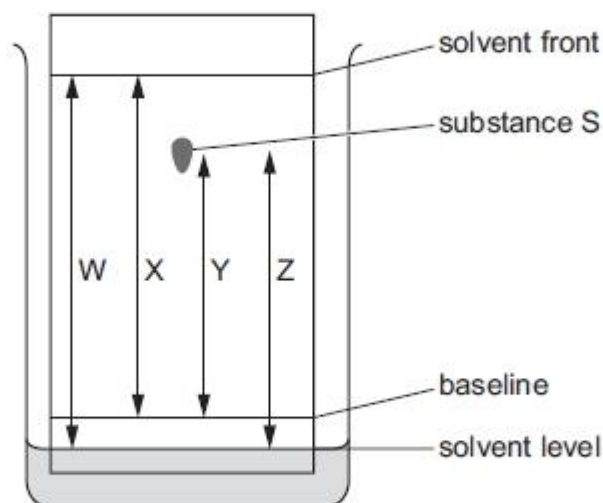
Which pieces of apparatus are needed to obtain solid lead(II) iodide from 20 cm³ of aqueous lead(II) nitrate?



- A 1, 2 and 4 B 1, 3 and 5 C 1, 4 and 5 D 2, 4 and 5

4 The chromatogram of substance S is shown.

Some distances, W, X, Y and Z, are labelled on the diagram.



How is the R_f value of substance S calculated?

- A $\frac{X}{Y}$ B $\frac{W}{Z}$ C $\frac{Y}{X}$ D $\frac{Y}{W}$



6.8.1 ESSENTIAL EXAM QUESTIONS Paper 2 T2 11marks Mark Scheme

Q# 1/ iGCSE Chemistry/2018/w/Paper 21/

2	A
---	---

Q# 2/ iGCSE Chemistry/2018/s/Paper 23/

2	D
3	A

Q# 3/ iGCSE Chemistry/2018/s/Paper 22/

2	C
3	D

Q# 4/ iGCSE Chemistry/2018/s/Paper 21/

2	D
3	A
4	C

Q# 5/ iGCSE Chemistry/2018/m/Paper 22/

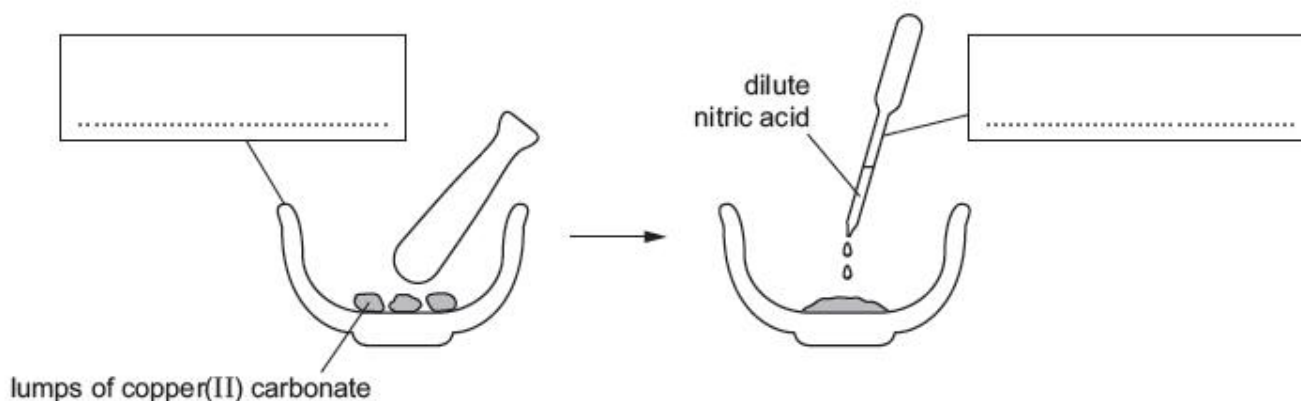
2	D
3	C
4	C

6.9 ESSENTIAL EXAM QUESTIONS Paper 6 Labelling Equipment and Understanding Experiments

iG Chem 2 EQ 18w to 16m Labelling Equipment and Understanding Experiments 66marks

Q# 2/ iGCSE Chemistry/2018/w/Paper 62/Q1

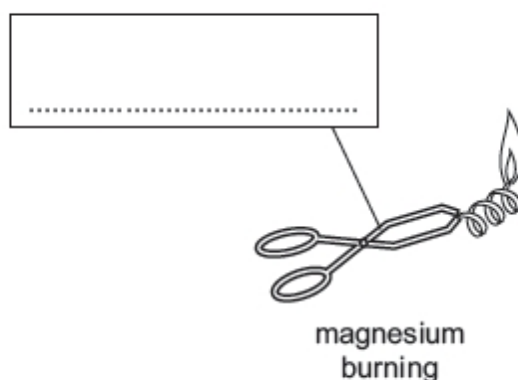
- 1 A sample of copper was prepared from lumps of copper(II) carbonate. The first step was to make a solution of copper(II) nitrate as shown. Carbon dioxide was produced.



(a) Complete the boxes to name the apparatus.

[2]

- 1 Magnesium ribbon was burned in air.



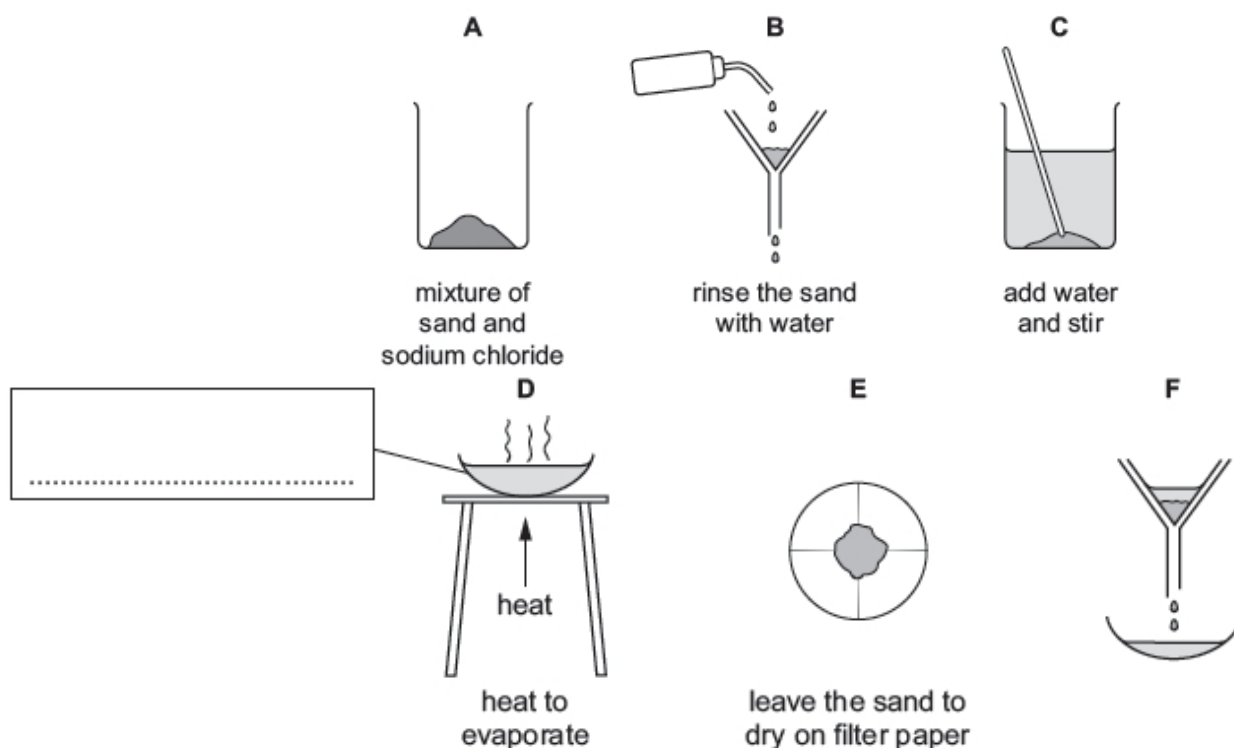
(a) Complete the box to name the apparatus.

[1]

(f) State **one** safety precaution that should be taken when magnesium is burned in air.

Q# 3/ IGCSE Chemistry/2018/w/Paper 61/Q1

- 1 A student obtains pure, dry samples of sand and sodium chloride from a mixture of sand and sodium chloride.
The student uses the apparatus shown. The method consists of six steps, **A**, **B**, **C**, **D**, **E** and **F**, which are shown in the wrong order.



- (a) Order the steps in the method.

A → → → → →

[2]

- (b) Complete the box to name the apparatus in **D**.

[1]

- (c) Why is the sand rinsed with water in **B**?

.....
..... [1]

- (d) Name the process in **F**.

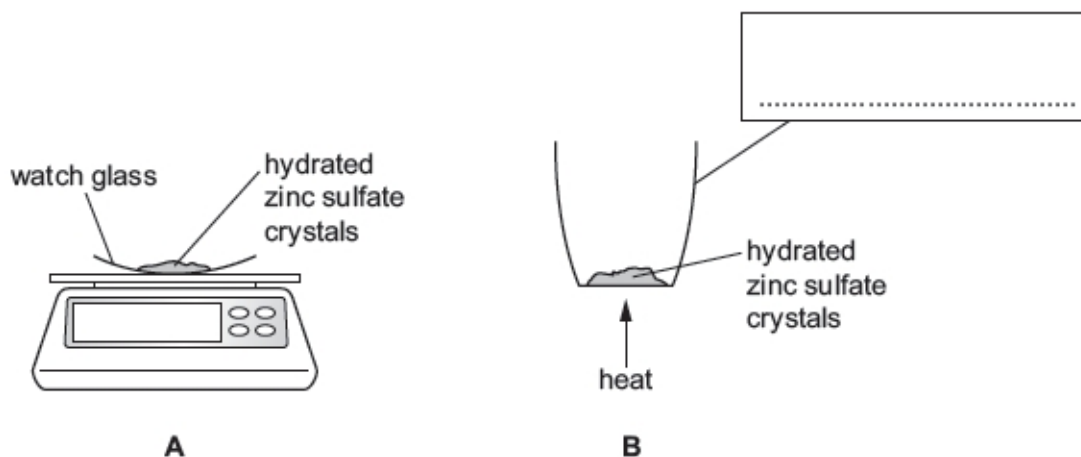
..... [1]

- (e) How could the purity of the sodium chloride obtained be checked?

..... [1]

Q# 4/ IGCSE Chemistry/2018/s/Paper 63/Q1

- 1 Zinc sulfate crystals are hydrated. They contain water of crystallisation. A student did an experiment to find the mass of water in hydrated zinc sulfate crystals.
The hydrated zinc sulfate crystals were weighed and then heated with a Bunsen burner to remove the water as shown.

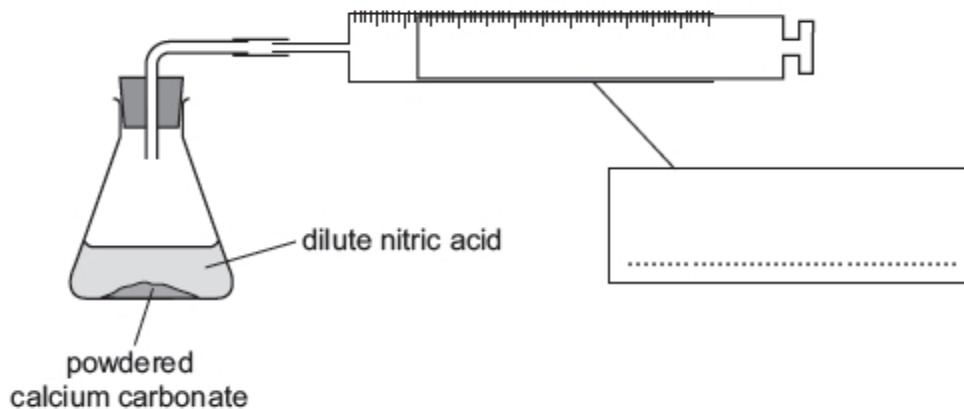


- (a) (i) Name the apparatus used to weigh the crystals in A.

..... [1]
(ii) Complete the box to name the apparatus. [1]

Q# 5/ IGCSE Chemistry/2018/s/Paper 62/Q1

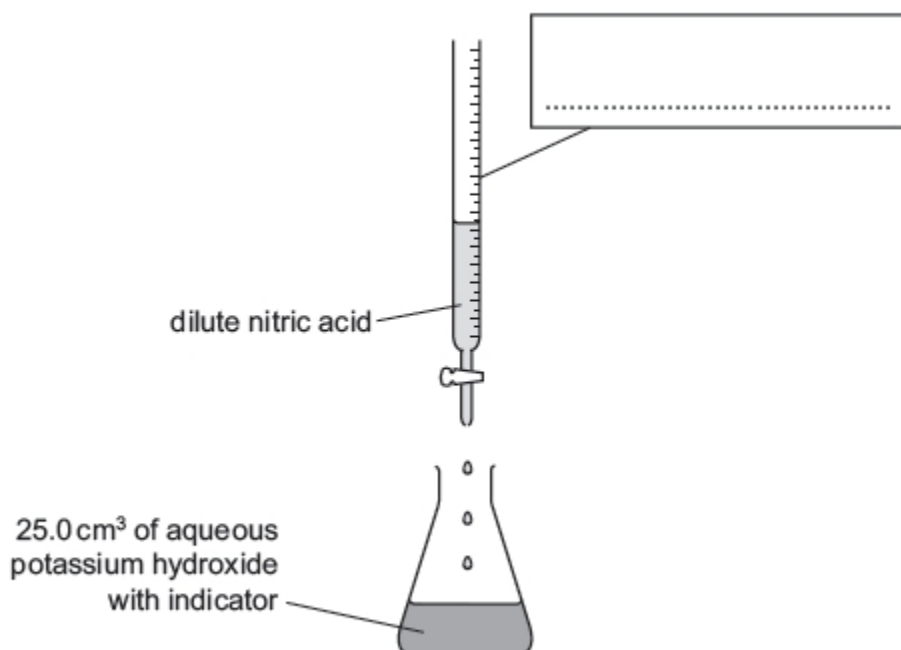
- 1 The rate of reaction between an excess of dilute nitric acid and powdered calcium carbonate was investigated. The carbon dioxide produced was collected. The apparatus used is shown.



- (a) Complete the box to name the apparatus. [1]

Q# 6/ iGCSE Chemistry/2018/s/Paper 61/Q1

- 1** The volume of dilute nitric acid that reacts with 25.0 cm^3 of aqueous potassium hydroxide can be found by titration using the apparatus shown.

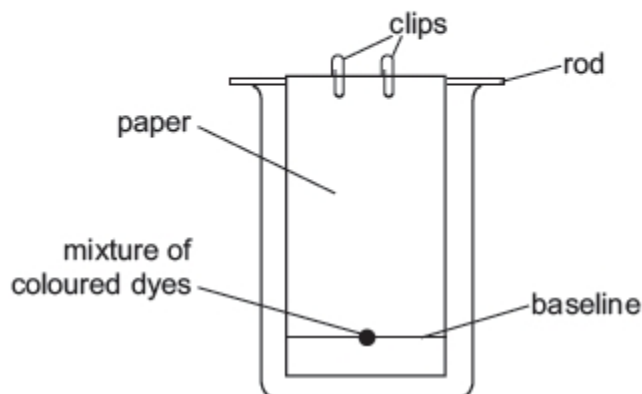


(a) Complete the box to name the apparatus.

[1]

Q# 7/ iGCSE Chemistry/2018/m/Paper 62/Q1

- 1** A student used paper chromatography to separate a mixture of coloured dyes. The diagram shows the apparatus used.



(a) (i) Draw a line on the diagram to show the level of the solvent.

[1]

(ii) Suggest a suitable solvent that could be used.

..... [1]

(b) What could be used to put the mixture of coloured dyes onto the paper?

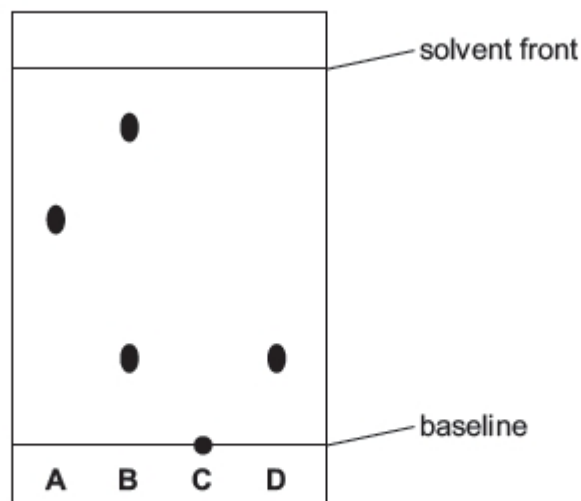
..... [1]

(c) The clips hold the paper in position.

Why is this important for the chromatography experiment?

..... [1]

The diagram shows the chromatogram obtained from four dyes, A, B, C and D.



(d) Give **one** conclusion that can be drawn about dye B.

..... [1]

(e) Suggest why dye C remained on the baseline.

..... [1]

(f) R_f values are used to identify compounds.

$$R_f = \frac{\text{distance travelled by the compound}}{\text{distance travelled by the solvent}}$$

Calculate the R_f value of dye A.

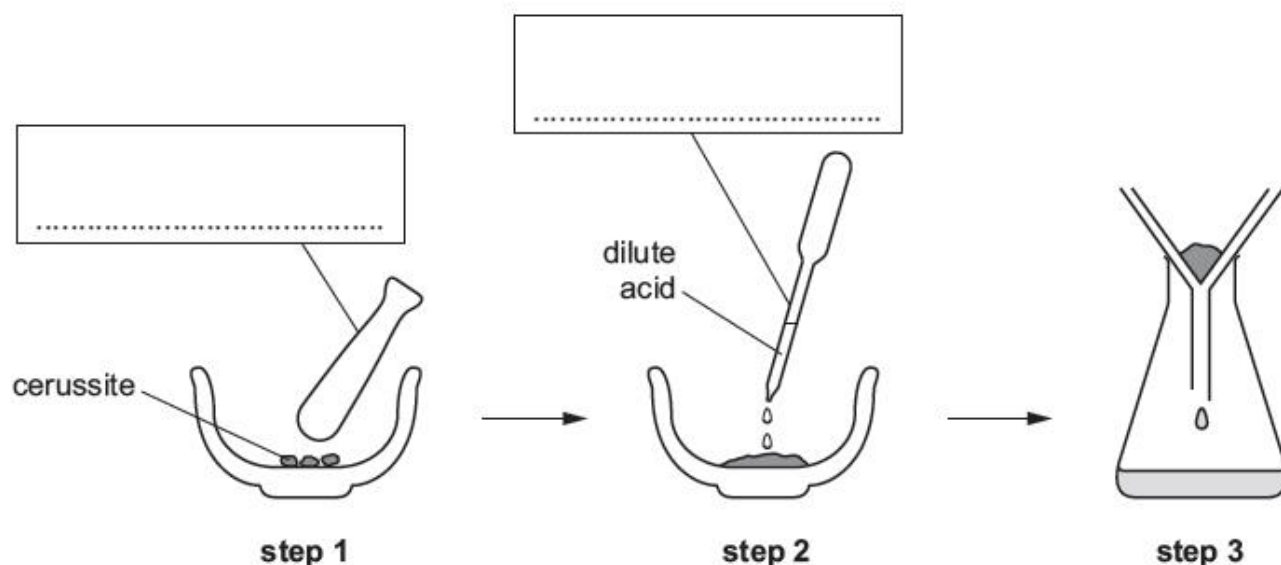
$R_f =$ [2]

[Total: 8]



Q# 8/ IGCSE Chemistry/2017/w/Paper 63/Q1

- 1 Cerussite is a lead ore which contains lead(II) carbonate. A student obtained a solution of lead(II) nitrate from cerussite using the apparatus shown.



(a) Complete the boxes to name the apparatus.

[2]

(b) Why was the cerussite crushed in **step 1**?

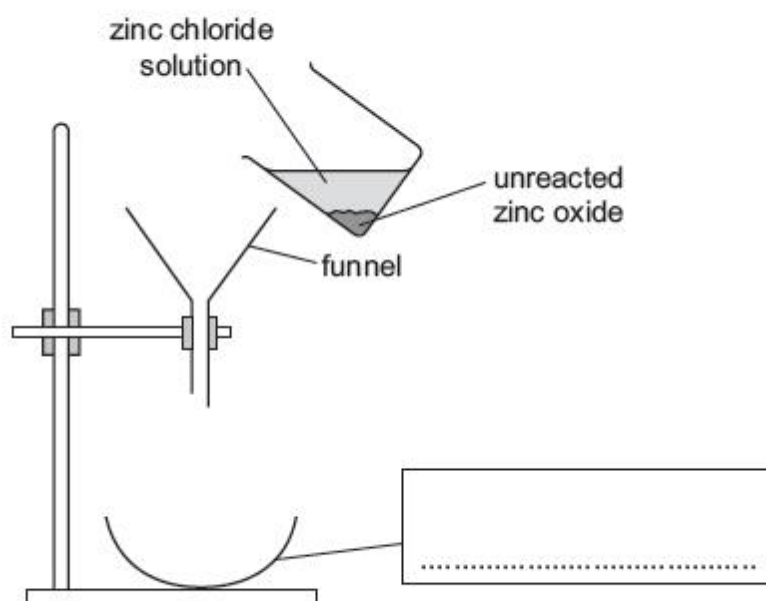
..... [1]

(d) What is the general name given to an insoluble solid left on a filter paper after filtration?

..... [1]

Q# 9/ IGCSE Chemistry/2017/w/Paper 61/Q1

- 1 A student reacted dilute hydrochloric acid with zinc oxide to prepare zinc chloride solution. The diagram shows part of the procedure.



(a) Complete the box to name the apparatus.

[1]

(b) Which of the reactants was in excess?

..... [1]

(c) (i) Name the separation process this apparatus is used for.

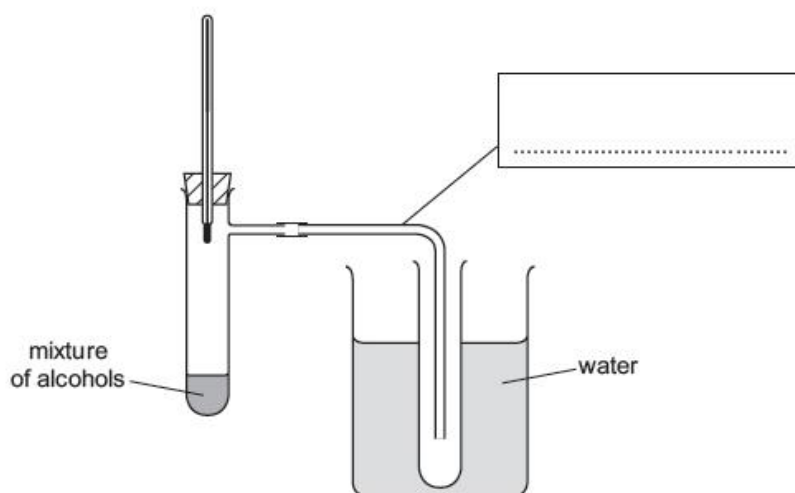
..... [1]

(ii) Suggest why this apparatus would **not** work.

.....
..... [1]

Q# 10/ iGCSE Chemistry/2017/s/Paper 63/Q1

- 1 A mixture of alcohols can be separated by fractional distillation. The apparatus shown was used to separate ethanol from the mixture.



(a) (i) Complete the box to identify the apparatus. [1]

(ii) Indicate with an arrow where heat is applied. [1]

(b) What is the purpose of the water?

.....
..... [2]

(c) Why is the thermometer bulb placed as shown and **not** in the mixture of alcohols?

.....
..... [1]

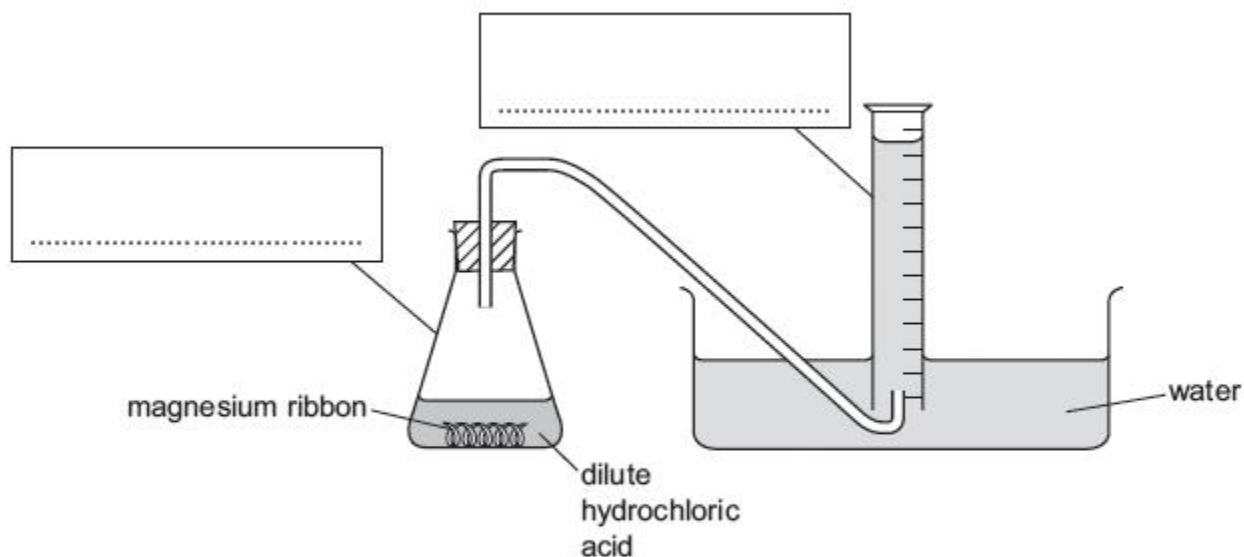
(d) Use the letter **E** to indicate on the diagram where ethanol would collect. [1]

(e)

(ii) Give a physical test to identify pure ethanol.

..... [1]

- 1 A student investigated the rate of reaction between an excess of dilute hydrochloric acid and magnesium ribbon. The apparatus is shown.



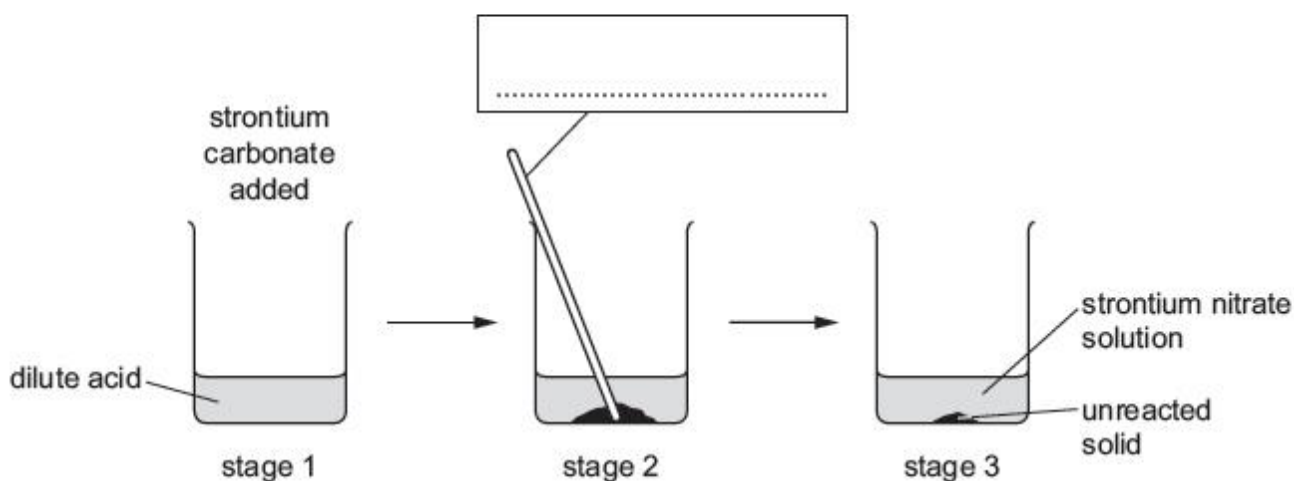
Two experiments were carried out. The temperature was the same in each case.

- (a) Complete the boxes to identify the apparatus.

[2]

- 1 A student prepared strontium nitrate crystals.

The diagram shows some of the stages in this preparation.



- (a) (i) Complete the box to identify the apparatus.

[1]

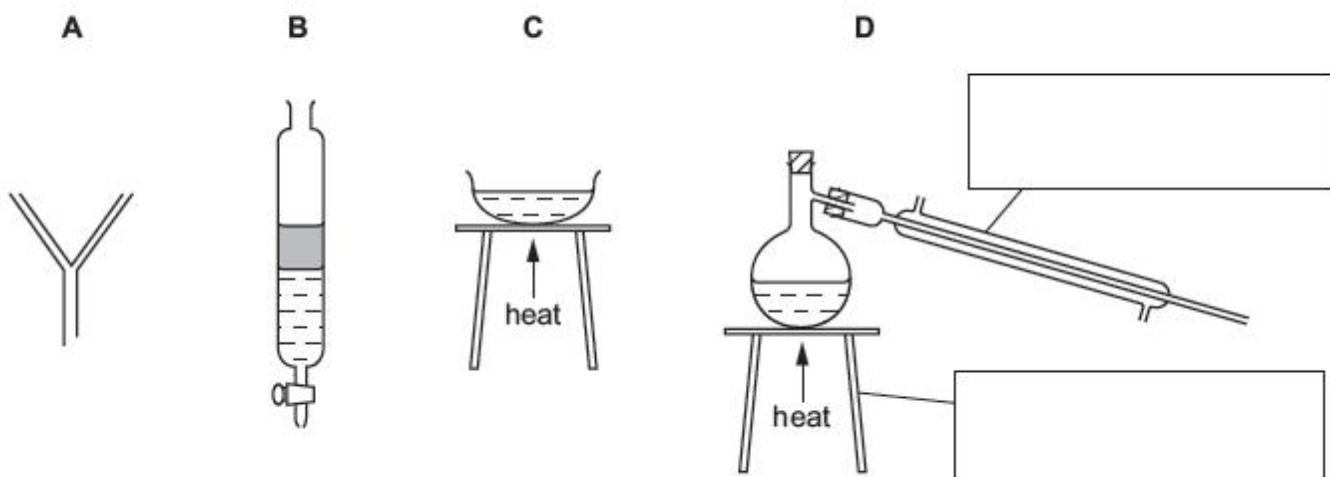
- (ii) What is used to add the strontium carbonate to the acid in stage 1?

..... [1]



1 This question is about the separation of mixtures.

The diagram shows four sets of apparatus that can be used to separate mixtures.



(a) Complete the boxes to name the apparatus.

[2]

(b) The table shows four different mixtures.

Complete the table to show which set of apparatus should be used to obtain the substance listed. The first one has been completed for you. Each set of apparatus can be used once, more than once or not at all.

mixture	to obtain	use apparatus
petroleum and water	petroleum	B
sodium chloride dissolved in water	sodium chloride crystals	.....
sodium chloride dissolved in water	water	.....
insoluble silver chloride and water	silver chloride	.....

[3]

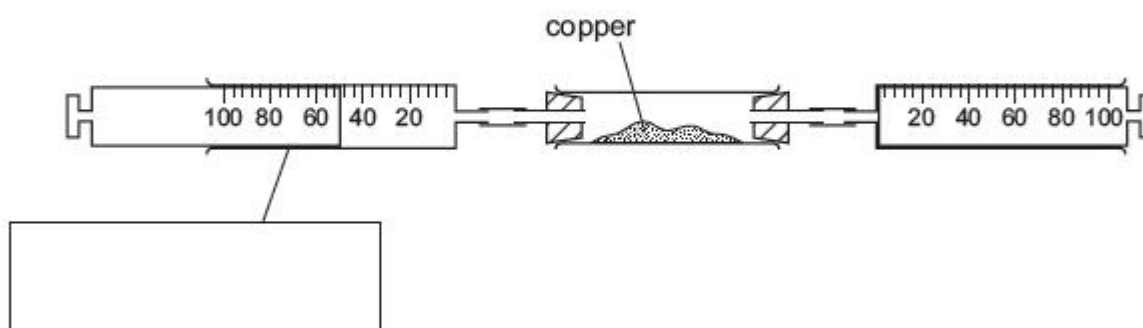
(c) Put a ring around the separation method that should be used to separate a mixture of coloured dyes.

centrifugation chromatography condensation evaporation

[1]

Q# 14/ IGCSE Chemistry/2016/s/Paper 63/Q1

- 1 Air is a mixture of gases. The diagram shows the apparatus used to find the percentage of oxygen in air.
50 cm³ of air were passed backwards and forwards over excess heated copper until there was no further change. The apparatus was left to cool and the volume of gas remaining was 40 cm³.



(a) Complete the box to name the apparatus.

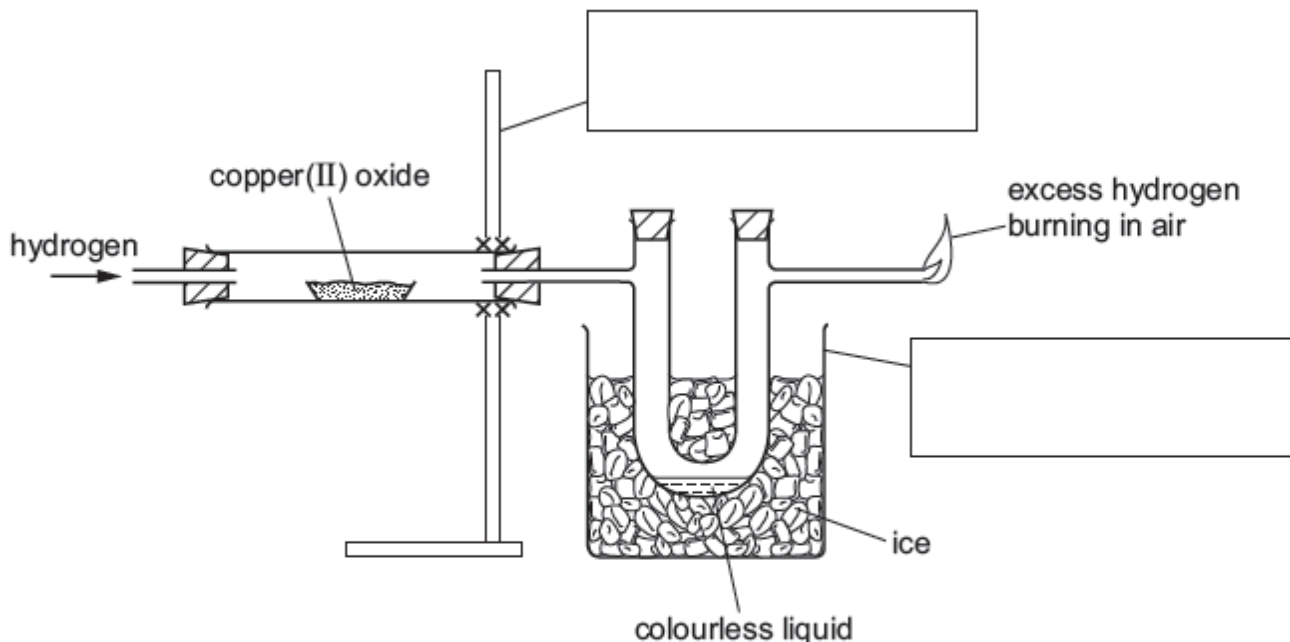
[1]

(b) Use an arrow to indicate where heat is applied.

[1]

Q# 15/ IGCSE Chemistry/2016/s/Paper 62/Q1

- 1 The diagram shows the apparatus used to reduce copper(II) oxide with hydrogen.



(a) Complete the boxes to name the apparatus.

[2]

(d) Suggest a reason why the U-tube is surrounded by ice.

[1]

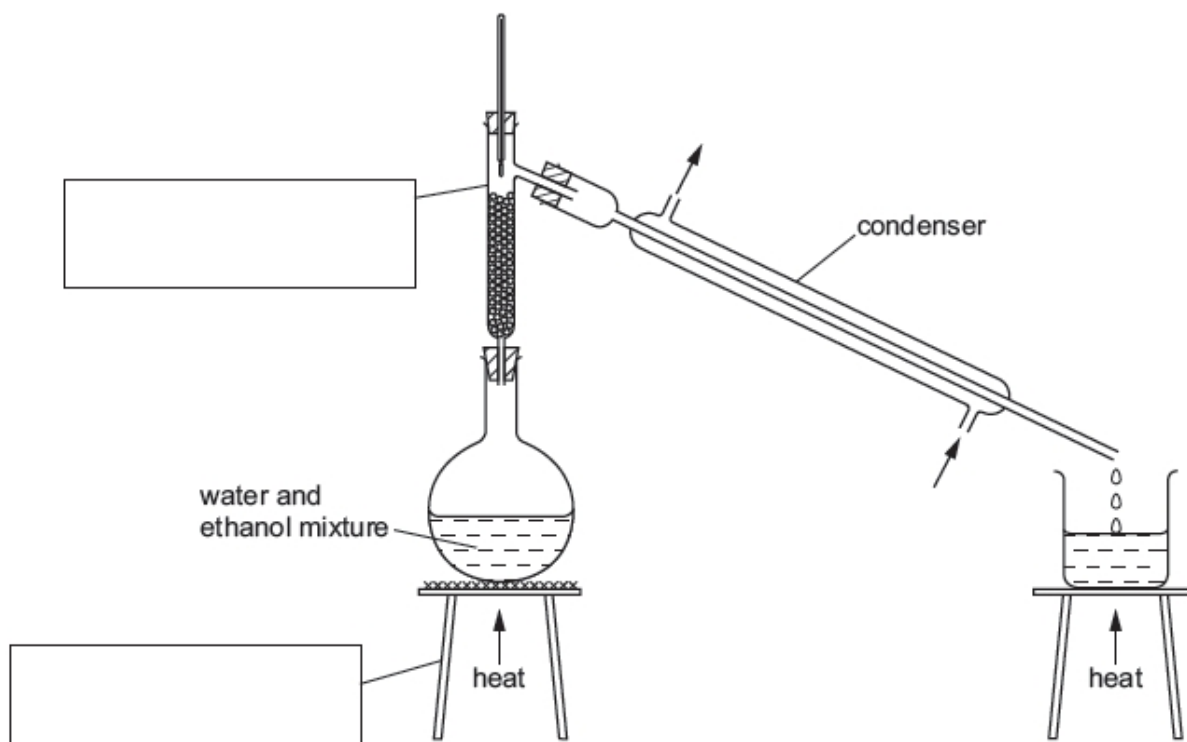
(e) The colourless liquid is water

(iii) How could you show that this liquid is pure?

[1]

Q# 16/ IGCSE Chemistry/2016/s/Paper 61/Q1

- 1 The diagram shows the apparatus used to separate a mixture of water, boiling point 100°C , and ethanol, boiling point 78°C .



(a) Complete the boxes to name the apparatus.

[2]

(b) Label the arrows on the condenser.

[1]

(c) Identify **one** mistake in the apparatus.

[1]

(d) Which liquid would collect first? Explain your answer.

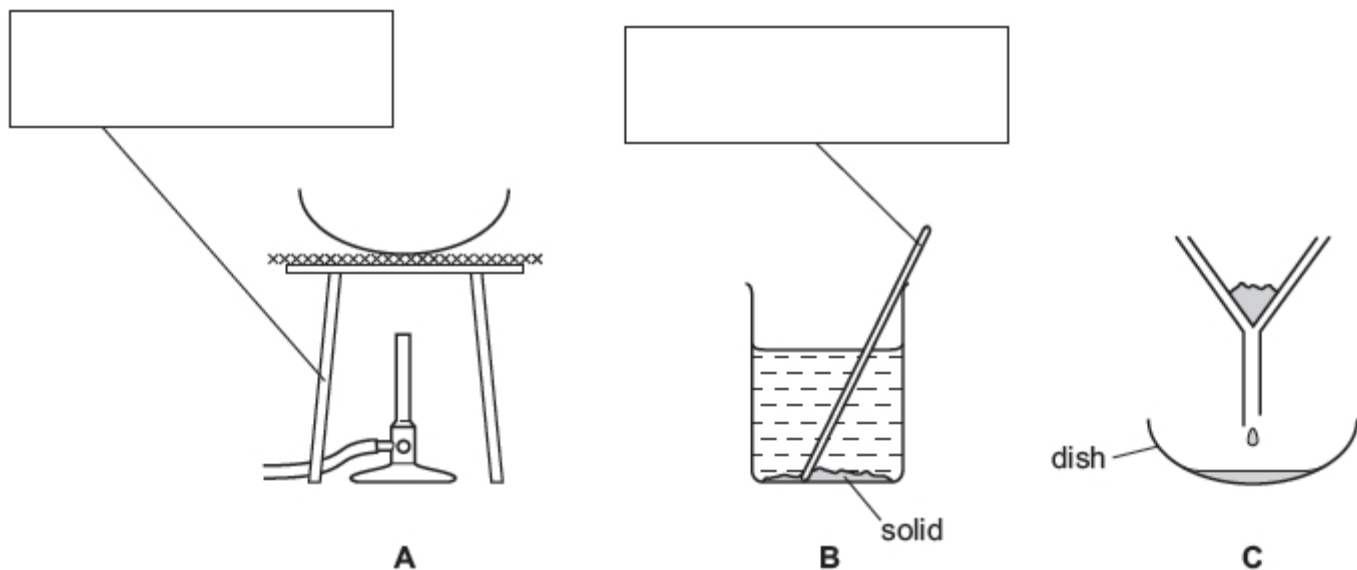
[2]

(e) Why would it be better to use an electrical heater instead of a Bunsen burner to heat the water and ethanol mixture?

[1]

Q# 17/ IGCSE Chemistry/2016/m/Paper 62/Q1

- 1** The diagrams show the apparatus used to obtain crystals of calcium chloride from a mixture of solid calcium chloride and solid calcium carbonate.
Calcium chloride is soluble in water and calcium carbonate is insoluble in water.



(a) Complete the boxes to name the apparatus. [2]

(b) (i) Write down the order in which the apparatus should be used in this experiment.

..... [1]

(ii) Name the separation process in **C**.

..... [1]

(c) (i) What has been added to the mixture in **B**?

..... [1]

(ii) What is the general name given to the liquid in the dish in **C**?

..... [1]

(d) How would you know when to stop heating the dish in **A**?

.....

..... [1]

6.9.1 Mark Scheme iG Chem 2 EQ 18w to 16m Labelling Equipment

Q# 1/ iGCSE Chemistry/2018/w/Paper 63/Q1

1(a)	mortar	1
	(Teat / dropping) pipette / dropper	1

Q# 2/ iGCSE Chemistry/2018/w/Paper 62/Q1

1(a)	Tong(s)	1
------	---------	---



1(f)	Goggles / blue glass	1
------	----------------------	---

Q# 3/ iGCSE Chemistry/2018/w/Paper 61/Q1

1(a)	M1 (A),C,F	1
	M2 B,D,E OR B,E,D OR D,B,E	1
1(b)	Evaporating / crystallising basin / dish	1
1(c)	To wash-out / dissolve / remove sodium chloride / salt	1
1(d)	Filtration	1
1(e)	Melting point	1

Q# 4/ iGCSE Chemistry/2018/s/Paper 63/Q1

1(a)(i)	balance	1
1(a)(ii)	crucible	1
1(b)	open	1
1(c)	weigh the solid	1
	heat to constant mass	1
1(d)	anhydrous copper sulfate / cobalt chloride paper	1
	turns blue / turns pink	1

Q# 5/ iGCSE Chemistry/2018/s/Paper 62/Q1

1(a)	(gas) syringe	1
------	---------------	---

Q# 6/ iGCSE Chemistry/2018/s/Paper 61/Q1

1(a)	burette	1
------	---------	---

Q# 7/ iGCSE Chemistry/2018/m/Paper 62/Q1

1(a)(i)	line drawn on diagram between base line and bottom of paper and below dot	1
1(a)(ii)	water	1
1(b)	dropper / teat pipette	1
1(c)	so mixture is above / not in contact/does not run/dissolve in solvent	1
1(d)	is two substances / contains D	1
1(e)	insoluble	1
1(f)	2.8 to 3.2 / 5	1
	0.56–0.64	1

Q# 8/ iGCSE Chemistry/2017/w/Paper 63/

1(a)	pestle	1
	(teat) pipette	1
1(b)	to increase surface area / make it dissolve faster	1
1(c)	nitric (acid)	1
1(d)	residue	1

Q# 9/ iGCSE Chemistry/2017/w/Paper 61/

1(a)	evaporating basin / dish	1
1(b)	zinc oxide	1
1(c)(i)	filtration	1
1(c)(ii)	no filter paper	1



Q# 10/ iGCSE Chemistry/2017/s/Paper 63/

1(a)(i)	(delivery) tube	1
1(a)(iii)	arrow beneath the tube containing the mixture of alcohols	1
1(b)	to cool	1
	the gas into a liquid	1
1(c)	to measure the temperature of the vapour/temperature of liquid would not be constant	1
1(d)	E shown on the test-tube in water bath	1
1(a)(i)	(delivery) tube	1
1(a)(iii)	arrow beneath the tube containing the mixture of alcohols	1
1(b)	to cool	1
	the gas into a liquid	1
1(c)	to measure the temperature of the vapour/temperature of liquid would not be constant	1
1(d)	E shown on the test-tube in water bath	1
1(e)(i)	lighted splint ignites the liquid /test for water, e.g. add anhydrous copper(II) sulfate gives a negative result	1
1(e)(ii)	melting /boiling point determination	1

Q# 11/ iGCSE Chemistry/2017/s/Paper 62/

1(a)	measuring cylinder	1
	conical flask	1

Q# 12/ iGCSE Chemistry/2017/s/Paper 61/

1(a)(i)	stirrer / glass rod	1
1(a)(ii)	Spatula	1

Q# 13/ iGCSE Chemistry/2016/w/Paper 62/

1(a)	(liebig) condenser tripod	1 1
1(b)	sodium chloride crystals: C water: D silver chloride: A	1 1 1
1(c)	chromatography	1

Q# 14/ iGCSE Chemistry/2016/s/Paper 63/

1(a)	(gas) syringe;	1
1(b)	arrow under copper;	1

Q# 15/ iGCSE Chemistry/2016/s/Paper 62/

1(a)	stand; beaker;	1 1	2
1(d)	to condense (the water vapour);	1	
1(e)(iii)	boiling / melting point determination;	1	

Q# 16/ iGCSE Chemistry/2016/s/Paper 61/

Question	Answer	Marks
1(a)	fractionating column; tripod;	1 1
1(b)	<u>water</u> labelled twice;	1
1(c)	heat under (the collecting) beaker;	1
1(d)	M1 ethanol; M2 lowest/ lower boiling point;	1 1
1(e)	ethanol is flammable;	1



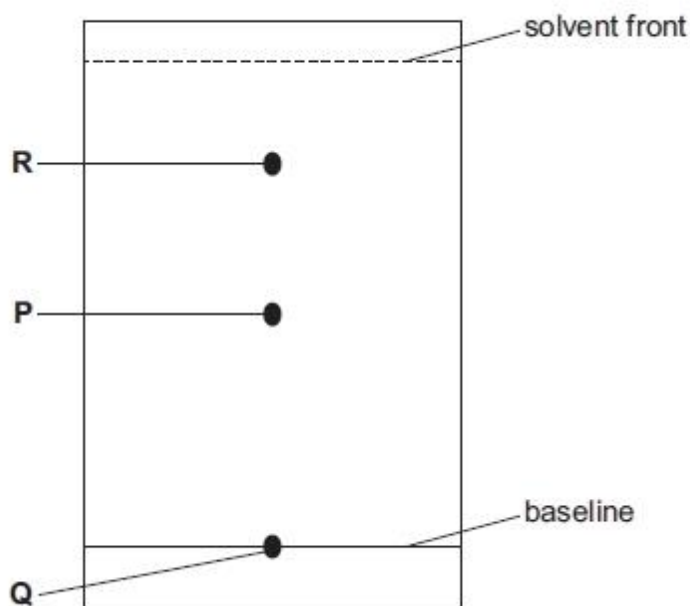
Q# 17/ iGCSE Chemistry/2016/m/Paper 62/

1(a)	tripod; stirring rod/stirrer;	2
1(b)(i)	B C A;	1
1(b)(ii)	filtration;	1
1(c)(i)	water;	1
1(c)(ii)	filtrate;	1
1(d)	solid/ crystals appearing on edge/glass rod test;	1

6.10 ESSENTIAL EXAM QUESTIONS Paper 6 Topic 2 Experimental Techniques 79 marks

Q# 1/ iGCSE Chem/2015/w/Paper 62/

2 A mixture of three compounds, **P**, **Q** and **R**, was separated using a piece of paper.



(a) Name this method of separation.

..... [1]

(b) What could have been used to apply the mixture onto the paper?

..... [1]

(c) Suggest a possible solvent that could be used for this separation.

..... [1]

(d) Suggest why compound **Q** remained on the baseline.

.....
 [1]



(e) R_f values are used to identify compounds.

$$R_f = \frac{\text{distance travelled by compound}}{\text{distance travelled by the solvent}}$$

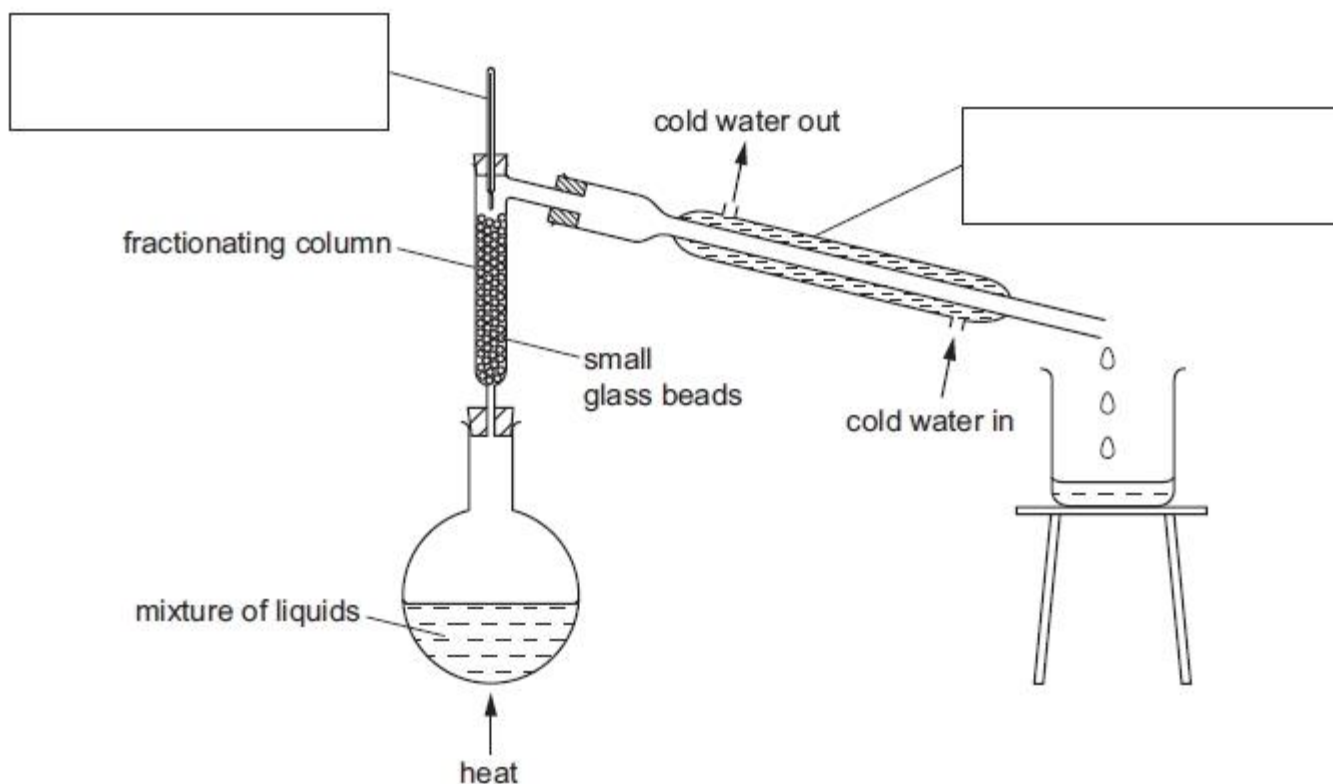
Use the diagram to work out the R_f value of compound R.

.....
..... [2]

Q# 2/ iGCSE Chem/2015march/Paper 6/

1 A teacher separated a mixture of two liquids using the apparatus shown. The liquids were:

- ethanoic acid, boiling point 118°C ,
- chloroethanoic acid, boiling point 190°C .



(a) Complete the boxes to label the pieces of apparatus used.

[2]

(b) (i) Which liquid would be collected first? Explain why.

.....
..... [2]

(ii) How would the teacher know when all of this liquid had been collected?

..... [1]

- (c) Suggest why small glass beads are used in the fractionating column instead of large glass beads.

.....
 [1]

Q# 3/ iGCSE Chem/2015march/Paper 6/

- 4 A student investigated the solubility of salt **D** in water at various temperatures.

Four experiments were carried out.

(a) *Experiment 1*

4 g of salt **D** was added to a boiling tube. A burette was filled with distilled water and 10.0 cm³ of water added to the boiling tube. The mixture of salt **D** and water was heated carefully until all of the solid had dissolved. The boiling tube was removed from the heat and the solution allowed to cool. The solution was stirred gently with a thermometer.

The temperature at which crystals first appeared was noted.

The boiling tube and its contents were kept for the remaining three experiments.

(b) *Experiment 2*

From the burette another 2.0 cm³ of water was added to the boiling tube and contents from Experiment 1.

The mixture was heated to dissolve the crystals and allowed to cool as in Experiment 1. The temperature at which crystals first appeared was noted.

Record, in the table, the total volume of water in the boiling tube.

(c) *Experiment 3*

From the burette another 2.0 cm³ of water was added to the boiling tube and contents from Experiment 2. The experiment was repeated exactly as before.

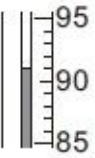
Record, in the table, the total volume of water in the boiling tube.

(d) *Experiment 4*

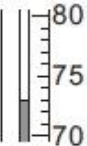
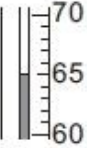
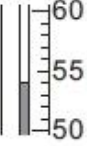
From the burette another 4.0 cm³ of water was added to the boiling tube and contents from Experiment 3. The experiment was repeated exactly as before.

Record in the table the total volume of water in the boiling tube.

Use the thermometer diagrams in the table to record the temperatures at which crystals first appeared in the four experiments.

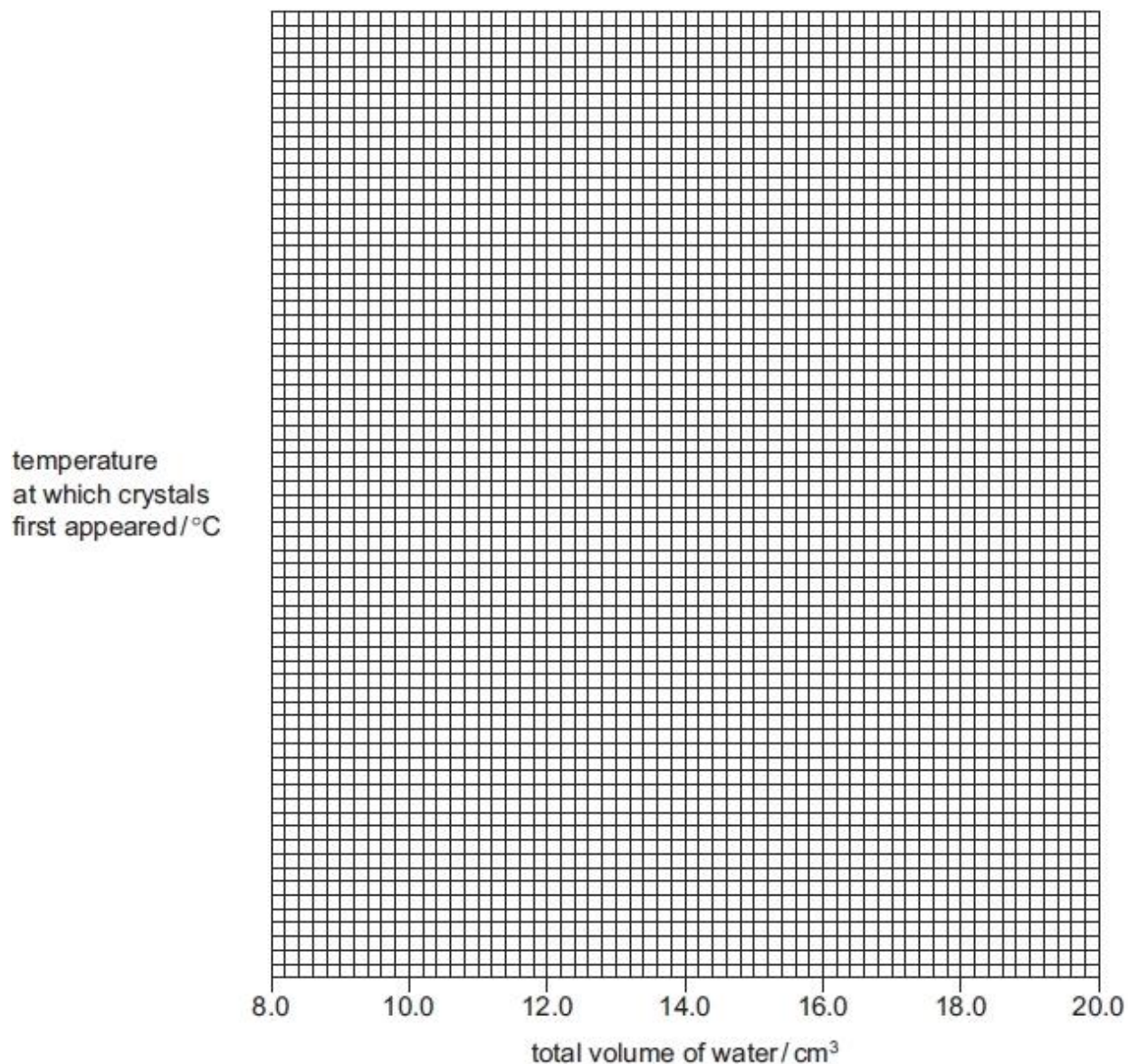
Experiment number	total volume of water / cm ³	thermometer diagram	temperature at which crystals first appeared / °C
1	10.0		



2			
3			
4			

[3]

(e) Plot the results on the grid below and draw a smooth line graph.



[5]



- (f) From your graph, find the temperature at which crystals of **D** would first appear if the total volume of water in the solution was 20.0 cm^3 .
Show clearly **on the grid** how you worked out your answer.

..... [3]

- (g) How would the student know when salt **D** was completely dissolved in the water?

..... [1]

- (h) The solubility of salt **D** at 100°C is 57 g in 100 cm^3 of water.
Suggest, with a reason, the effect of using 8 g of salt **D** instead of 4 g in these experiments.

..... [2]

- (i) Salt **C** is less soluble in water than salt **D**.

Sketch on the grid the graph you would expect for salt **C**. Label this graph. [2]

- (j) Describe and explain **one** improvement that could be made to the experimental method to obtain more reliable results in this investigation.

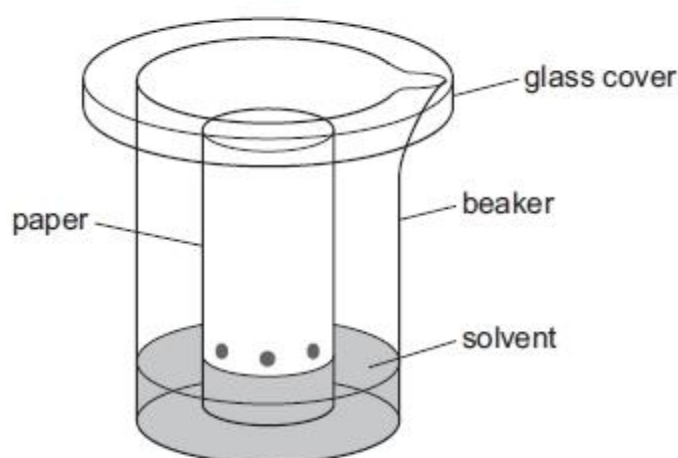
improvement

explanation

..... [2]

Q# 4/ IGCSE Chem/2014/w/Paper 6/

- 3** A student investigated the colours present in a fruit drink. The fruit drink was tested to check that no artificial colours had been added. The apparatus below was used.



- (a) (i) Name the method used.

..... [1]

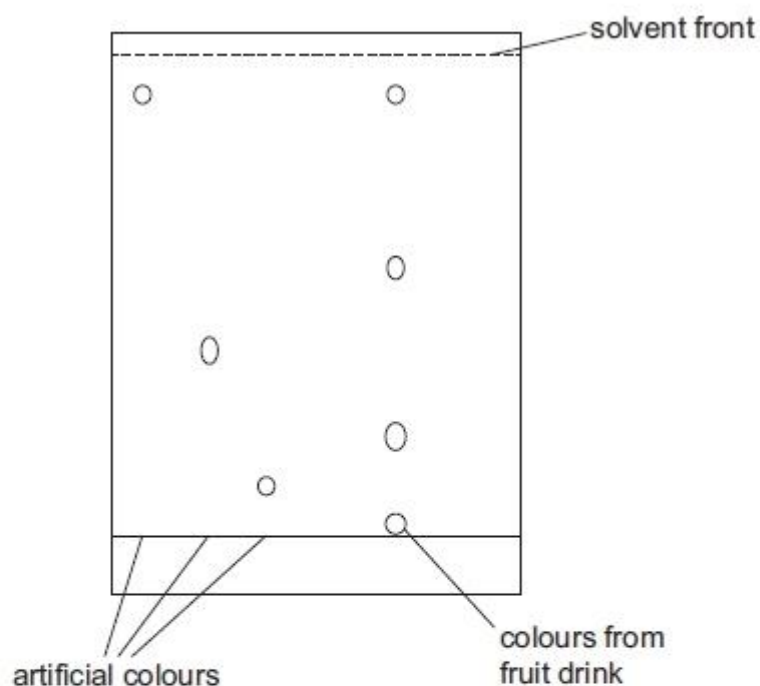
(ii) Why is there a glass cover on the beaker?

..... [1]

(b) When should the paper be removed from the beaker?

..... [1]

(c) The diagram shows the results of the experiment.



(i) How many different coloured compounds were present in the fruit drink?

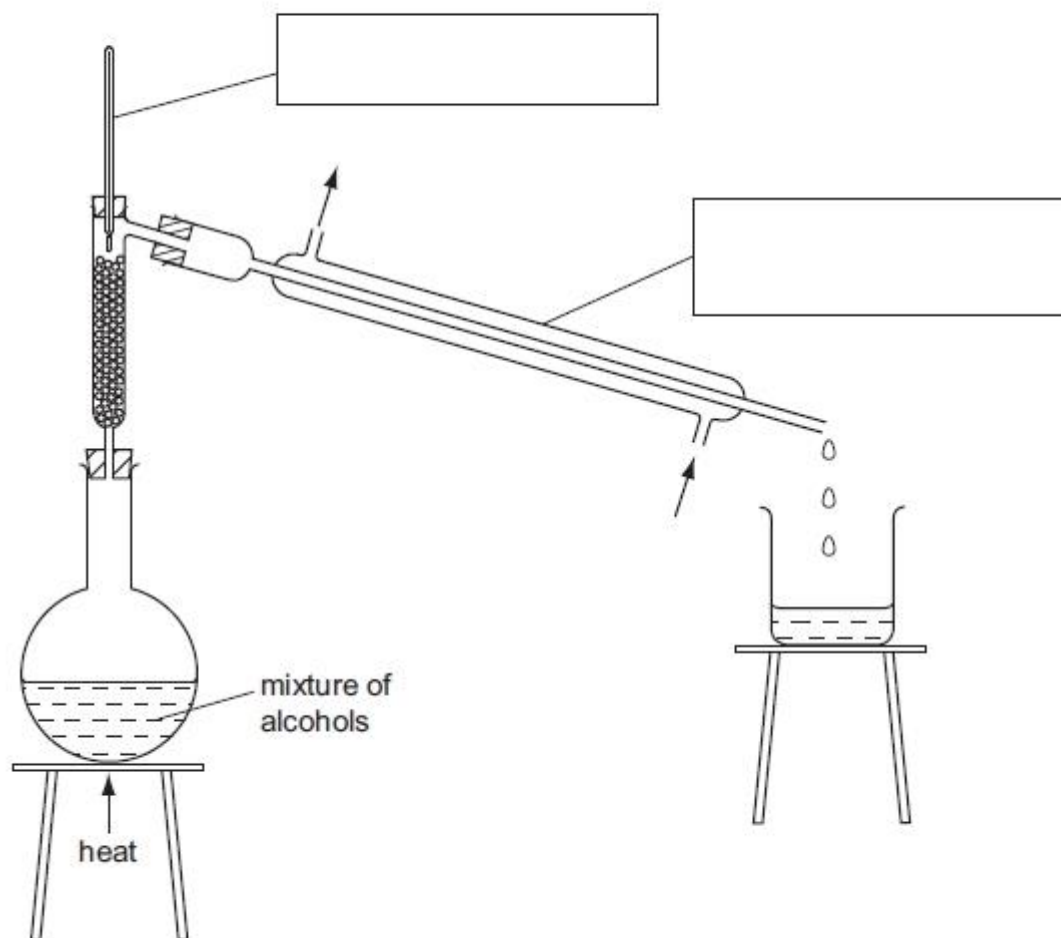
..... [1]

(ii) Are there any of the artificial colours present in the fruit drink? Explain your answer.

.....
.....
..... [2]



- 1 A student separated a mixture of two alcohols, ethanol (boiling point 78°C) and butanol (boiling point 118°C).
The apparatus used is shown below.



(a) Complete the boxes to identify the pieces of apparatus labelled. [2]

(b) Label the arrows. [1]

(c) State the name of this separation process.
..... [2]

(d) (i) Which liquid is first to collect in the beaker?
..... [1]

(ii) How would the student know when all of this liquid had collected?
.....
..... [1]

(e) Identify and explain a possible hazard in this experiment.

.....

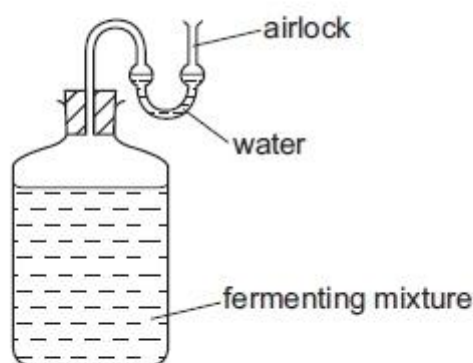
Q# 6/ iGCSE Chem/2013s/Paper 6/

[2]

2 A student found a recipe for making elderberry wine by fermentation.

- 1 kg elderberries
- 0.5 kg sugar
- 10 g yeast granules
- 3 dm³ water

The student decided to make some elderberry wine using the apparatus below.



The student carried out the following method.

Step 1 The elderberries were crushed.

Step 2 The crushed elderberries and sugar were added to the water and the mixture was boiled for ten minutes. The crushed elderberries were then separated from the mixture.

Step 3 Yeast was added to the liquid when it had cooled to room temperature.

(a) Suggest the purpose of the airlock in the apparatus.

..... [1]

(b) What apparatus could be used in Step 1?

..... [1]

[2]

(d) Why was the yeast in Step 3 not added until the liquid was at room temperature?

..... [1]



(e) (i) State **one** observation during the fermentation.

..... [1]

(ii) Suggest how the rate of the fermentation reaction could be measured.

.....

..... [2]

(f) Name the method that could be used to separate ethanol from the fermented mixture.

..... [1]

Q# 7/ iGCSE Chem/2012s/Paper 6/

3 Coffee beans contain caffeine and other compounds. Caffeine is soluble in water and in trichloromethane, an organic solvent.

A student obtained crystals of caffeine by the following method.

Stage 1 Some coffee beans were crushed into small pieces.

Stage 2 Hot water was added to the crushed beans to dissolve the soluble substances.

Stage 3 The crushed beans were separated from the liquid solution.

Stage 4 The liquid was allowed to cool and shaken with trichloromethane to extract the caffeine from the water.

Stage 5 The caffeine was crystallised from the trichloromethane solution.

Stage 6 The caffeine crystals were checked for purity.

(a) What apparatus should be used to crush the beans in Stage 1?

..... [2]

(b) How could the dissolving process in Stage 2 be speeded up?

..... [1]

(c) Draw a diagram of the apparatus used in Stage 3.

[2]



(d) How should Stage 5 be carried out?

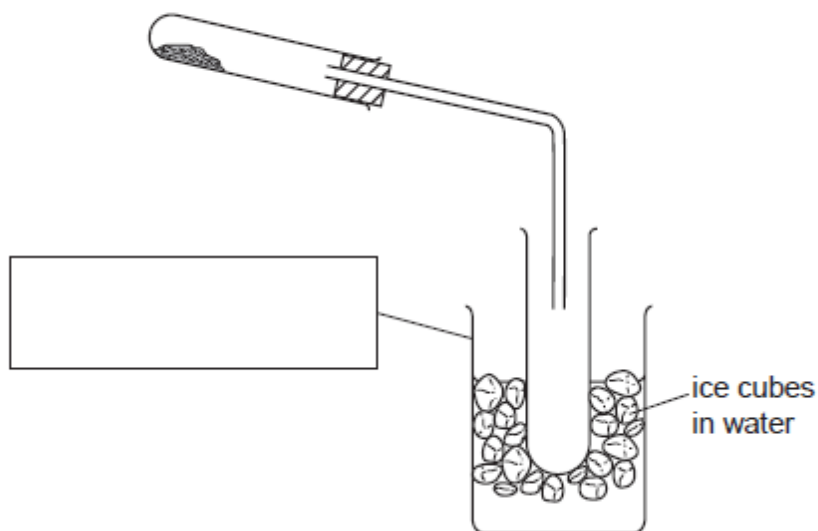
.....
..... [2]

(e) What method could be used to check the purity of the crystals in Stage 6?

..... [1]

Q# 8/ iGCSE Chem/2011s/Paper 6/

- 1 A student heated hydrated zinc sulfate crystals, $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$, using the apparatus below to obtain a sample of water.



(a) Complete the box to identify the piece of apparatus labelled. [1]

(b) Use labelled arrows to indicate:

(i) where the heat is applied,

(ii) where the sample of water would collect. [2]

(c) State the purpose of the ice cubes.

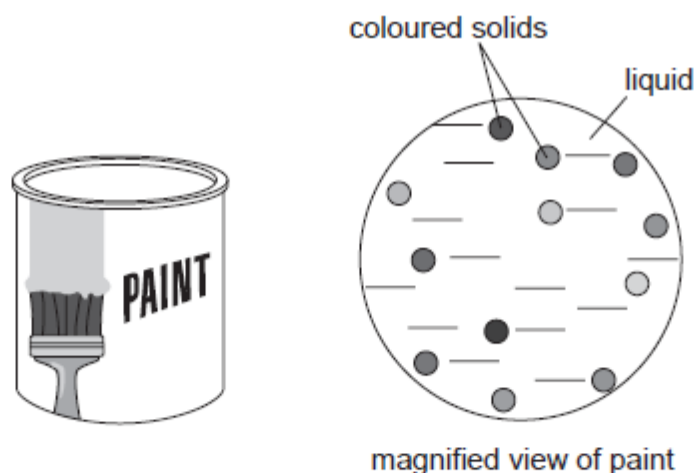
..... [1]

(d) Describe a physical test for pure water.

test

result [2]

6 You are provided with a pot of paint as shown below.



The paint is a mixture of a liquid and a solid.

The liquid can be dissolved in water. The solids are insoluble in water but soluble in organic solvents.

(a) How can a sample of the solid be separated from the rest of the paint?

.....

.....

..... [2]

(c) The label on the paint tin states

"Touch-dry in three hours"

(i) How could you check this value?

.....

..... [2]

(ii) Suggest how you could speed up this drying process.

..... [1]

2 A student extracted and investigated the orange colour in some sweets.
The student followed these instructions:

- 1 Collect sweets, a watch glass, a beaker, eye protection and 100 cm³ of ethanol.
- 2 Crush the sweets.
- 3 Place the crushed sweets in the beaker containing 100 cm³ of ethanol.
- 4 Boil the mixture with the watch glass covering the beaker.
- 5 Decant the liquid and concentrate it by evaporation until the colour is dark orange.
- 6 Investigate which colours are present in the orange solution.

(a) Why should the sweets be crushed?

.....
.....[2]

(b) Why should the experiment be carried out in a well-ventilated laboratory?

.....[1]

(c) State one safety precaution that the student should have taken, other than carrying out the experiment in a well-ventilated laboratory and using eye protection.

.....[1]

(d) State the purpose of the watch glass.

.....[1]

(e) Explain the term *decant*.

.....[1]

6.10.1 ESSENTIAL EXAM QUESTIONS Paper 6 Topic 2 Experimental Techniques 79
marks Mark Scheme

Question	Answer	Marks	Guidance
2(a)	chromatography;	1	
2(b)	(teat) pipette/capillary tube;	1	A: dropper/ glass rod
2(c)	water/ organic solvent;	1	
2(d)	compound Q is insoluble;	1	R: it reacts with the solvent
2(e)	between (4.7 and 5.1) divided by (6.2 or 6.3); answer: between 0.74 and 0.82;	1 1	correct answer with no working scores 2



1 (a) thermometer (1)

condenser (1)

[2]

(b) (i) ethanoic acid (1)

lower boiling point/evaporates first (1)

[2]

(ii) temperature reading will rise/ gap in liquid coming over/no more collected at 118°C (1)

[1]

(c) larger surface area (1)

[1]

4 (d) Table of results

total volume of water boxes completed correctly (1),

10, 12, 14, 18

temperature boxes completed (2)

all 4 correct (2)

3 correct (1)

2 or fewer correct (0)

91, 73, 65, 54

[3]

(e) appropriate scale for y axis (1)

note: must use at least 4 large squares vertically to plot points

all points correctly plotted (3),

all 4 correct (3)

3 correct (2)

2 correct (1)

1 or fewer correct (0)

note: origin should not be included

smooth line graph (1)

[5]

(f) value from graph for 20 cm³ water, 50–53 (1) ± half a small square

shown clearly by extrapolation (1)

unit, °C (1)

[3]



(g) clear / colourless liquid forms / no solid / crystals / salt visible (1) [1]

(h) salt would not all dissolve (1)

use of figures (1) [2]
e.g. only 5.7 g would dissolve in 10 cm³ water at 100 °C

(i) sketch graph always above line (1)

label (1) [2]

(j) any **one** improvement from: (1)

do not remove thermometer from solution
use IT method / second person to note formation of crystals
repeat
do separate experiments
use smaller volumes of water
evaporation

linked explanation (1)

loss of solid on thermometer
observing formation of first crystals may vary
average
more results to plot on graph
method of avoiding evaporation e.g. separate experiments, lid

[2]

Q# 4/ iGCSE Chem/2014/w/Paper 6/

3 (a) (i) chromatography (1) [1]

(ii) to prevent loss / evaporation of solvent (1) [1]

(b) when the solvent is near the top of the paper / before the solvent reaches the top of the paper (1) [1]

(c) (i) 4 (1) [1]

(ii) yes, one artificial dye (1)
at same height / matches (1) [2]

Q# 5/ iGCSE Chem/2014s/Paper 6/

1 (a) thermometer (1)

condenser (1)
allow condensing tube, condensating tube, etc. [2]

(b) arrows labelled – water (in) and water (out) (1) [1]

(c) fractional (1)

distillation (1)

[2]



- (d) (i) ethanol (1) [1]
 (ii) temperature would rise (above 78°C) (1) [1]

(e) alcohols are (in)flammable / catch fire / burn (1)
 ignore: explode

Bunsen burner / flame / heat (1) [2]

Q# 6/ iGCSE Chem/2013s/Paper 6/

2 (a) to prevent air / oxygen / bacteria entering jar (1) [1]

(b) pestle and / or mortar (1) [1]

(c) diagram of funnel and filter paper (1) labelled (1) [2]

(d) yeast would not work at high temperatures / kills yeast / denatures enzymes / owtte (1) [1]
 allow: kills enzyme

(e) (i) bubbles / froth (1) [1]
 not: gas / CO₂ given off / turns cloudy

(ii) (collect gas) and measure volume / count bubbles (1)
 over certain time interval (1) [2]
 allow: one mark for timing until bubbles / reaction stopped

(f) fractional distillation (1) [1]

Q# 7/ iGCSE Chem/2012s/Paper 6/

3 (a) pestle (1) mortar (1) [2]

(b) stir/mix/shake (1) allow: heat/boil [1]

(c) diagram showing funnel (1)
 indication of filter paper (1) note: labels not necessary [2]

(d) heat/evaporation (1)
 to crystallising point or description (1)
 in fume cupboard (1) max 2 [2]

(e) melting point/description of (1) allow: chromatography ignore: bp [1]



Q# 8/ iGCSE Chem/2011s/Paper 6/

- 1 (a) beaker (1) [1]
- (b) (i) (arrow) labelled heat in correct position under shaded crystals (1)
- (ii) arrow labelled water in test-tube at or below the level of the ice (1) [2]
- (c) to cool/condense the water or steam/owtte (1) [1]
- (d) physical test **ignore** chemical tests
boiling point/freezing point (1)
100/0°C (1) [2]

Q# 9/ iGCSE Chem/2006/w/Paper 6/

- 6 (a) paint sample + water(1) filter(1) solid residue(1) max 2 [2]
- (c) (i) apply paint, start timer(1) method of checking dry, note time(1)
no painting = 0 [2]
- (ii) correct method(1) e.g. hair drier/wind/fan/increase temperature.
NOT catalyst. [1]

Q# 10/ iGCSE Chem/2003/w/Paper 6/

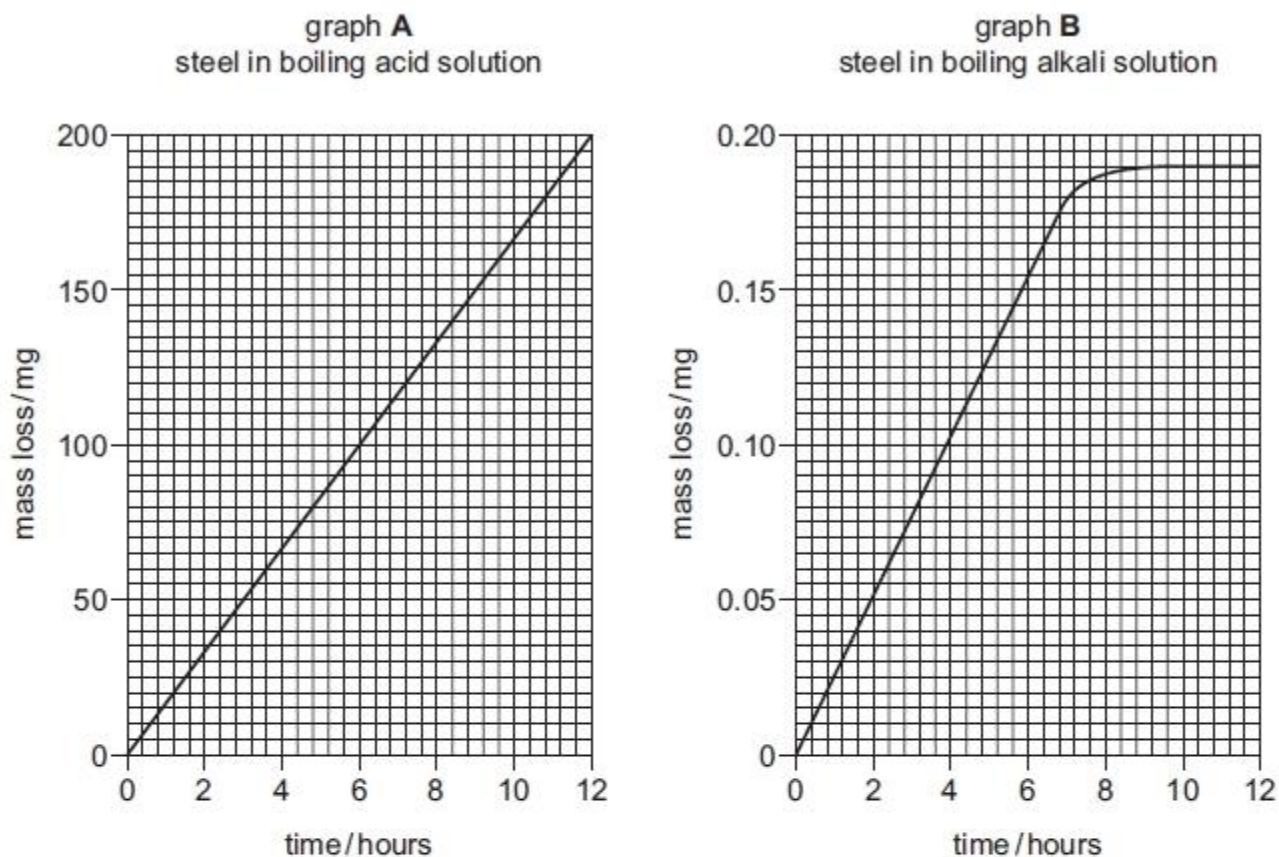
- | | | |
|-------|---|---|
| 2 (a) | Larger surface area (1)
Quicker to extract colour/more colour extracted (1) <u>not</u> easier/faster | 2 |
| (b) | Reference to ethanol (1) | 1 |
| (c) | Reference to flammability of ethanol (1) | 1 |
| (d) | To prevent loss of solvent (1) <u>not</u> splash/evaporation | 1 |
| (e) | <u>Pour</u> off liquid (1) | 1 |



Plan an investigation to obtain crystals of ethanedioic acid dihydrate from some rhubarb leaves. You are provided with common laboratory apparatus, water and sand.

[7]

- 5 Identical pieces of steel were placed in two different boiling liquids for 12 hours. The graphs show how the mass of each piece of steel changed.



- (a) Give **one** similarity in the change in mass of the steel in both liquids. [1]
-
- (b) Describe **two** ways in which the mass loss shown in graph A is different from that shown in graph B. [3]
1.
-
2.
-
- (c) State **two** different safety precautions that would need to be taken when carrying out this investigation. [2]
1.
2.



Q# 3/ iGCSE Chem/2011/w/Paper 6/

- 6 Seawater contains sodium chloride and other salts.
Plan an experiment to find the mass of salts in 1 dm^3 of seawater.
You will be provided with a small bottle of seawater.
You should include details of the method and any apparatus used.
($1 \text{ dm}^3 = 1000 \text{ cm}^3$)

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

Q# 4/ iGCSE Chem/2010/w/Paper 6/

- 7 E numbers identify chemicals which are added to foods.
(c) E110 is Sunset yellow.
Outline a method you could use to show the presence of E110 in a food colouring.
A space has been left if you want to draw a diagram to help you answer the question.

.....

.....

.....

.....

.....

..... [4]



- 7 Leaves from trees contain a mixture of coloured pigments which are not soluble in water. A student was given these two instructions to investigate the pigments in the leaves.

1. Crush some leaves to extract the coloured pigments.
2. Use the liquid extract to find the number of coloured pigments in the leaves.

(a) What would the student need in order to effectively carry out instruction 1?

.....

.....

.....

..... [3]

(b) Describe an experiment to carry out instruction 2.
A space has been left below if you want to draw a diagram to help answer the question.

.....

.....

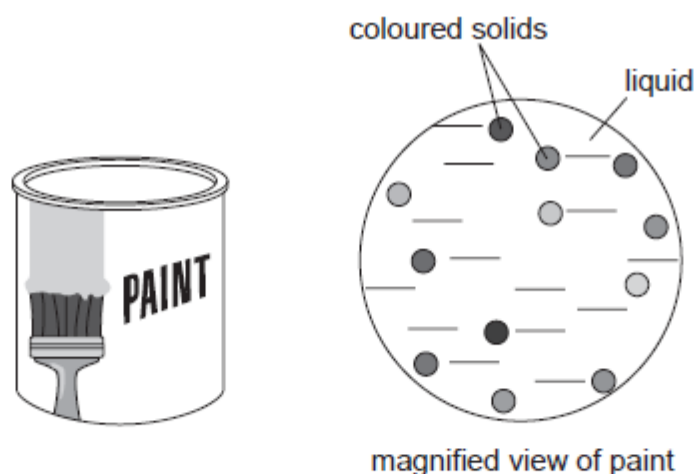
.....

.....

..... [4]



6 You are provided with a pot of paint as shown below.



The paint is a mixture of a liquid and a solid.

The liquid can be dissolved in water. The solids are insoluble in water but soluble in organic solvents.

(b) How would you determine the number of coloured substances contained in the solid you separated in (a)?

.....

.....

.....

..... [4]

3 The green pigment chlorophyll can be obtained from grass.

Step 1 The grass is crushed with sand.

Step 2 The grass is ground with ethanol until the solution is saturated.

Step 3 The solution is separated from the rest of the mixture.

Step 4 The colours in the solution are separated.

(d) Describe how Step 4 is carried out.

.....

.....

.....

..... [4]

Q# 8/ iGCSE Chem/2004/w/Paper 6/

7 Forged Banknote

A fake banknote can be investigated by dissolving the ink off the paper.

You are provided with four different inks from four different criminals. Describe an experiment to show which one of these inks is the same as the ink from the banknote.

You can use a labelled diagram to help you answer the question.

.....

.....

.....

.....

.....

..... [6]



- 2 A student extracted and investigated the orange colour in some sweets.
The student followed these instructions:

- 1 *Collect sweets, a watch glass, a beaker, eye protection and 100 cm³ of ethanol.*
- 2 *Crush the sweets.*
- 3 *Place the crushed sweets in the beaker containing 100 cm³ of ethanol.*
- 4 *Boil the mixture with the watch glass covering the beaker.*
- 5 *Decant the liquid and concentrate it by evaporation until the colour is dark orange.*
- 6 *Investigate which colours are present in the orange solution.*

- (f) Describe how the student could carry out instruction 6. You may draw a diagram in the space below to help you answer the question.

.....

.....

.....

.....

.....[5]



6.11.1 EXTENSION EXAM QUESTIONS Paper 6 Topic 2 Long Answer Questions 53
marks Mark Scheme

Q# 1/ iGCSE Chem/2015march/Paper 6/

6 any seven from:

extraction

cut leaves up/ small pieces/ grind / crush (1)

use of pestle/ mortar (1)

add water (1)

sand (1)

boil/ heat/ stir/ mix/ shake (1)

separation

decant/ filter (1)

obtaining crystals

evaporate/ heat solution (1)

to crystallising point/ until crystals start to form (1)

leave to cool (1)

[7]

Q# 2/ iGCSE Chem/2013s/Paper 6/

5 (a) both lose mass (1)
not: change mass

[1]

(b) mass loss increases constantly in graph A (1)

becomes constant in graph B (after about 7–9 hours) (1)

mass loss or change is greater in acid/ less in alkali (1)

[3]

(c) goggles / lab coat / tongs / fume cupboard / well ventilated area any two
ignore: reference to hair

[2]

Q# 3/ iGCSE Chem/2011/w/Paper 6/

6 measured volume of seawater (1)
using measuring cylinder (1)
into evaporating dish/ beaker (1)
pre-weighed (1)
evaporate/ heat (1)
to dryness/ constant mass (1)
re-weigh (1)
indication of calculation method (1)

max [6]

would not work = max 0



Q# 4/ iGCSE Chem/2010/w/Paper 6/ Q7

- (c) marks can be obtained from diagram
chromatography (1) description of applying E110 to paper (1)
use of solvent (1) results / number of spots (1) [4]

Q# 5/ iGCSE Chem/2009/w/Paper 6/

- 7 (a) pestle/mortar/solvent/sand (any three) [3]
ignore water and/or heat

- (b) NB marks can be obtained from a diagram
chromatography or chromatogram (1)
paper (1)
apply spot/extract to paper (1)
description or name of solvent used (1)
and separation e.g. spots on paper (1) (max 4) [4]

If water used as solvent (max 3)
If paper dipped into extract (max 3)
If method would not work (max 2)

Q# 6/ iGCSE Chem/2006/w/Paper 6/ Q6

- (b) solid + organic solvent(1) add to paper(1)
chromatography(1) use of solvent(1) description of spots(1)
max 4 NB use of water = max 1 for chromatography [4]

Q# 7/ iGCSE Chem/2005/w/Paper 6/

- 3 (a) pestle (1) and mortar (1) [2]
(b) chlorophyll more soluble in ethanol or similar [1]
(c) filtration [1]
(d) chromatography (1), paper (1), add pigments (1), use of solvent (1) [4]

Q# 8/ iGCSE Chem/2004/w/Paper 6/

- 7 chromatography (1) apply inks/spots to paper (1)
organic solvent/water (1) rises up paper (1)
check heights/positions of spots (1) compare to find ink from banknote (1) (6)
N.B. all marks can be obtained from a diagram

Q# 9/ iGCSE Chem/2003/w/Paper 6/ Q5

- | | | |
|-----|--|---|
| (f) | Chromatography (1)
Apply orange concentrate (1) to paper (1)
Use of solvent (1)
Description of elution (1)
Result of experiment (1)

Max 5 – all marks could be obtained from a suitable diagram | 5 |
|-----|--|---|



6.12 FUNDAMENTAL Assessed Activity 1 Keyword Test

Only complete this Assessed Activity if you are struggling in this subject and finding the course and the language really difficult.

English	Meaning
distillation	
downward delivery	
risk assessment	
R_f value	
chromatogram	
locating agent	
soluble	
saturated solution	
solvent front	
solubility	
chromatography	
filtrate	
mixture	
pure substance	
crystallisation	
fractional distillation	



English	Meaning
decanting	
upward delivery	
filtration	
solute	
solvent	
residue	
insoluble	
solution	

6.13 ESSENTIAL Assessed Activity 2 –Which separation technique?

Q#1/

1 The following techniques are used to separate mixtures.

A simple distillation

B fractional distillation

C evaporation

D chromatography

E filtration

F diffusion

From this list, choose the most suitable technique to separate the following.

(a) methane from a mixture of the gases, methane and ethane [1]

(b) water from aqueous magnesium sulfate [1]

(c) glycine from a mixture of the amino acids, glycine and lysine [1]

(d) iron filings from a mixture of iron filings and water [1]

(e) zinc sulfate crystals from aqueous zinc sulfate [1]

(f) hexane from a mixture of the liquids, hexane and octane [1]

[Total: 6]



EXTENSION activity – How fast can you finish?

Q# 2/

Butane and propane are both gases, silver chloride is a salt that is insoluble in water, glucose and maltose are both sugars.

- 1 A list of techniques used to separate mixtures is given below.

filtration
diffusion
fractional distillation
simple distillation
crystallisation
chromatography

From this list, choose the most suitable technique to separate the following mixtures.
A technique may be used once, more than once or not at all.

- (a) butane from a mixture of propane and butane [1]
(b) oxygen from liquid air [1]
(c) water from aqueous magnesium sulfate [1]
(d) potassium chloride from aqueous potassium chloride [1]
(e) silver chloride from a mixture of silver chloride and water [1]
(f) glucose from a mixture of glucose and maltose [1]

Q# 3/

Helium and argon are gases at room temperature.

Barium sulphate does not dissolve in water.

- 1 A list of techniques used to separate mixtures is given below.

fractional distillation	simple distillation	crystallization	filtration	diffusion
------------------------------------	--------------------------------	------------------------	-------------------	------------------

From the list choose the most suitable technique to separate the following.

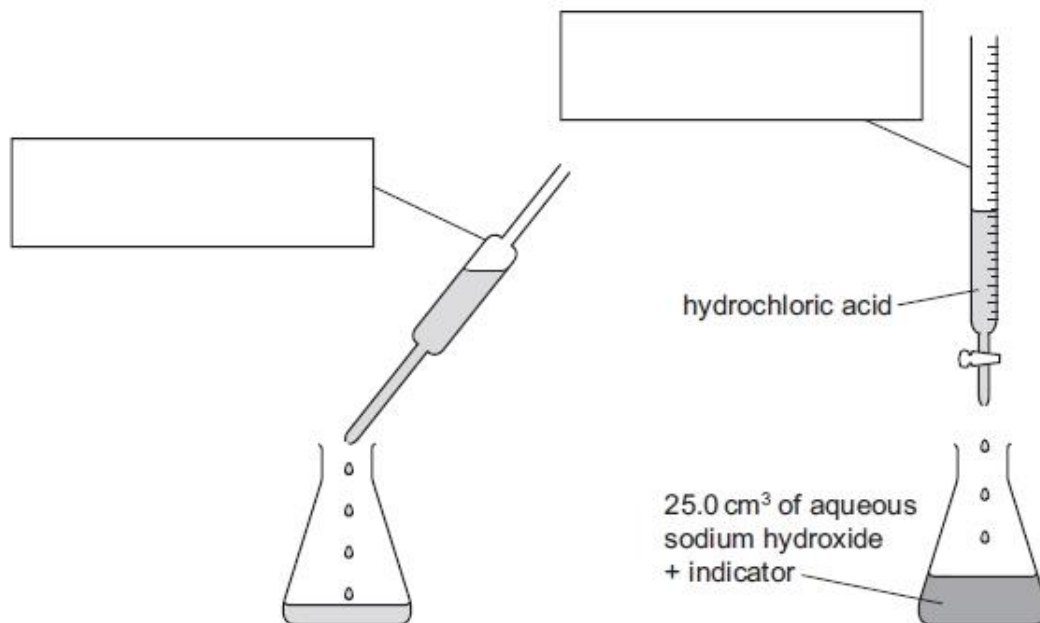
- water from aqueous copper(II) sulphate
helium from a mixture of helium and argon
copper(II) sulphate from aqueous copper(II) sulphate
ethanol from aqueous ethanol
barium sulphate from a mixture of water and barium sulphate [5]



6.14 ESSENTIAL Assessed Activity 3 Labelling equipment

Q# 2/

- 1 The volume of hydrochloric acid that reacts with 25.0 cm^3 of aqueous sodium hydroxide can be found using the apparatus below.

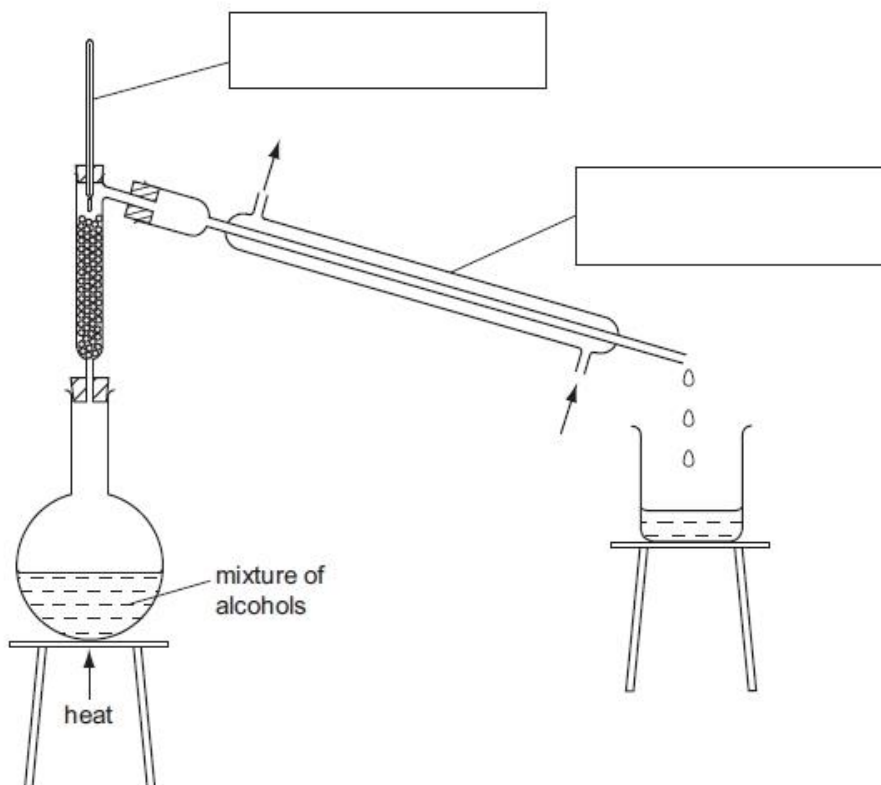


(a) Complete the boxes to identify the pieces of apparatus labelled.

[2]

Q# 3/

- 1 A student separated a mixture of two alcohols, ethanol (boiling point 78°C) and butanol (boiling point 118°C). The apparatus used is shown below.



(a) Complete the boxes to identify the pieces of apparatus labelled.

[2]



(b) Label the arrows.

[1]

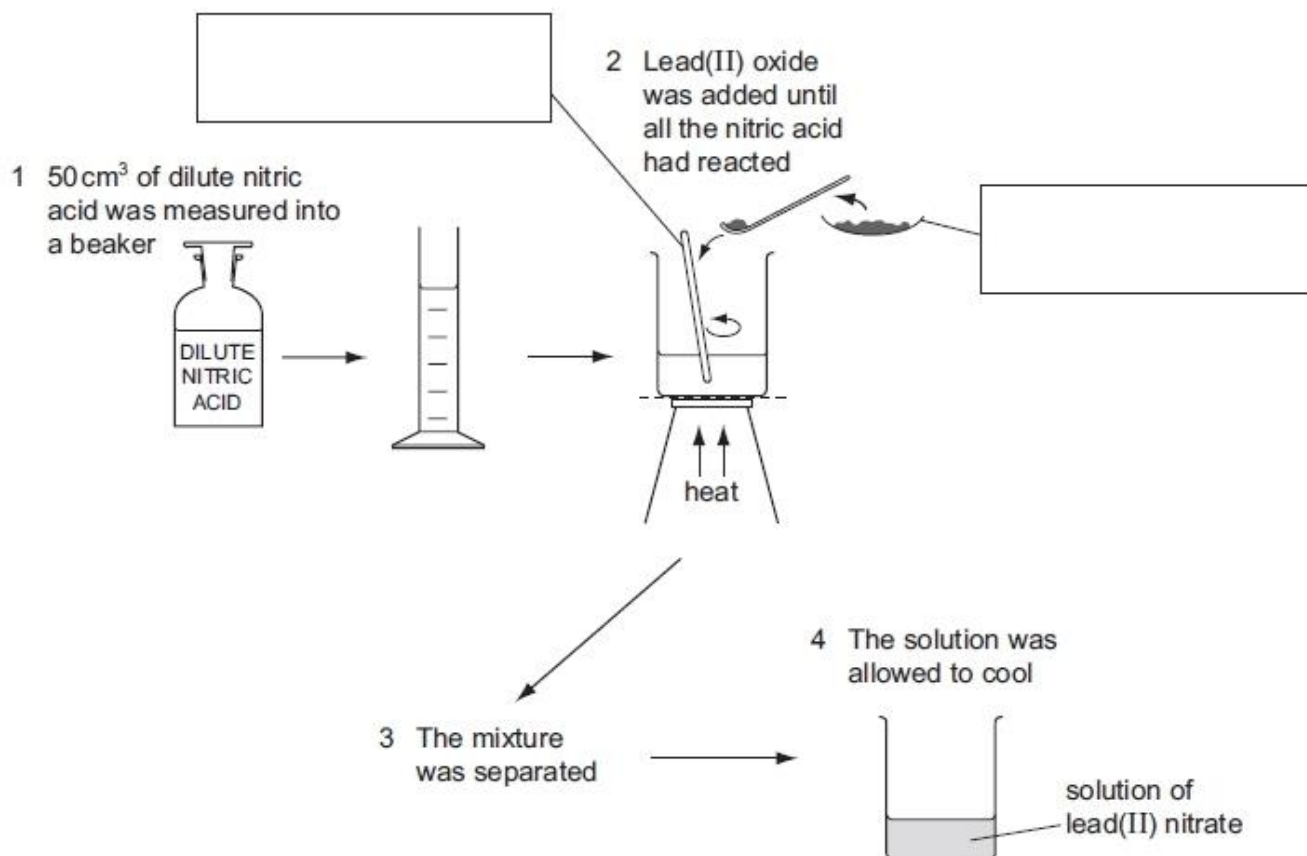
(e) Identify and explain a possible hazard in this experiment.

.....

[2]

Q# 4/

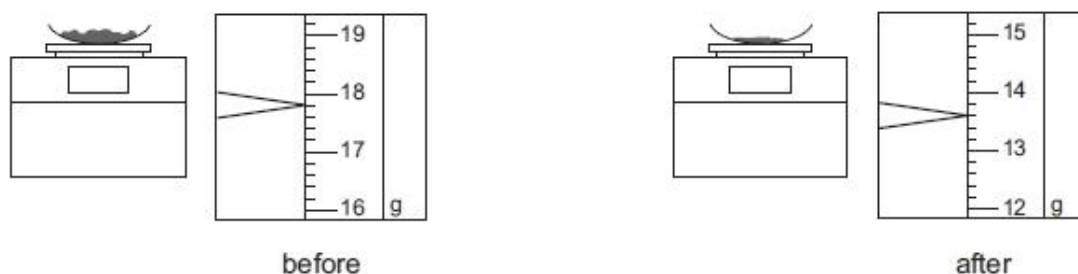
1 A student reacted dilute nitric acid with lead(II) oxide to prepare lead(II) nitrate. The diagram shows the stages in the method used.



(a) Complete the boxes to identify the pieces of apparatus.

[2]

(c) The lead(II) oxide was weighed before and after the additions.



Use the balance diagrams to work out the mass of lead(II) oxide added to the dilute nitric acid.

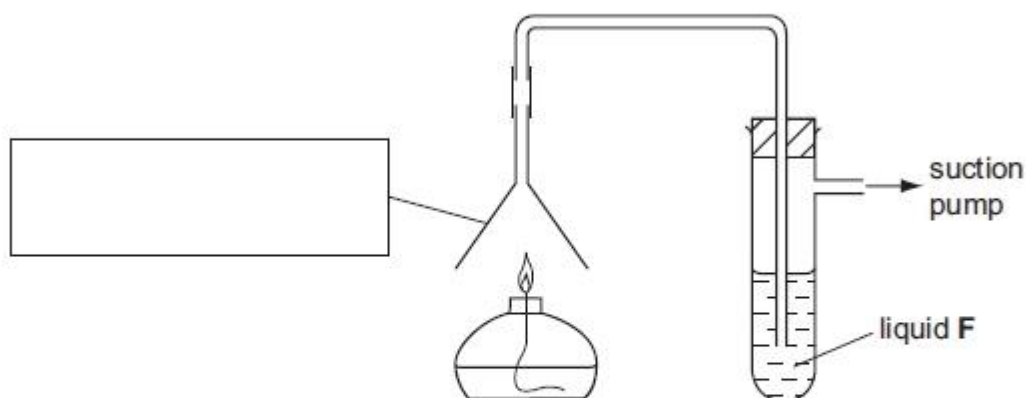
..... [2]

Extension work Labelling equipment

Q# 6/



- 1 A student investigated the products formed when ethanol was burned using the apparatus shown.



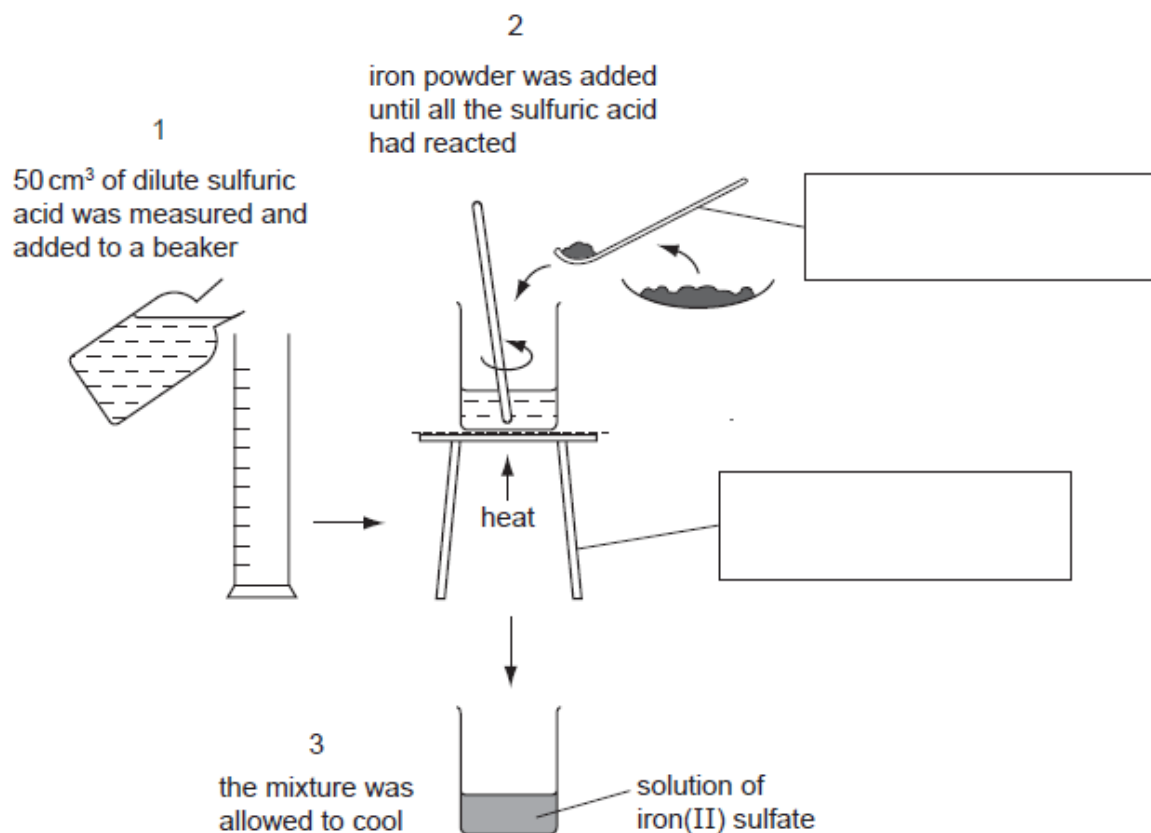
(a) Complete the box to identify the piece of apparatus. [1]

(b) Why is a suction pump used?

..... [1]

Q# 7/

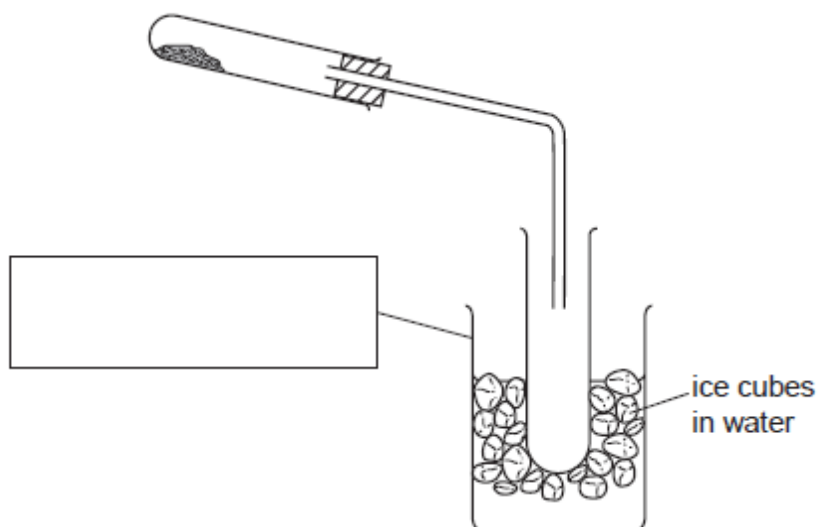
- 1 A student reacted excess iron powder with sulfuric acid to prepare a solution of iron(II) sulfate.
The diagram shows the procedure followed in three stages.



(a) Complete the boxes to identify the pieces of apparatus labelled. [2]

Q# 8/

- 1 A student heated hydrated zinc sulfate crystals, $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$, using the apparatus below to obtain a sample of water.

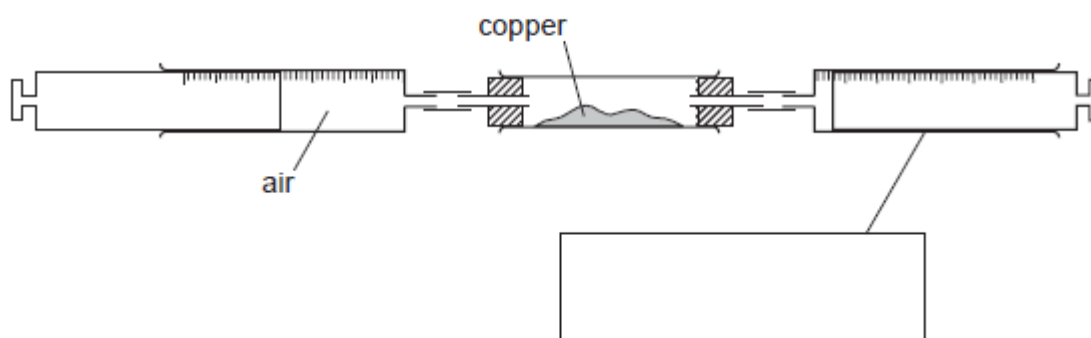


- (a) Complete the box to identify the piece of apparatus labelled. [1]
- (b) Use labelled arrows to indicate:
- (i) where the heat is applied,
- (ii) where the sample of water would collect. [2]
- (c) State the purpose of the ice cubes.

..... [1]

Q# 9/

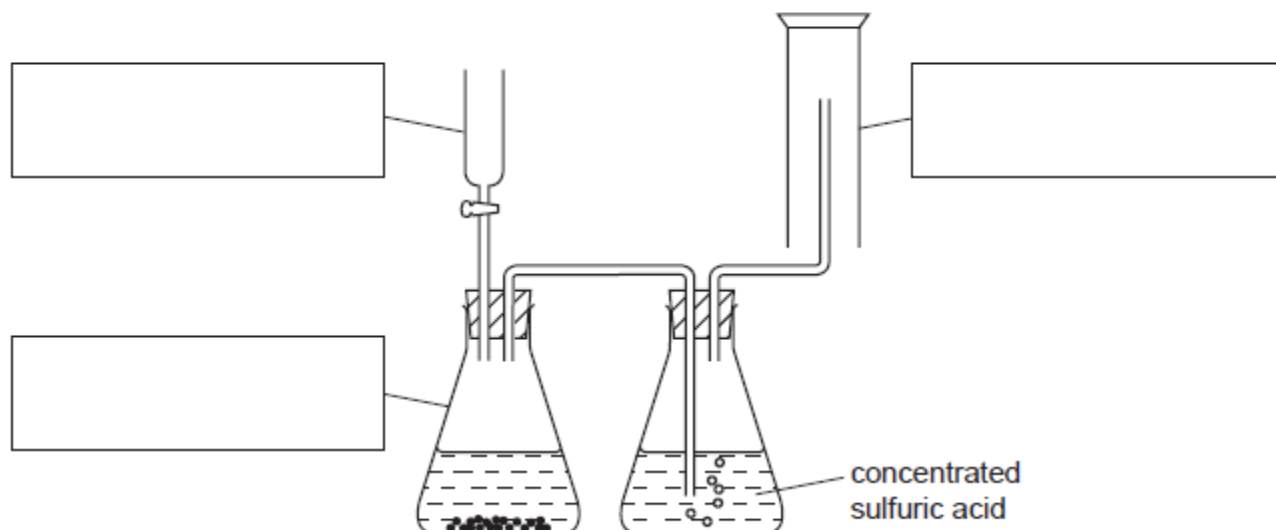
- 1 A student investigated the reaction of air with copper. 100 cm^3 of air was passed continuously over heated copper using the apparatus below. When the volume remained constant, the apparatus was left to cool and the volume of gas was measured.



- (a) (i) Complete the box to show the apparatus labelled. [1]
- (ii) Indicate on the diagram, with an arrow, where heat is applied. [1]

Q# 10/ iGCSE Chem/2010s/Paper 6/

1 The diagram shows the apparatus used to prepare a gas. The gas is more dense than air.



(a) Complete the boxes to name the apparatus.

[3]

6.15 Extension Mind Map for Topic 2 Experimental Techniques and Separation

6.16 Essential End of Topic 2 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?





Learning about science by reading newspapers, journals, and popular science magazines. Not all of these magazines can be accessed everywhere, but it is important that you understand and read as widely as you can, especially about the subject you are interested in pursuing at A levels and beyond. You may need to buy a subscription, but the school library also has an excellent selection of current magazines and newspapers.

To give you a sample of the kinds of articles and things you could be reading I've downloaded selected articles that relate to this topic, which is about experiments. If you find the language challenging, which is likely, instead of reading for meaning you could instead try reading for vocabulary, print out an article and translate any words you may find. One way to learn another language if you are already very confident in that language is to explain the meaning of new words in English, rather than simply translate them. All are available from here:

<https://www.smashingsciencecn.org/igcse-chem-additional-resources>

- The Atlantic (an article which helped to introduce the idea that medicine and chemistry might be a new direction in healthcare, back in 1909)
- The Economist, possibly the most read newspaper by CEO's and corporate executives, as well as politicians and academics, published an article which challenged the idea that science is getting better
- The Smithsonian looked at 10 of the most interesting experiments
- The New York Times also looked at 10 important experiments
- Some of the most popular online (and sometimes offline) sources for news aimed at an educated general audience include:
- <https://www.wired.com/>
- <https://www.newscientist.com/>
- <https://www.scientificamerican.com/>
- National Institute of Health: <https://kids.niehs.nih.gov/>
- Smithsonian website: <https://ssec.si.edu/> and <https://www.si.edu/kids>
- And especially Wikipedia, which also has a Simple English version: https://simple.wikipedia.org/wiki/Main_Page

Academic Journals

This is where new science and discoveries is reported to the scientific community, and then the world. They follow a very specific set of rules, and try to explain exactly what they did in their experiments and what they think their results mean. Normally, even after finishing a degree it is difficult to understand what is going on in these articles (usually you just read the abstract, which tells you roughly what they found out, and sometimes the conclusions, which tells you in more detail why their study matters) The two most famous journals are : "Nature" and "Science".

You are unlikely to understand anything about these, but two famous experiments are included if you go to the [IGCSE Additional Resources webpage](https://www.smashingsciencecn.org/igcse-chem-additional-resources).



7 Topic 3 Atoms, Elements and Compounds

7.1 End of Topic 3 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTENSION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTENSION
	Scored over 95%		SMASHING!!!



Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book <u>you enjoy</u> (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book <u>you enjoy</u> in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book <u>you enjoy</u> in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

7.2 Topic 3 Syllabus

3 Atoms, elements and compounds

3.1 Atomic structure and the Periodic Table

Core

- State the relative charges and approximate relative masses of protons, neutrons and electrons
- Define *proton number* (atomic number) as the number of protons in the nucleus of an atom
- Define *nucleon number* (mass number) as the total number of protons and neutrons in the nucleus of an atom
- Use proton number and the simple structure of atoms to explain the basis of the Periodic Table (see section 9), with special reference to the elements of proton number 1 to 20
- Define *isotopes* as atoms of the same element which have the same proton number but a different nucleon number
- State the two types of isotopes as being radioactive and non-radioactive

Supplement

- Understand that isotopes have the same properties because they have the same number of electrons in their outer shell

continued



3.1 Atomic structure and the Periodic Table continued

Core

- State one medical and one industrial use of radioactive isotopes
- Describe the build-up of electrons in 'shells' and understand the significance of the noble gas electronic structures and of the outer shell electrons. (The ideas of the distribution of electrons in s and p orbitals and in d block elements are **not** required.)

Note: a copy of the Periodic Table, as shown in the Appendix, will be available in Papers 1, 2, 3 and 4.

3.2 Structure and bonding

3.2.1 Bonding: the structure of matter

Core

- Describe the differences between elements, mixtures and compounds, and between metals and non-metals
- Describe an alloy, such as brass, as a mixture of a metal with other elements

3.2.2 Ions and ionic bonds

Core

- Describe the formation of ions by electron loss or gain
- Describe the formation of ionic bonds between elements from Groups I and VII

Supplement

- Describe the formation of ionic bonds between metallic and non-metallic elements
- Describe the lattice structure of ionic compounds as a regular arrangement of alternating positive and negative ions

3.2.3 Molecules and covalent bonds

Core

- Describe the formation of single covalent bonds in H_2 , Cl_2 , H_2O , CH_4 , NH_3 and HCl as the sharing of pairs of electrons leading to the noble gas configuration
- Describe the differences in volatility, solubility and electrical conductivity between ionic and covalent compounds

Supplement

- Describe the electron arrangement in more complex covalent molecules such as N_2 , C_2H_4 , CH_3OH and CO_2
- Explain the differences in melting point and boiling point of ionic and covalent compounds in terms of attractive forces



3.2.4 Macromolecules

Core

- Describe the giant covalent structures of graphite and diamond
- Relate their structures to their uses, e.g. graphite as a lubricant and a conductor, and diamond in cutting tools

Supplement

- Describe the macromolecular structure of silicon(IV) oxide (silicon dioxide)
- Describe the similarity in properties between diamond and silicon(IV) oxide, related to their structures

3.2.5 Metallic bonding

Supplement

- Describe metallic bonding as a lattice of positive ions in a 'sea of electrons' and use this to describe the electrical conductivity and malleability of metals



7.3 ESSENTIAL Glossary for Keywords for this topic

Many words used in science have a meaning that is slightly different to their common everyday English meaning, for instance a salt is the product of an acid and base reacting together in chemistry, but normally thought of as table salt (NaCl) in common use.

The keywords have been auto translated into Chinese, so the translations will not be perfect but they should hopefully make sense. If there is a better translation you can simply write it out yourself on a Post-it note and stick it over the printed one.

Topic #	English	Chinese
3	atom the smallest particle of an element that can take part in a chemical reaction	原子可以参与化学反应的元素的最小颗粒
3	atomic number (Z) the number of protons in the nucleus of an atom; it is also the number of electrons present in an atom and the position of the element in the Periodic Table	原子序数 (Z) 原子核中的质子数；它也是原子中存在的电子数和元素在周期表中的位置
3	chemical bonding the strong forces that hold atoms (or ions) together in the various structures that chemical substances can form – metallic bonding, covalent bonding and ionic (electrovalent bonding)	化学键将化学物质可形成的各种结构中的原子 (或离子) 保持在一起的强大力-金属键·共价键和离子 (电价键)
3	compound a substance formed by the chemical combination of two or more elements in fixed proportions	由两种或多种元素按固定比例化学结合形成的物质
3	covalent bond a chemical bond formed by the sharing of one or more pairs of electrons between two atoms	共价键由两个原子之间共享一对或多对电子形成的化学键
3	density expresses the relationship between the mass of a substance and the volume it occupies: density = mass / volume	密度表示物质的质量与它所占据的体积之间的关系：密度=质量/体积
3	diatomic molecule a molecule containing two atoms, for example hydrogen, H ₂	双原子分子一种包含两个原子的分子，例如氢·H ₂
3	electrical conductor a substance that conducts electricity but is not chemically changed in the process	电导体导电但在过程中不会发生化学变化的物质
3	electron (arrangement) configuration a shorthand method of describing how electrons are organised by energy levels of an atom.	电子 (排列) 构型是描述电子如何通过原子能级组织的简写方法。
3	electron a subatomic particle with negligible mass and a charge of -1; electrons are present in all atoms, located in energy levels outside the nucleus	电子是质量可忽略且电荷为-1的亚原子粒子；电子存在于所有原子中，位于原子核之外的能级
3	electrostatic force of attraction a strong pulling force between particles with opposite charges – such forces are involved in	静电吸引力在带相反电荷的粒子之间产生强大的拉力-这种力与
3	element a substance which cannot be further divided into simpler substances by chemical methods; all the atoms of an element contain the same number of protons	指不能通过化学方法进一步分为简单物质的物质；元素的所有原子都包含相同数量的质子
3	energy levels (of electrons) the allowed energies of electrons in atoms – electrons fill these levels (or shells) starting with the one closest to the nucleus	(电子的) 能级原子中电子的允许能量-电子从最靠近原子核的那一层开始填充这些能级 (或壳)



3	giant ionic structure a lattice held together by the electrostatic forces of attraction between positive and negative ions	巨大的离子结构通过正负离子之间的静电吸引力将晶格保持在一起的结构
3	giant metallic lattice a regular arrangement of positive metal ions held together by the mobile 'sea' of electrons moving between the ions	巨大的金属晶格，正离子的规则排列通过在离子之间移动的电子“移动”海洋而保持在一起
3	giant molecular structure substance where large numbers of atoms are joined by covalent bonds forming a strong lattice structure	巨大的分子结构物质，其中大量原子通过共价键连接而形成坚固的晶格结构
3	insulator substance that does not conduct electricity	不导电的绝缘体物质
3	intermolecular forces the weak attractive forces which act between molecules	分子间作用力作用于分子之间的弱吸引力
3	ionic (electrovalent) bond a strong electrostatic force of attraction between oppositely charged ions	离子（电价）键在带相反电荷的离子之间形成强大的静电吸引力
3	ions charged particles made from an atom, or groups of atoms (polyatomic ions), by the loss or gain of electrons	离子通过电子的丢失或获得而使由一个原子或一组原子（多原子离子）制成的粒子带电
3	isotopes atoms of the same element which have different numbers of neutrons in their nuclei: they differ in their mass (nucleon) numbers; some isotopes are radioactive because their nuclei are unstable (radio-isotopes)	同一元素的原子核中子数不同的同位素原子：它们的质量（核子）数不同；一些同位素具有放射性，因为它们的原子核不稳定（放射性同位素）
3	lattice a regular three-dimensional arrangement of atoms, molecules or ions in a crystalline solid	将晶体，固体中原子，分子或离子的规则三维排列成晶格
3	malleable a word used to describe the property that metals can be bent and beaten into sheets	可塑性的单词，用来描述金属可以弯曲并打成薄片的特性
3	mass number (A) the total number of protons and neutrons present in the nucleus of an atom	质量数（A）原子核中存在的质子和中子总数
3	matter anything which occupies space and has mass	占据空间并具有质量的任何事物都无所谓
3	metallic bond an electrostatic force of attraction between the mobile 'sea' of electrons and the regular array of positive metal ions within a solid metal	金属键是电子的移动“海洋”与固体金属中规则的正金属离子阵列之间的静电吸引力
3	molecule a group of atoms held together by covalent bonds	分子通过共价键结合在一起的一组原子
3	neutron an uncharged subatomic particle present in the nuclei of atoms – a neutron has a mass of 1 relative to a proton	中子原子核中存在的带电荷的亚原子粒子—中子相对于质子的质量为1
3	non-metals a class of chemical elements that are typically poor conductors of heat and electricity	非金属一类化学元素，通常是热和电的不良导体
3	nucleon number (A) the total number of protons and neutrons present in the nucleus of an atom	核子数（A）原子核中存在的质子和中子总数



3	nucleus (of an atom) the central region of an atom that is made up of the protons and neutrons of the atom; the electrons orbit around the nucleus in different 'shells' or 'energy levels'	原子核（原子的）原子的中心区域，由原子的质子和中子组成；电子围绕原子核以不同的“壳”或“能级”运行
3	proton a subatomic particle with a relative mass of 1 and a charge +1 found in the nucleus of all atoms	质子是在所有原子的原子核中都具有相对质量1且电荷+1的亚原子粒子
3	proton number another name for atomic number	质子数原子数的别称
3	radioactivity the spontaneous decay of unstable radio-isotopes	放射性不稳定同位素的自发衰减
3	salts ionic compounds made by the neutralisation of an acid with a base (or alkali); for example, copper(II) sulfate and potassium nitrate	通过酸与碱（或碱）中和而制得的盐离子化合物；例如，硫酸铜（II）和硝酸钾
3	simple molecular substances are made up of individual molecules held together by covalent bonds: there are only weak forces between the molecules	简单的分子物质由通过共价键结合在一起的单个分子组成：分子之间只有弱力
3	subatomic particles very small particles – protons, neutrons and electrons – from which all atoms are built	亚原子粒子非常小的粒子-质子，中子和电子-构成所有原子
3	valency the combining power of an atom or group of atoms: in ionic compounds the valency of each ion is equal to its charge; in a covalent molecule the valency of an atom is the number of bonds that atom makes	化合价一个原子或一组原子的结合能：在离子化合物中，每个离子的化合价等于其电荷；在共价分子中，原子的化合价是原子形成的键的数量



7.4 ESSENTIAL EXAM QUESTIONS Paper 4 Topic 3 327marks

Subtopic Chem 3.1 **Q# 1/** iGCSE Chemistry/2012/w/Paper 31/ Q2

(b) A radioactive isotope of iodine, $^{131}_{53}\text{I}$, is used to treat cancer.

(i) Define the term *isotope*.

.....
 [2]

(ii) How many protons, electrons and neutrons are there in one atom of $^{131}_{53}\text{I}$?

number of protons

number of electrons

number of neutrons [2]

(iii) When this isotope, $^{131}_{53}\text{I}$, emits radiation, a different element with a proton number of 54 is formed.

What is the name of this element?

..... [1]

Subtopic Chem 3.1 **Q# 2/** iGCSE Chemistry/2012/s/Paper 31/

4 Vanadium is a transition element. It has more than one oxidation state.
 The element and its compounds are often used as catalysts.

(a) Complete the electron distribution of vanadium by inserting one number.

2 + 8 + + 2

[1]

Subtopic Chem 3.1 **Q# 3/** iGCSE Chemistry/2010/w/Paper 31/

1 The table gives the composition of three particles.

particle	number of protons	number of electrons	number of neutrons
A	15	15	16
B	15	18	16
C	15	15	17

(a) What is the evidence in the table for each of the following?

(i) Particle **A** is an atom.

.....
 [1]



(ii) They are all particles of the same element.

.....
..... [1]

(iii) Particle **B** is a negative ion.

.....
..... [2]

(iv) Particles **A** and **C** are isotopes.

.....
..... [2]

(b) (i) What is the electronic structure of particle **A**?

..... [1]

(ii) What is the valency of the element?

..... [1]

(iii) Is the element a metal or a non-metal? Give a reason for your choice.

.....
..... [1]

Subtopic Chem 3.1 **Q# 4/** iGCSE Chemistry/2008/s/Paper 31/

2 (a) Complete the table which gives the names, symbols, relative masses and relative charges of the three subatomic particles.

name	symbol	relative mass	relative charge
electron	e^-		
proton		1	
	n		0

[3]

(b) Use the information in the table to explain the following.

(i) Atoms contain charged particles but they are electrically neutral because they have no overall charge.

.....
..... [2]



(ii) Atoms can form positive ions.

.....
..... [2]

(iii) Atoms of the same element can have different masses.

.....
..... [2]

(iv) Scientists are certain that there are no undiscovered elements missing from the Periodic Table from hydrogen to lawrencium.

..... [1]

Subtopic Chem 3.1 Q# 5/ iGCSE Chemistry/2007/w/Paper 3/

2 The table below gives the number of protons, neutrons and electrons in atoms or ions.

particle	number of protons	number of electrons	number of neutrons	symbol or formula
A	9	10	10	${}^{19}_{9}\text{F}^{-}$
B	11	11	12	
C	18	18	22	
D	15	18	16	
E	13	10	14	

(a) Complete the table. The first line is given as an example. [6]

(b) Which atom in the table is an isotope of the atom which has the composition 11p, 11e and 14n? Give a reason for your choice.

.....
..... [2]

Subtopic Chem 3.1 Q# 6/ iGCSE Chemistry/2006/s/Paper 3/ QiGCSE Chemistry/201 (b)

(ii) Use the Periodic Table to work out the number of protons and the number of neutrons in one atom of iron.

number of protons = number of neutrons = [1]

Subtopic Chem 3.1 Q# 7/ iGCSE Chemistry/2006/s/Paper 3/ Q6

(b) Some radioactive isotopes are used as nuclear fuels.

(ii) Give another use of radioactive isotopes.

..... [1]



- 5 Strontium and zinc are both metals with a valency of 2. Strontium is more reactive than zinc. Its chemistry is similar to that of calcium.

(a) (i) Complete the following table that shows the number of protons, electrons and neutrons in each particle.

particle	protons	electrons	neutrons
^{88}Sr			
^{90}Sr			
$^{65}\text{Zn}^{2+}$			

[3]

(ii) Explain why ^{88}Sr and ^{90}Sr are isotopes.

..... [1]

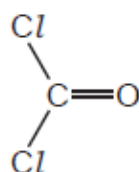
(iii) Complete the electron distribution of an atom of strontium.

2 + 8 + 18 + + [1]

(ii) Complete the electron distribution of manganese by inserting one number.

2 + 8 + + 2 [1]

(c) The structural formula of carbonyl chloride is given below.



Draw a diagram showing the arrangement of the outer (valency) electrons in one molecule of this covalent compound.

Use o to represent an electron from a carbon atom.

Use x to represent an electron from a chlorine atom.

Use • to represent an electron from an oxygen atom.

- 7 Both strontium and sulfur have chlorides of the type XCl_2 . The table below compares some of their properties.

	strontium chloride	sulfur chloride
appearance	white crystals	red liquid
formula	SrCl_2	SCl_2
melting point/ $^{\circ}\text{C}$	874	-120
boiling point/ $^{\circ}\text{C}$	1250	59
conductivity of liquid	good	poor
solubility in water	dissolves to form a neutral solution	reacts to form a solution of pH 1

- (ii) Strontium is a metal and sulfur is a non-metal. Explain why both have chlorides of the type XCl_2 .

The electron distribution of a strontium atom is $2 + 8 + 18 + 8 + 2$.

.....

 [2]

- (b) Lithium reacts with nitrogen to form the ionic compound, lithium nitride.

(i) State the formula of the lithium ion. [1]

(ii) Deduce the formula of the nitride ion. [1]

- (iii) In all solid ionic compounds, the ions are held together in a lattice. Explain the term *lattice*.

.....
 [1]

- (iv) What is the ratio of lithium ions to nitride ions in the lattice of lithium nitride? Give a reason for your answer.

..... lithium ions : nitride ions

.....
 [2]



1 This question is concerned with the following oxides.

sulfur dioxide
carbon monoxide
lithium oxide
aluminium oxide
nitrogen dioxide
strontium oxide

(this list is referred to in the next

question)

(c) Lithium oxide is an ionic compound.

(i) Identify another ionic oxide in the list on page 3.

..... [1]

(ii) Draw a diagram which shows the formula of lithium oxide, the charges on the ions and the arrangement of the valency electrons around the negative ion.
Use x to represent an electron from an atom of oxygen.
Use o to represent an electron from an atom of lithium.

[2]

Subtopic Chem 3.21-2 Q# 14/ iGCSE Chemistry/2011/s/Paper 31/ Q2

(b) The electron distribution of a selenium atom is $2 + 8 + 18 + 6$.

(i) Selenium forms an ionic compound with potassium. Draw a diagram which shows the formula of this ionic compound, the charges on the ions and the arrangement of the **valency** electrons around the negative ion.
Use o to represent an electron from an atom of potassium.
Use x to represent an electron from an atom of selenium.

[3]



3 The following is a list of the electron distributions of atoms of unknown elements.

element	electron distribution
A	2,5
B	2,8,4
C	2,8,8,2
D	2,8,18,8
E	2,8,18,8,1
F	2,8,18,18,7

(b) Elements C and F can form an ionic compound.

- (i) Draw a diagram that shows the formula of this compound, the charges on the ions and the arrangement of the valency electrons around the negative ion.
Use o to represent an electron from an atom of C.
Use x to represent an electron from an atom of F.

[3]

- (ii) Predict two properties of this compound.

.....

.....

..... [2]



2 There are three types of giant structure – ionic, metallic and macromolecular.

- (a) Sodium nitride is an ionic compound. Draw a diagram that shows the formula of the compound, the charges on the ions and the arrangement of the valency electrons around the negative ion.

Use x to represent an electron from a sodium atom.

Use o to represent an electron from a nitrogen atom.

[3]

3 Magnesium reacts with bromine to form magnesium bromide.

- (a) Magnesium bromide is an ionic compound. Draw a diagram that shows the formula of the compound, the charges on the ions and the arrangement of outer electrons around the negative ion.

The electron distribution of a bromine atom is 2, 8, 18, 7.

Use x to represent an electron from a magnesium atom.

Use o to represent an electron from a bromine atom.

[3]

- (b) In the lattice of magnesium bromide, the ratio of magnesium ions to bromide ions is 1:2.

- (i) Explain the term *lattice*.

.....

..... [2]

- (ii) Explain why the ratio of ions is 1:2.

..... [1]



4 Use your copy of the periodic table to help you answer these questions.

(a) Predict the formula of each of the following compounds.

(i) barium oxide [1]

(ii) boron oxide [1]

(b) Give the formula of the following ions.

(i) sulphide [1]

(ii) gallium [1]

2 Complete the following table.

type of structure	particles present	electrical conductivity of solid	electrical conductivity of liquid	example
ionic	positive and negative ions	poor	.....	.....

[2]

2 The table shows the melting points, boiling points and electrical properties of the six substances **A** to **F**.

substance	melting point / °C	boiling point / °C	electrical conductor at room temperature	electrical conductor of substance dissolved in water
A	961	2193	good	does not dissolve
B	113	444	does not conduct	does not dissolve
C	0	100	very poor	very poor
D	803	1465	does not conduct	good
E	-5 to -10	102 to 105	good	good
F	-85	-60	does not conduct	does not dissolve

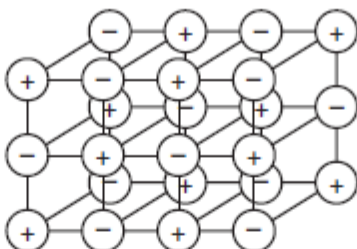


(ii) Which one is an ionic compound?

[1]

Subtopic Chem 3.21-2 Q# 21/ iGCSE Chemistry/2005/w/Paper 3/

- 1 (a) The structure of a typical ionic compound is a regular arrangement of positive and negative ions.



- (i) What is the name of this regular arrangement of particles?

[1]

- (ii) Give **two** physical properties of ionic compounds.

[2]

- (b) Ions are formed by electron loss or gain. The electron distribution of a magnesium atom is $2 + 8 + 2$ and of a nitrogen atom is $2 + 5$.

- (i) Give the formula of the magnesium ion.

[1]

- (ii) Give the formula of the nitride ion.

[1]

- (iii) What is the formula of the ionic compound, magnesium nitride?

[1]

- (iv) In this compound there is an ionic bond. Why are the two ions attracted to each other?

[1]



- (e) Describe, by means of a simple diagram, the lattice structure of an ionic compound, such as caesium chloride.

[2]

- 5 The first three elements in Period 6 of the Periodic Table of the Elements are caesium, barium and lanthanum.

- (d) Barium chloride is an ionic compound. Draw a diagram that shows the formula of the compound, the charges on the ions and gives the arrangement of the valency electrons around the negative ion.

The electron distribution of a barium atom is 2.8.18.18.8.2

Use x to represent an electron from a barium atom.

Use o to represent an electron from a chlorine atom.

[2]

- (e) Draw a diagram that shows the arrangement of the valency electrons in the ionic compound sodium phosphide.

Use o to represent an electron from sodium.

Use x to represent an electron from phosphorus.

[3]



- (c) Sulphur reacts violently with magnesium to form the ionic compound magnesium sulphide. Draw a diagram that shows the arrangement of the valency electrons in this compound.

Use O to represent an electron from a magnesium atom.
Use X to represent an electron from a sulphur atom.

[3]

- 7 Both strontium and sulfur have chlorides of the type XCl_2 . The table below compares some of their properties.

	strontium chloride	sulfur chloride
appearance	white crystals	red liquid
formula	SrCl_2	SCl_2
melting point/ $^{\circ}\text{C}$	874	-120
boiling point/ $^{\circ}\text{C}$	1250	59
conductivity of liquid	good	poor
solubility in water	dissolves to form a neutral solution	reacts to form a solution of pH 1

- (iv) Explain the difference in the electrical conductivity of liquid strontium chloride and liquid sulfur chloride.

.....

 [3]

- 4 Silicon(IV) oxide, SiO_2 , and zirconium(IV) oxide, ZrO_2 , are both macromolecules. They have similar physical properties but silicon(IV) oxide is acidic and zirconium(IV) oxide is amphoteric.

- (a) Define the term *macromolecule*.

.....
 [1]



(b) (i) Predict **three** physical properties of these two oxides.

.....
.....
..... [3]

(ii) Name an element which has the same physical properties as these two oxides.

..... [1]

Subtopic Chem 3.23-4 **Q# 28/** iGCSE Chemistry/2011/s/Paper 31/ Q2

(b) The electron distribution of a selenium atom is $2 + 8 + 18 + 6$.

(ii) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound selenium chloride.

Use x to represent an electron from an atom of selenium.

Use o to represent an electron from an atom of chlorine.

[3]

(iii) Predict **two** differences in the physical properties of these two compounds.

.....
..... [2]

Subtopic Chem 3.23-4 **Q# 29/** iGCSE Chemistry/2010/w/Paper 31/ Q6

(c) (i) Give the formulae of lithium fluoride and nitrogen fluoride.

lithium fluoride

nitrogen fluoride [2]



(ii) Predict **two** differences in their properties.

.....
..... [2]

(iii) Explain why these two fluorides have different properties.

.....
..... [2]

Subtopic Chem 3.23-4 **Q# 30/** iGCSE Chemistry/2010/w/Paper 31/

4 Ammonia is an important industrial chemical.

(a) (i) Give the electron structure of an atom of nitrogen.

..... [1]

(ii) Use this electronic structure, rather than the valency of nitrogen, to explain why the formula of ammonia is NH_3 not NH_4 .

.....
.....
..... [2]

Subtopic Chem 3.23-4 **Q# 31/** iGCSE Chemistry/2010/w/Paper 31/

6 The table below shows the elements in the second period of the Periodic Table and some of their oxidation states in their most common compounds.

element	Li	Be	B	C	N	O	F	Ne
number of outer electrons	1	2	3	4	5	6	7	8
oxidation state	+1	+2	+3	+4	-3	-2	-1	0

(a)

(iii) Select **two** elements in the table which exist as diatomic molecules of the type X_2 .

..... [1]



- (b)** Two of the oxides of these elements are carbon dioxide, CO_2 , and silicon(IV) oxide, SiO_2 .
- (i)** Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound carbon dioxide.
Use x to represent an electron from a carbon atom.
Use o to represent an electron from an oxygen atom.

[3]

- (c)** It is now known that the smell of the seaside is due to the chemical dimethyl sulfide, $(\text{CH}_3)_2\text{S}$.
- (i)** Draw a diagram that shows the arrangement of the valency electrons in one molecule of this covalent compound.
Use x to represent an electron from a carbon atom.
Use o to represent an electron from a hydrogen atom.
Use • to represent an electron from a sulfur atom.

[3]

- 5** The first three elements in Group IV are carbon, silicon and germanium.
The elements and their compounds have similar properties.
- (a)** The compound, silicon carbide, has a macromolecular structure similar to that of diamond.



(ii) Complete the following description of the structure of silicon carbide.

Each carbon atom is bonded to four atoms.

Each silicon atom is bonded to carbon atoms. [2]

(b) Germanium(IV) oxide, GeO_2 , has the same macromolecular structure as silicon(IV) oxide. Draw the structural formula of germanium(IV) oxide.

[3]

Subtopic Chem 3.23-4 Q# 35/ iGCSE Chemistry/2008/w/Paper 31/ Q6

(b) Potassium and calcium are very reactive metals at the top of the series. Because their ions have different charges, K^+ and Ca^{2+} , their compounds behave differently when heated.

(i) Explain why the ions have different charges.

.....
..... [2]

Subtopic Chem 3.23-4 Q# 36/ iGCSE Chemistry/2008/w/Paper 31/

2 There are three types of giant structure – ionic, metallic and macromolecular.

(c) Silicon(IV) oxide has a macromolecular structure.

(i) Describe the structure of silicon(IV) oxide (a diagram is not acceptable).

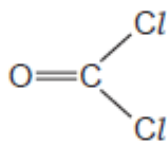
.....
.....
..... [3]

(ii) Diamond has a similar structure and consequently similar properties.
Give two physical properties common to both diamond and silicon(IV) oxide.

.....
..... [2]



(d) The structural formula of carbonyl chloride is given below.



Draw a diagram that shows the arrangement of the valency electrons in one molecule of this covalent compound.

Use x for an electron from a chlorine atom.

Use o for an electron from a carbon atom.

Use • for an electron from an oxygen atom.

[4]

Subtopic Chem 3.23-4 Q# 38/ iGCSE Chemistry/2007/s/Paper 3/

4 Use your copy of the periodic table to help you answer these questions.

(c) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound nitrogen trichloride.

Use x to represent an electron from a nitrogen atom.

Use o to represent an electron from a chlorine atom.

[3]

Subtopic Chem 3.23-4 Q# 39/ iGCSE Chemistry/2007/s/Paper 3/

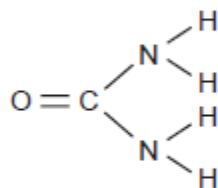
2 Complete the following table.

type of structure	particles present	electrical conductivity of solid	electrical conductivity of liquid	example
macro molecular	atoms of two different elements in a giant covalent structure	poor	poor	.....

[1]



- (d) Give a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound urea. Its structural formula is given below.



Use o to represent an electron from a carbon atom.
Use x to represent an electron from a hydrogen atom.
Use • to represent an electron from a nitrogen atom.

[3]

- (iii) Draw a diagram to show the arrangement of the valency electrons in one molecule of the covalent compound hydrogen sulphide.
Use o to represent an electron from a sulphur atom.
Use x to represent an electron from a hydrogen atom.

[2]



- 5 Strontium and sulphur chlorides both have a formula of the type XCl_2 but they have different properties.

property	strontium chloride	sulphur chloride
appearance	white crystalline solid	red liquid
melting point / °C	873	-80
particles present	ions	molecules
electrical conductivity of solid	poor	poor
electrical conductivity of liquid	good	poor

- (a) The formulae of the chlorides are similar because both elements have a valency of 2. Explain why Group II and Group VI elements both have a valency of 2.

[2]

- (b) Draw a diagram showing the arrangement of the valency electrons in one covalent molecule of sulphur chloride.

Use x to represent an electron from a sulphur atom.
Use o to represent an electron from a chlorine atom.

[3]

- (c) Explain the difference in electrical conductivity between the following.

- (i) solid and liquid strontium chloride

[1]

- (ii) liquid strontium chloride and liquid sulphur chloride

[1]



(b) Silicon has the same type of macromolecular structure as diamond.

(i) Explain why one atom of either element can form four covalent bonds.

.....
..... [2]

(ii) Predict **two** physical properties of silicon.

.....
..... [2]

(iii) Name a different element that has a similar structure and properties to silicon.

..... [1]

(c)

(iii) Describe the structure of silicon(IV) oxide. You may use a diagram.

..... [2]

(b) Draw a diagram to show the arrangement of the valency electrons in **one** molecule of nitrogen.

[2]



(e) Another compound that contains nitrogen and hydrogen is hydrazine, N_2H_4 .

(i) Draw the structural formula of hydrazine. Hydrogen can form only one bond per atom but nitrogen can form three.

(ii) Draw a diagram that shows the arrangement of the valency electrons in one molecule of hydrazine. Hydrazine is a covalent compound.
Use x to represent an electron from a nitrogen atom.
Use o to represent an electron from a hydrogen atom.

[3]



- 2 Calcium and other minerals are essential for healthy teeth and bones. Tablets can be taken to provide these minerals.

Healthy Bones

Each tablet contains

calcium
magnesium
zinc
copper
boron

- (a) Boron is a non-metal with a macromolecular structure.

- (i) What is the valency of boron?

.....

- (ii) Predict **two** physical properties of boron.

.....
.....

- (iii) Name another element and a compound that have macromolecular structures.

element

compound

- (iv) Sketch the structure of one of the above macromolecular substances.

4 Bromine is one of the halogens in Group VII.

- (c) Bromine reacts with phosphorus to form phosphorus tribromide.
Draw a diagram showing the arrangement of the **valency** electrons in one molecule of this covalent compound. The electron distribution of bromine is:

$$2 + 8 + 18 + 7.$$

Use x to represent an electron from phosphorus.

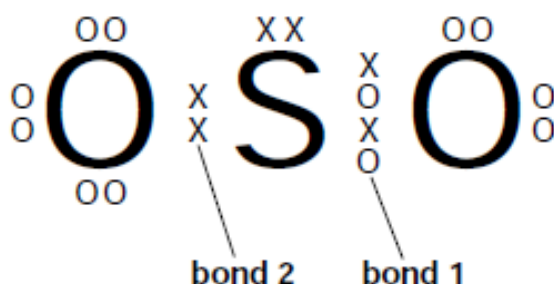
Use o to represent an electron from bromine.

[3]

- (b) The diagram shows a possible arrangement of the valency electrons in a molecule of sulphur dioxide.

O represents an electron from an oxygen atom

X represents an electron from a sulphur atom



- (i) What type of covalent bond is labelled **bond 1**?

.....[1]

- (ii) What is unusual about the covalent bond labelled **bond 2**?

.....[1]



- 5** The first three elements in Group IV are carbon, silicon and germanium.
The elements and their compounds have similar properties.

(a) The compound, silicon carbide, has a macromolecular structure similar to that of diamond.

- (i)** A major use of silicon carbide is to reinforce aluminium alloys which are used in the construction of spacecraft. Suggest **three** of its physical properties.

.....

.....

..... [3]

- (c)** Both iron and steel have typical metallic structures - a lattice of positive ions and a sea of electrons.

- (i)** Suggest an explanation for why they have high melting points.

.....

.....

..... [2]

- (ii)** Explain why, when a force is applied to a piece of steel, it does not break but just changes its shape.

.....

..... [2]

- 2** About 4000 years ago the Bronze Age started in Britain. Bronze is an alloy of copper and tin.

- (a) (i)** Suggest a reason why a bronze axe was better than a copper axe.

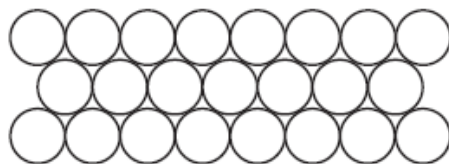
..... [1]

- (ii)** Brass is another copper alloy. Name the other metal in brass.

..... [1]



(b) The diagram below shows the arrangement of particles in a pure metal.



(i) What is the name given to a regular arrangement of particles in a crystalline solid?

..... [1]

(ii) Draw a diagram which shows the arrangement of particles in an alloy.

[2]

(iii) Explain the term *malleable*.

..... [1]

(iv) Why are metals malleable?

..... [2]

Subtopic Chem 3.25 **Q# 52/** iGCSE Chemistry/2010/s/Paper 31/ Q5 (a)

(iii) Explain why graphite is a soft material.

..... [2]

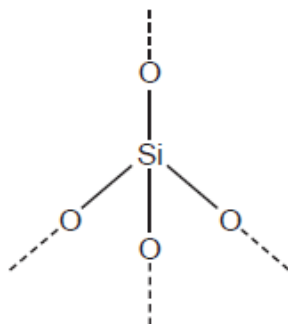
(iv) Give **one** use of graphite.

..... [1]

(b) Two of the oxides of these elements are carbon dioxide, CO_2 , and silicon(IV) oxide, SiO_2 .



- (ii) A section of the macromolecular structure of silicon(IV) oxide is given below.



Use this diagram to explain why the formula is SiO_2 not SiO_4 .

.....
..... [2]

- (iii) Predict **two** differences in the physical properties of these two oxides.

.....
..... [2]

Subtopic Chem 3.25 **Q# 53/** iGCSE Chemistry/2010/s/Paper 31/

- 5** Carbon and silicon are elements in Group IV. Both elements have macromolecular structures.

- (a) Diamond and graphite are two forms of the element carbon.

- (i) Explain why diamond is a very hard substance.

.....
.....
..... [2]

- (ii) Give **one** use of diamond.

..... [1]



2 There are three types of giant structure – ionic, metallic and macromolecular.

(b) (i) Describe metallic bonding.

.....
 [3]

(ii) Use the above ideas to explain why
 metals are good conductors of electricity,

..... [1]

metals are malleable.

..... [2]

2 Complete the following table.

type of structure	particles present	electrical conductivity of solid	electrical conductivity of liquid	example
metallic	 and	good	.....	copper

[3]

(c) Two of the elements in chalcopyrite are the metal, copper, and the non-metal, sulphur. These have different properties. Copper is an excellent conductor of electricity and is malleable. Sulphur is a poor conductor and is not malleable, it is brittle. Explain, in terms of their structures, why this is so.

difference in electrical conductivity

.....
 [2]

difference in malleability

.....
 [2]



- 2** The table shows the melting points, boiling points and electrical properties of the six substances **A** to **F**.

substance	melting point / °C	boiling point / °C	electrical conductor at room temperature	electrical conductor of substance dissolved in water
A	961	2193	good	does not dissolve
B	113	444	does not conduct	does not dissolve
C	0	100	very poor	very poor
D	803	1465	does not conduct	good
E	-5 to -10	102 to 105	good	good
F	-85	-60	does not conduct	does not dissolve

(v) Which substance is a metal?

[1]

- 4** The first three elements in Group IV are
carbon,
silicon,
germanium.

(a) The element germanium has a diamond-type structure. Describe the structure of germanium. A diagram is acceptable.

[2]

(b) Unlike diamond, graphite is soft and is a good conductor of electricity.

(i) Explain why graphite has these properties.

[3]



(ii) Give a use of graphite that depends on one of these properties.

property
use [1]

(c) Carbon dioxide and silicon(IV) oxide have similar formulae but different types of structure.

(i) Give the formulae of these oxides.

..... [1]

(ii) How are their structures different?

.....
..... [2]

(d) All these elements form compounds with hydrogen called hydrides. The saturated hydrides of carbon are the alkanes. Predict the formula of the hydride of germanium which contains two germanium atoms.

..... [1]

Subtopic Chem 3.25 Q# 59/ iGCSE Chemistry/2004/s/Paper 3/

5 (a) Copper has the structure of a typical metal. It has a lattice of positive ions and a "sea" of mobile electrons. The lattice can accommodate ions of a different metal.

Give a **different** use of copper that depends on each of the following.

(i) the ability of the ions in the lattice to move past each other

..... [1]

(ii) the presence of mobile electrons

..... [1]

(iii) the ability to accommodate ions of a different metal in the lattice

..... [1]

Subtopic Chem 3.25 Q# 60/ iGCSE Chemistry/2003/w/Paper 3/ Q2 (b)

(ii) Describe the structure of a typical metal, such as zinc, and explain why it is malleable.

.....
.....
.....[3]



Q# 1/ iGCSE Chemistry/2012/w/Paper 31/ Q22

- (b) (i) same Z / same number of protons; [1]
accept: atoms of the same element
 different number of neutrons / different nucleon number / different mass number; [1]
- (ii) 53 protons and 53 electrons; [1]
 78 neutrons; [1]
- (iii) xenon; [1]

Q# 2/ iGCSE Chemistry/2012/s/Paper 31/

- 4 (a) $2 + 8 + 11 + 2$ [1]

Q# 3/ iGCSE Chemistry/2010/w/Paper 31/

- 1 (a) (i) same number of protons and electrons [1]
- (ii) all have the same number of protons / same proton number / same atomic number [1]
- (iii) more electrons than protons [2]
 number of protons and electrons not equal **ONLY** [1]
- (iv) same number of protons (and electrons) / same proton number / same atomic number [1]
 different number of neutrons / different mass number / nucleon number [1]
- (b) (i) $2 + 8 + 5$ [1]
- (ii) $3 / 5$ [1]
- (iii) non-metal because it accepts electrons
 / needs 3e to complete outer energy level
 / because it is in Group V or 5e in outer shell [1]
note need both non-metal and reason for [1]

[Total: 9]**Q# 4/** iGCSE Chemistry/2008/s/Paper 31/

2 (a)

electron	e^- or e	1/1840 or 1/2000 or 0 1/1837 or negligible	-1
proton	p or p^+ or H^+	1	+1
neutron	n	1	0 or neutral

each correct row (1) [3]

- (b) (i) equal numbers of protons and electrons of positive and negative charges or charges cancel/balance [1]
 or net charge = 0 [1]



- (ii) lose electron(s) [1]
more protons than electrons [1]
NOT more + than –
- (iii) different numbers of neutrons [1]
same number of protons or same number of electrons [1]
for just giving- they are isotopes [1] **ONLY**
- (iv) an element is known for each proton number [1]
accept any sensible idea, for example no gaps between $z = 1$ and $z = 103$

Q# 5/ iGCSE Chemistry/2007/w/Paper 3/

- 2 (a) $^{23}_{11}\text{Na}$ [1]
 $^{40}_{18}\text{Ar}$ [1]
 $^{31}_{15}\text{P}^{3-}$ [1] for charge and [1] for symbol etc. [2]
 $^{27}_{13}\text{Al}^{3+}$ [1] for charge and [1] for symbol etc. [2]
ACCEPT +3 and –3
NOTE Only the above are to be awarded the mark
- (b) particle B or $^{23}_{11}\text{Na}$ or sodium [1]
COND they have the same proton number or the same number of protons or the same atomic number [1]
NOT the same number of electrons
Accept same number of electrons and protons

Q# 6/ iGCSE Chemistry/2006/s/Paper 3/ QiGCSE Chemistry/201 (b)

- (ii) $26p$ and $30n$ [1]

Q# 7/ iGCSE Chemistry/2006/s/Paper 3/ Q6 (b)

- (ii) treatment of cancer, autoradiographs, tracer, sterilising food, surgical equipment, measuring thickness, checking welds [1]

Q# 8/ iGCSE Chemistry/2005/w/Paper 3/

Question 5

- (a)(i) 38p 38e 50n [1]
38p 38e 52n [1]
30p 28e 35n [1]
- (ii) Same number of protons and different number of neutrons [1]
- (iii) $8 + 2$ [1]

Q# 9/ iGCSE Chemistry/2002/w/Paper 3/ Q2 (a)

- (ii) 13 [1]

Q# 10/ iGCSE Chemistry/2012/w/Paper 31/ Q5

- (c) each chlorine 1 bp and 3 nbps; [1]
4 e between carbon atom and oxygen atom; [1]
2 nbps on oxygen atom; [1]

Q# 11/ iGCSE Chemistry/2012/w/Paper 31/

- (ii) strontium loses $2e$; [1]
sulfur gains $2e$; [1]



Q# 12/ iGCSE Chemistry/2012/s/Paper 31/Q3

- (b) (i) Li^+ [1]
- (ii) N^{3-} [1]
- (iii) regular arrangement of ions / particles / positive and negative ions alternate;
not: atoms [1]
- (iv) 3:1; [1]
ratio to balance charges / reason in terms of valency; [1]

Q# 13/ iGCSE Chemistry/2011/w/Paper 31/
iGCSE Chemistry/201

- (c) (i) strontium oxide [1]
accept: aluminium oxide
- (ii) use correct formula [1]
cond: charges on ions
6x and 2o around oxygen [1]
ignore: electrons around Li

Q# 14/ iGCSE Chemistry/2011/s/Paper 31/ Q2

- (b) (i) correct formula [1]
- cond** following marks conditional on correct formula
If covalent mark 1 only
correct charges [1]
6x and 2o around anion [1]
do **NOT** penalise for incorrect coding
ignore electrons around potassium

Q# 15/ iGCSE Chemistry/2009/s/Paper 31/ Q3

- (b) (i) CF_2 or CaI_2 [1]
COND next two marks conditional on correct formula
 C^{2+} and F^- or Ca^{2+} and I^- [1]
7x and 1o round F/I [1]
NOTE covalent = 0
Ignore electrons around Ca
accept arrow notation arrow from electron on calcium atom to iodine
- (ii) high melting point or boiling point
conducts when molten or in solution
soluble in water
brittle
correct chemical properties
hard
Any **TWO** [2]
NOT crystalline solid **NOT** does not conduct as a solid



Q# 16/ iGCSE Chemistry/2008/w/Paper 31/

- 2 (a) 3Na : 1N correct ratio [1]
correct charges [1]
8e around N [1]

if no symbols then must have correct key
if covalent only mark 1
ignore electrons around sodium
if the response includes both a correct and an incorrect answer
do not select correct one, mark = [0]

Q# 17/ iGCSE Chemistry/2007/w/Paper 3/

- 3 (a) Correct ratio MgBr_2 or Mg 2Br [1]
Accept anywhere in space
IF formula suggests covalency then [1] only for MgBr_2
or Mg 2Br
correct charges Mg^{2+} and Br^- [1]
Do not be concerned about location of minus sign
8e around bromine [1]
NOTE do not require correct coding – just 7 and 1 coded differently
NOTE ignore electrons around magnesium

- (b) (i) pattern or order or regular or repeat or alternate [1]
COND positive and negative ions or atoms or molecules or particles [1]
NOTE Accept a sketch that shows the above, that is particles arranged in a regular way, e.g. any ionic compound such as sodium chloride
(ii) Any reason from the list: [1]
charges must balance
or based on valencies
or group II and group VII
or 2e in outer level and 7e in outer level
or magnesium loses 2 electrons and bromine gains 1 electron (per atom)

Q# 18/ iGCSE Chemistry/2008/s/Paper 31/

- 4 (a) (i) BaO [1]
(ii) B_2O_3 [1]
(b) (i) S^{2-} [1]
(ii) Ga^{3+} [1]

Q# 19/ iGCSE Chemistry/2008/s/Paper 31/

- 2 good [1]
named example e.g. sodium chloride [1]
ACCEPT correct formula

Q# 20/ iGCSE Chemistry/2006/w/Paper 3/

- (ii) D^{2+} [1]



Q# 21/

Question 1

- (a)(i) lattice [1]
- (ii) high melting point **or** high fixed points
poor conductor as solid
good conductor as liquid, accept either aqueous or molten
hard
soluble in water
Any **TWO** [2]
- (b)(i) Mg^{2+} [1]
- (ii) N^{3-} [1]
- (iii) Mg_3N_2 [1]
- (iv) opposite charges [1]
Do NOT accept "attract" it is in the question
accept electrostatic attraction as a phrase

Q# 22/ iGCSE Chemistry/2003/s/Paper 3/ Q5

- (e) alternating (positive and negative) [1]
pattern [1]

Q# 23/ iGCSE Chemistry/2003/s/Paper 3/Q5

- (d) correct formula 1Ba to 2Cl
charges correct
8e around the anion
All three points [2]
Two points ONLY [1]
If covalent [0] out [2]

Q# 24/ iGCSE Chemistry/2002/w/Paper 3/ Q3

- (c) 3Na to 1P [1]
COND next two marks
correct charges [1]
8e around P [1]
If covalent then only one mark for 3Na to 1P

Q# 25/ iGCSE Chemistry/2001/w/Paper 3/ Q5

- (c) 2+ on Mg [1]
2- and 8e on sulphur [1]
1Mg : 1S [1]

Q# 26/ iGCSE Chemistry/2012/w/Paper 31/

- (iv) molten strontium chloride has ions/ionic compound; [1]
which can move; [1]
sulfur chloride has no ions / only molecules / molecular / covalent; [1]



Q# 27/ iGCSE Chemistry/2012/w/Paper 31/

- 4 (a) giant covalent; [1]
or: polymer made from monomers;
- (b) (i) any three from:
high mp / bp;
hard;
brittle;
insoluble (in water);
poor conductor of electricity / heat; [3]
- (ii) carbon / diamond / silicon / boron; [1]
not: graphite

Q# 28/ iGCSE Chemistry/2011/s/Paper 31/ Q2

- (ii) correct formula [1]
- If ionic mark 1 only
cond
2 bp and 2 nbp around selenium [1]
1 bp and 3 nbp around both chlorine atoms [1]
- (iii) the ionic compound
higher melting point / boiling point / less volatile
conducts when molten or aqueous, covalent compound does not
is soluble in water, covalent is not / ionic insoluble in organic solvents, covalent soluble in organic solvents
harder
any **two** [2]
note there has to be comparison between the ionic compound and the covalent compound
not density

Q# 29/ iGCSE Chemistry/2010/w/Paper 31/ Q6

- (c) (i) LiF [1]
NF₃ [1]
- (ii) LiF has higher mp / bp
LiF is a (crystalline) solid, NF₃ is probably a gas / a liquid
/ LiF is less volatile
as liquids only LiF conducts
LiF is soluble in water, NF₃ is not
when both solids LiF is harder
any **two** [2]
- (iii) LiF is an ionic compound [1]
NF₃ is a covalent/molecular compound [1]
for stating that one is ionic and the other covalent [1] without specifying which is which

Q# 30/ iGCSE Chemistry/2010/w/Paper 31/

- 4 (a) (i) nitrogen 2+5 [1]
- (ii) needs three electrons [1]
to complete energy level [1]



- Q# 31/** iGCSE Chemistry/2010/w/Paper 31/ Q6 (a)
 (iii) any **two** from nitrogen, oxygen and fluorine [1]
 accept symbols / molecular formulae
- Q# 32/** iGCSE Chemistry/2010/s/Paper 31/ Q5 (a)
 (b) (i) 4e between carbon and oxygens [1]
 2 non-bonding pairs on both oxygens [1]
cond correct coding – only scored if marks 1 and 2 awarded [1]
 ignore O₂ in atom
- Q# 33/** iGCSE Chemistry/2009/w/Paper 3/ Q4
 (c) (i) correct structural skeleton [1]
COND 4bp around both carbon atoms [1]
 2bp and 2nbp around sulfur atom [1]
NOTE marks 2 and 3 can only be awarded if mark 1 has been scored
- Q# 34/** iGCSE Chemistry/2009/w/Paper 3/
 (ii) silicon [1]
 four [1]
- (b) diagram to include:
 each germanium atom bonded 4 oxygen atoms [1]
 each oxygen to 2 germanium atoms [1]
 looks **or** stated to be tetrahedral [1]
 "tetrahedral" scores mark even if diagram does not look tetrahedral
 independent marking of three points
- Q# 35/** iGCSE Chemistry/2008/w/Paper 31/ Q6
 (b) (i) potassium has one valency electron [1]
or loses one electron
 calcium has two valency electrons
or loses two electrons [1]
- Q# 36/** iGCSE Chemistry/2008/w/Paper 31/
 (c) (i) tetrahedral [1]
 1Si : 4O bonded/surrounded, etc. [1]
 1O : 2 Si [1]
- NOT** molecules of oxygen, etc.
NOT intermolecular forces
ONLY tetrahedral can score for either of the above
- Despite what the question states, **ACCEPT** a clear accurate diagram which shows the above three points.
- (ii) hard
 high mp **or** bp
 colourless (**NOT** clear) **or** shiny **or** translucent
 non/poor conductor (of electricity)
 brittle
 insoluble
 any **TWO** [2]
NOT crystalline **or** strong



Q# 37/ iGCSE Chemistry/2008/s/Paper 31/ Q5

- (d) 8e around both chlorine atoms [1]
4e between carbon and oxygen atoms [1]
8e around carbon atom [1]
8e around oxygen [1]
if a bond contains a line with no electrons, no marks for atoms joined by that line
ignore keying

Q# 38/ iGCSE Chemistry/2008/s/Paper 31/

- (c) NCl_3 [1]
COND 8e (1bp and 3nbp) around each chlorine [1]
8e (3bp and 1nbp) around nitrogen [1]

Q# 39/ iGCSE Chemistry/2008/s/Paper 31/

- silica or silicon(IV) oxide or sand or silicon oxide
named polymer only **TWO** elements [1]

Q# 40/ iGCSE Chemistry/2006/w/Paper 3/ Q5

- (d) Correct diagram for urea [3]
one error ONLY [2]
two errors ONLY [1]
three errors 0

Q# 41/ iGCSE Chemistry/2005/s/Paper 3/ 4 (b)

- (iii) 2H to 1S
COND 8e around sulphur atom
2e per hydrogen atom
THREE correct [2]
TWO from above [1]
Ionic structure = [0]

Q# 42/ iGCSE Chemistry/2004/w/Paper 3/

- 5 (a) Group II metals will lose 2e [1]
Group VI elements will gain 2e [1]
(b) SCl_2 [1]
COND 8e around both chlorine atoms [1]
8e around sulphur with 2nbp and 2bp [1]
If x and o reversed ignore if this is the only error
(c) (i) Ions cannot move in solid or can move in liquid [1]
(ii) No ions in sulphur chloride or it is covalent or only molecules or only strontium chloride has ions [1]

Q# 43/ iGCSE Chemistry/2004/s/Paper 3/ QIGCSE Chemistry/201

- (b) (i) both have four outer or valency electrons [1]
need to share four more [1]
or need four more to complete energy level
NOT four bonds
(ii) hard
brittle
high melting or boiling point
poor conductor of electricity or semi-conductor
any **TWO** [2]
NOT insoluble in water, NOT tough
NOT appearance
(iii) germanium or carbon [1]
NOT graphite



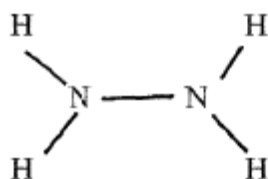
- (c)
- (iii) 4 oxygen atoms around 1 silicon atom [1]
 2 silicon atoms around 1 oxygen [1]
 tetrahedral or diagram that looks tetrahedral [1]
 If some wrong chemistry, such as ionic MAX
 2/3

Q# 44/ iGCSE Chemistry/2004/s/Paper 3/ Q3

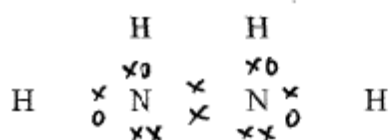
- (b) 6 electrons in bond between two nitrogen atoms [1]
 2 electrons on each nitrogen [1]
 ignore any coding of electrons with dots or crosses

Q# 45/ iGCSE Chemistry/2003/w/Paper 3/ Q1GCSE Chemistry/201

- (e) (i) correct structural formula [1]



- (ii) 8e around nitrogen [1]
 2e around each hydrogen [1]



Q# 46/ iGCSE Chemistry/2003/s/Paper 3/

- 2 (a) (i) 3 ignore any charges [1]
 (ii) high melting or boiling point
 hard
 poor conductor of electricity or heat
 brittle
 Any TWO [2]
 NOT insoluble, dull, or malleable
 (iii) carbon, graphite diamond silicon, germanium [1]
 silicon (IV) oxide or silica or silicon dioxide or silicon oxide
 or sand or silicon carbide or named polymer [1]
 (iv) four around one [1]
 cond looks tetrahedral or shows continuation [1]
 For graphite layers [1] weak bonds between layers [1]
 Accept any macromolecule, no link with (iii)
 For polymer repeat unit [1] continuation [1]

Q# 47/ iGCSE Chemistry/2002/s/Paper 3/ Q4

- (c) P and 3Br [1]
COND upon first mark being awarded
 3bp and 1nbp around phosphorus [1]
 8c around each bromine [1]
 if charges then first mark only

Q# 48/ iGCSE Chemistry/2001/w/Paper 3/ Q5

- (b) (i) double [1]
 (ii) both electrons from sulphur or equivalent [1]



Q# 49/ iGCSE Chemistry/2009/w/Paper 3/

- 5 (a) (i) strong
hard
light **or** low density
high melting point **or** high fixed points
Accept high strength to weight ratio for [2]
it includes marks 1 and 3
any **THREE** [3]

Q# 50/ iGCSE Chemistry/2011/s/Paper 31/ Q3

- (c) (i) strong attractive forces / strong bonds / bonds hard to break / requires a lot of energy to break bonds [1]
not between ions, **not** between positive and negative ions,
not between electrons

between positive ions and (negative) electrons / opposite charges attract [1]

(ii) because the layers, lattice or rows of ions/cations [1]
accept sheets of ions
not atoms / molecules / protons / nuclei

can move / slip / slide past each other [1]

Q# 51/ iGCSE Chemistry/2010/w/Paper 31/

- 2 (a) (i) harder / stronger / any sensible suggestion which relates to better properties for purpose e.g. stays sharp longer / cuts better / more corrosion resistant [1]

(ii) zinc [1]

(b) (i) lattice [1]

(ii) regular pattern of one type of atom [1]
with different atom interspersed [1]
can show the difference – size, shading, label etc.

(iii) can change its shape by force / plastically deform / can be hammered into sheets / can bend etc. [1]

(iv) particles / ions / atoms / layers [1]
cond can slide past each other [1]
or metallic bond is non-directional [1]
particles can move past each other [1]

Q# 52/ iGCSE Chemistry/2010/s/Paper 31/ Q5 (a)

- (iii) layer structure / sheets [1]
molecules / ions in layers = [0]
layers can slide (over each other) [1]

(iv) lubricant / pencils / electrodes [1]
mark first use offered



b

- (ii) 4O around each Si [1]
2Si around each O [1]
must refer to diagram **not** valencies **or** electron distributions

- (iii) SiO₂ has higher mp or bp
SiO₂ is a solid, CO₂ is a gas (at rtp)
(when both are solids) then SiO₂ is harder
has higher density
SiO₂ insoluble, CO₂ soluble [2]
any **two**, comparison needed

Q# 53/ iGCSE Chemistry/2010/s/Paper 31/

- 5 (a) (i) macromolecular / giant covalent / giant atomic [1]
all atoms held in position / in tetrahedral structure / to four other carbon
atoms / all strong bonds [1]
(ii) jewellery / drilling / cutting / engraving / cutting edges in scalpels [1]
mark first use offered

Q# 54/ iGCSE Chemistry/2008/w/Paper 31/

- (b) (i) positive ions or cations [1]
NOT atoms **or** cores **or** nuclei
layers **or** lattice **or** regular pattern [1]
delocalised **or** free **or** mobile electrons **or** sea [1]

OR positive ions or cations [1]
NOT atoms **or** cores **or** nuclei
attraction between ions and electrons [1]
delocalised **or** free **or** mobile electrons **or** sea [1]
the attraction/electrostatic bonding must be between ions and
delocalised electrons, between cations and anions does not score
ACCEPT bond if qualified - electrostatic bond, etc.
if molecular **or** molecules then cannot score cation mark
(ii) delocalised/free/mobile electrons
or electrons can move [1]

layers **or** ions **or** atoms **or** particles [1]
NB more flexible than 2(b)(i)
can slip **or** move past each other **or** bonding non-directional [1]

Q# 55/ iGCSE Chemistry/2008/s/Paper 31/

- electrons [1] and positive ions [1] [2]
good [1]

Q# 56/ iGCSE Chemistry/2006/w/Paper 3/Q6

- (c) Copper has delocalised electrons [1]
In sulphur the electrons are localised **or** cannot move in the piece of sulphur [1]

In copper there are layers of copper atoms/ions
Which can slip [1]
In sulphur there are no layers [1]

Q# 57/ iGCSE Chemistry/2006/w/Paper 3/

- (v) **A** [1]



Q# 58/ iGCSE Chemistry/2006/s/Paper 3/

- 4 (a) 4 Ge atoms around 1 Ge [1]
Looks tetrahedral or stated to be [1]
- (b) (i) Graphite has layers [1]
COND that can move/slip [1]
or weak bonds between layers [1]

Graphite has delocalised/free/mobile electrons [1]
- (ii) property and use [1]
soft lubricant or pencils
OR good conductor electrodes or in electric motors
- (c) (i) CO₂ and SiO₂ or XO₂ [1]
- (ii) CO₂ molecular or simple molecules or simple covalent [1]
SiO₂ macromolecular or giant covalent [1]
- (d) Ge₂H₆ [1]

Q# 59/ iGCSE Chemistry/2004/s/Paper 3/

5. (a) Has to be three different uses.
- any use that depends on malleability or ductility-
jewellery, pipes, wires, sheets, roofing, ornaments [1]
NOT that it is malleable or ductile
- electrical wires or cooking utensils or electrodes [1]
(good) conductor
- making alloys or named alloy [1]

Q# 60/ iGCSE Chemistry/2003/w/Paper 3/ Q2 (b)

- (ii) lattice or layers of (positive) ions
delocalised or free or mobile electrons
layers/atoms/particles can slip [3]



7.1 Essential End of Topic 3 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?



8 Topic 4.1 Stoichiometry

8.1 End of Topic 4.1 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTENSION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTENSION
	Scored over 95%		SMASHING!!!



Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book <u>you enjoy</u> (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book <u>you enjoy</u> in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book <u>you enjoy</u> in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

8.2 Topic 4.1 Syllabus

4 Stoichiometry

4.1 Stoichiometry

Core

- Use the symbols of the elements and write the formulae of simple compounds
- Deduce the formula of a simple compound from the relative numbers of atoms present
- Deduce the formula of a simple compound from a model or a diagrammatic representation
- Construct word equations and simple balanced chemical equations
- Define *relative atomic mass*, A_r , as the average mass of naturally occurring atoms of an element on a scale where the ^{12}C atom has a mass of exactly 12 units
- Define *relative molecular mass*, M_r , as the sum of the relative atomic masses. (*Relative formula mass* or M_r will be used for ionic compounds.)
(Calculations involving reacting masses in simple proportions may be set. Calculations will **not** involve the mole concept.)

Supplement

- Determine the formula of an ionic compound from the charges on the ions present
- Construct equations with state symbols, including ionic equations
- Deduce the balanced equation for a chemical reaction, given relevant information



8.3 ESSENTIAL Glossary for Keywords for this topic (4.1 Stoichiometry)

Topic #	English	Chinese
	balanced chemical (symbol) equation a summary of a chemical reaction using chemical formulae – the total number of any of the atoms involved is the same on both the reactant and product sides of the equation	平衡化学（符号）方程式-使用化学式进行化学反应的摘要-涉及的任何原子总数在方程式的反应物和产物侧均相同
	chemical reaction a change in which a new substance is formed	化学反应形成新物质的变化
	formula (chemical) a shorthand method of representing chemical elements and compounds using the symbols of the elements	公式（化学）：使用元素符号表示化学元素和化合物的简写方法
	ionic equation the simplified equation for a reaction involving ionic substances: only those ions which take part in the reaction are shown	离子方程式涉及离子物质的反应的简化方程式：仅显示那些参与反应的离子
	law of conservation of mass matter cannot be lost or gained in a chemical reaction – the total mass of the reactants equals the total mass of the products	物质守恒定律在化学反应中不会丢失或获得-反应物的总质量等于产物的总质量
	molecular formula a formula which shows the actual number of atoms of each element present in a molecule of the compound	分子式，表示化合物分子中存在的每种元素的实际原子数的分子式
	molecular mass another, less precise, name for relative molecular mass	分子量相对不太精确的另一个称呼是相对分子量
	products (in a chemical reaction) the substance(s) produced by a chemical reaction	产品（在化学反应中）由化学反应产生的物质
	reactants (in a chemical reaction) the chemical substances that react together in a chemical reaction	反应物（在化学反应中）在化学反应中一起反应的化学物质
	spectator ions these are present in a chemical reaction but take no part in it. They are not included in ionic equations	这些离子存在于化学反应中，但不参与其中。它们不包含在离子方程式中
	standard atom the atom against which the relative atomic masses of all other atoms are measured using the mass spectrometer; one atom of the carbon-12 isotope is given a mass of exactly 12	标准原子使用质谱仪测量所有其他原子的相对原子质量的原子；碳12同位素的一个原子的质量刚好为12
	state symbols these are used to show the physical state of the reactants and products in a chemical reaction: they are (s) solid, (l) liquid, (g) gas and (aq) dissolved in solution in water	状态符号，用于显示化学反应中反应物和产物的物理状态：它们是（s）固体，（l）液体，（g）气体和（aq）溶解在水中的溶液
	symbol (chemical) a simple letter, or group of letters, that represents an element in a chemical formula	符号（化学）一个简单的字母或一组字母，代表化学式中的元素
	word equation a summary of a chemical reaction using the chemical names of the reactants and products	词方程式，是使用反应物和产物的化学名称进行的化学反应的摘要
	relative formula mass (Mr) the sum of all the relative atomic masses of the atoms present in a 'formula unit' of a substance	相对公式质量（Mr）物质“公式单位”中存在的所有原子的相对原子质量的总和
	relative molecular mass (Mr) the sum of all the relative atomic masses of the atoms present in a molecule	相对分子质量（Mr）分子中所有原子的所有相对原子质量的总和



8.3.1 Other Keywords that are needed for Topic 4.2 which will be covered later on in your studies:

Topic #	English	Chinese
1	concentration a measure of how much solute is dissolved in a solvent. Solutions can be dilute (with a high proportion of the solvent), or concentrated (with a high proportion of the solute)	浓度衡量溶质溶解在溶剂中的量度。溶液可以是稀溶液（高比例的溶剂），也可以是浓缩液（高比例的溶质）
1	empirical formula a formula for a compound which shows the simplest ratio of atoms present	经验公式化合物的公式，显示存在的最简单的原子比
1	hydrated salts ionic compounds that contain water of crystallisation between the ions within the solid	在固体中离子之间含有结晶水的水合盐离子化合物
1	molar concentration the measure of the concentration of a solution in terms of the number of moles of the solute dissolved per cubic decimetre of solution (mol/dm ³)	摩尔浓度溶液浓度的量度，以每立方米溶液中溶解的溶质的摩尔数表示 (mol / dm ³)
1	molar mass the mass, in grams, of one mole of a substance	摩尔质量—摩尔物质的质量，以克为单位
1	molar volume of a gas one mole of any gas has the same volume under the same conditions of temperature and pressure (24 dm ³ at one atmosphere and room temperature)	气体的摩尔体积—摩尔的任何气体在相同的温度和压力条件下（在一个大气压和室温下为24 dm ³ ）具有相同的体积
1	mole the measure of amount of substance in chemistry; one mole of a substance has a mass equal to its relative formula mass in grams – that amount of substance contains 6.02×10^{23} (the Avogadro constant) atoms, molecules or formula units depending on the substance considered	摩尔化学中物质含量的量度；一摩尔物质的质量等于其相对分子式的质量（以克为单位）—该物质的数量包含 6.02×10^{23} （Avogadro常数）原子，分子或分子式，具体取决于所考虑的物质
1	percentage purity a measure of the purity of the product from a reaction carried out experimentally: percentage purity = mass of pure product / mass of impure product $\times 100$	纯度百分比衡量通过实验进行的反应的产物纯度的度量：纯度百分比=纯产物的质量/不纯产物的质量 $\times 100$
1	percentage yield a measure of the actual yield of a reaction when carried out experimentally compared to the theoretical yield calculated from the equation: percentage yield = actual yield / predicted yield $\times 100$	产率百分比相对于根据等式计算出的理论产率，通过实验进行的反应实际产率的量度：产率百分比=实际产率 / 预测产率 $\times 100$
1	standard solution a solution whose concentration is known precisely – this solution is then used to find the concentration of another solution by titration	标准溶液一种浓度精确已知的溶液—然后将该溶液用于通过滴定找到另一种溶液的浓度
1	structural formula the structural formula of an organic molecule shows how the atoms and bonds in a molecule are arranged in space: all the atoms and covalent bonds must be shown	结构分子式：有机分子的结构式表明分子中的原子和键如何在空间中排列：必须显示所有原子和共价键
1	titration a method of quantitative analysis using solutions: one solution is slowly added to a known volume of another solution using a burette until an end-point is reached	使用溶液进行滴定的定量分析方法：使用滴定管将一种溶液缓慢添加到已知体积的另一种溶液中，直至达到终点
1	water of crystallisation water included in the structure of certain salts as they crystallise; for example, copper(II) sulfate pentahydrate (CuSO ₄ ·5H ₂ O) contains five molecules of water of crystallisation per molecule of copper(II) sulfate	结晶水某些盐的结晶过程中所含的水；例如，五水合硫酸铜（II）（CuSO ₄ ·5H ₂ O）每分子硫酸铜（II）包含五分子结晶水



8.4 EXTENSION Keywords

You do not need to understand these words to score a good A, or even a low A* but if you are aiming for a good or high A* then understanding words like these here will be helpful.

Avogadro constant another name for a mole	Avogadro常数 它的另一个名字
mass concentration the measure of the concentration of a solution in terms of the mass of the solute, in grams, dissolved per cubic decimetre of solution (g/dm ³)	质量浓度，以每立方分米溶液中溶解的溶质质量（克）为单位的溶液浓度的量度（g / dm ³ ）
relative atomic mass (Ar) the average mass of an atom of an element, taking account of the isotopes of the element, on a scale where a carbon-12 atom has a mass of exactly 12	相对原子质量（Ar）元素的原子平均质量，考虑到元素的同位素，碳12原子的质量恰好为12

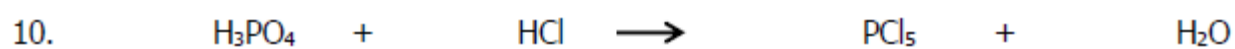
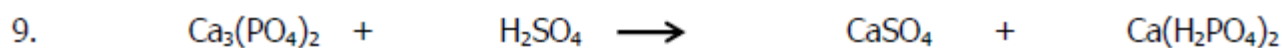
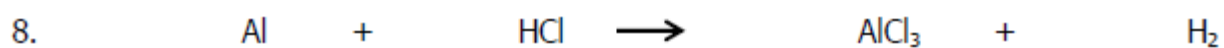
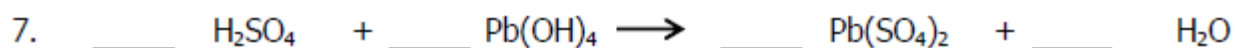
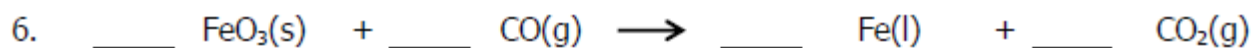
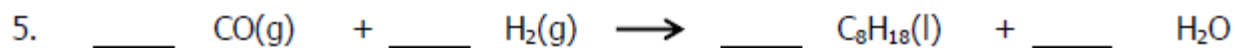
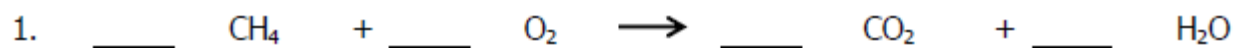
8.5 ESSENTIAL Active Learning Activity 1 Balancing chemical equations

Part 1

- _____ Fe + _____ H₂SO₄ → _____ Fe₂(SO₄)₃ + _____ H₂
- _____ C₂H₆ + _____ O₂ → _____ H₂O + _____ CO₂
- _____ KOH + _____ H₃PO₄ → _____ K₃PO₄ + _____ H₂O
- _____ SnO₂ + _____ H₂ → _____ Sn + _____ H₂O
- _____ NH₃ + _____ O₂ → _____ NO + _____ H₂O
- _____ KNO₃ + _____ H₂CO₃ → _____ K₂CO₃ + _____ HNO₃
- _____ B₂Br₆ + _____ HNO₃ → _____ B(NO₃)₃ + _____ HBr
- _____ BF₃ + _____ Li₂SO₃ → _____ B₂(SO₃)₃ + _____ LiF
- _____ (NH₄)₃PO₄ + _____ Pb(NO₃)₄ → _____ Pb₃(PO₄)₄ + _____ NH₄NO₃
- _____ SeCl₆ + _____ O₂ → _____ SeO₂ + _____ Cl₂



Part 2



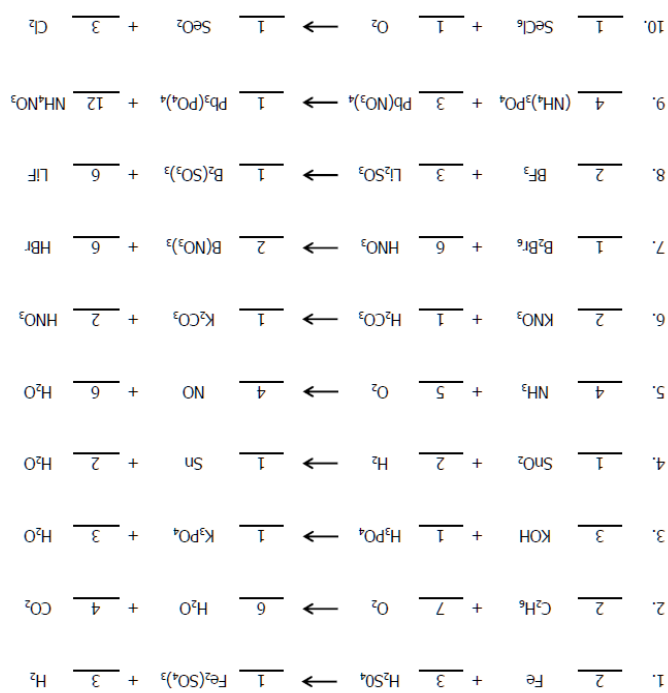
Extension activity

Name as many of the chemicals above as you can.

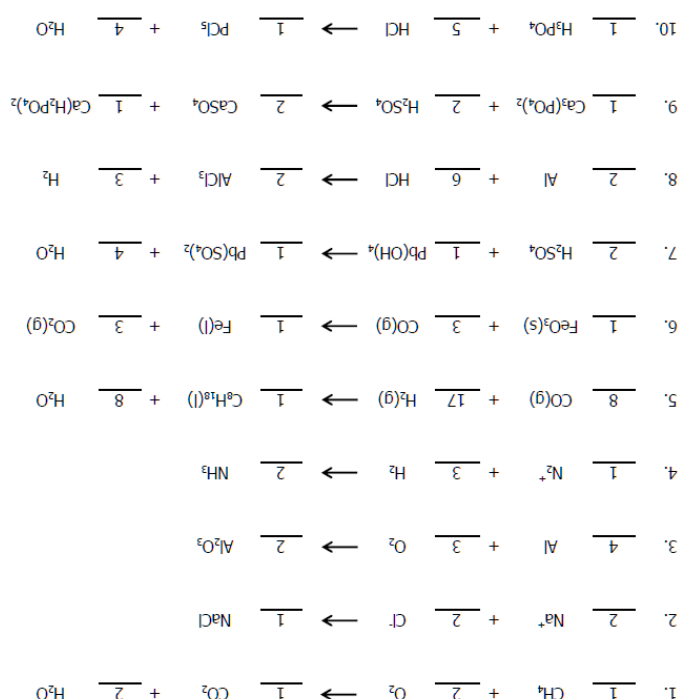


8.5.1 Active Learning Activity Balancing chemical equations Mark Scheme

Part 1



Part



2

8.6 FUNDAMENTAL Active Learning Activity 2 Table of Common, and Not-So Common Ions

Fundamental Activity

Use the information on the next page to find these ions and write out their chemical formula:

Ion	
Carbonate	
Phosphate	
Sulfate	
Nitrate	
Ammonium	
Silver	

Exceptional Reflection:

Transition metals are commonly said, at iGCSE to all have variable oxidation states, but some transition metals listed here are only given one charge. Can you think of why this may be? Is it accurate to call elements like Zn and Cd transition metals? If you go onto a website like ChemGuide find out if these metals really are considered transition metals (this is A-level material) either by scanning this code or clicking the link below:

<https://www.chemguide.co.uk/inorganic/transition/features.html#top>



Table of Ions and Charges

Polyatomic Ions

-1charge

acetate, $\text{C}_2\text{H}_3\text{O}_2^-$, or CH_3COO^-
 chlorate, ClO_3^-
 chlorite, ClO_2^-
 cyanide, CN^-
 hydrogen carbonate, HCO_3^-
 (also called bicarbonate)
 hydroxide, OH^-
 hypochlorite, ClO^-
 iodate, IO_3^-
 nitrate, NO_3^-
 nitrite, NO_2^-
 permanganate, MnO_4^-
 perchlorate, ClO_4^-

-2charge

carbonate, CO_3^{2-}
 chromate, CrO_4^{2-}
 dichromate, $\text{Cr}_2\text{O}_7^{2-}$
 sulfate, SO_4^{2-}
 sulfite, SO_3^{2-}

-3 charge

phosphate, PO_4^{3-}
 phosphite, PO_3^{3-}

+1 charge

ammonium, NH_4^+

Transition Metals without varying charges:

Ag^+	silver
Cd^{2+}	cadmium
Zn^{2+}	zinc

Transition Metals with varying charges:

Ion	Systematic Name
Fe^{3+}	iron(III)
Fe^{2+}	iron(II)
Cu^{2+}	copper(II)
Cu^+	copper(I)
Co^{3+}	cobalt(III)
Co^{2+}	cobalt(II)
Sn^{4+}	tin(IV)
Sn^{2+}	tin(II)
Pb^{4+}	lead(IV)
Pb^{2+}	lead(II)



8.7 ESSENTIAL Active Learning Activity Naming Chemical Compounds

Use the table from the last page to name the following compounds

1. The formulas and common names for several substances are given below. Give the systematic names for these substances. (see ion name table on the last page.)

	Common Name	Chemical Formula	Systematic Name
a.	Sugar of lead	$\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2$	Lead (II) Ethanoate
b.	Blue vitrol	CuSO_4	
c.	Epsom salts	MgSO_4	
d.	Milk of magnesia	$\text{Mg}(\text{OH})_2$	
e.	Gypsum	CaSO_4	
f.	Laughing gas	N_2O	

2. Write the formula for each of the following compounds:

a. Sulfur difluoride		g. Ammonium acetate	
b. Sulfur hexafluoride		h. Ammonium hydrogen carbonate	
c. Sodium phosphate		i. Cobalt (III) nitrate	
d. Lithium nitride		j. Copper (II) chloride	
e. Chromium (III) carbonate		k. Potassium sulfite	
f. Tin (II) fluoride		l. Sodium hydroxide	

3. EXTENSION Name each of the following compounds

a. CuF		i. NaNO_3	
b. CdI_2		j. $\text{Ca}(\text{NO}_2)_2$	
c. HI		k. $\text{Mg}_3(\text{PO}_4)_2$	
d. NO		l. H_3P	
e. NF_3		m. Na_2SO_4	
f. N_2Cl_2		n. $\text{Ca}(\text{HCO}_3)_2$	
g. CF_4			
h. KCl			



8.7.1 Naming Chemical Compounds Mark Scheme

- | | |
|--|--|
| 1. | 3 |
| a. lead (II) acetate | a. copper (I) fluoride |
| b. copper (II) sulfate | b. cadmium iodide |
| c. magnesium sulfate | c. hydrogen moniodide |
| d. magnesium hydroxide | d. nitrogen monoxide |
| e. calcium sulfate | e. nitrogen trifluoride |
| f. dinitrogen monoxide | f. dinitrogen dichloride |
| | g. carbon tetrafluoride |
| 2. | h. potassium chloride |
| a. SF ₂ | i. sodium nitrate |
| b. SF ₆ | j. calcium nitrite |
| c. Na ₃ PO ₄ | k. magnesium phosphate |
| d. Li ₃ N | l. trihydrogen monophosphide |
| e. Cr ₂ (CO ₃) ₃ | m. sodium sulfate |
| f. SnF ₂ | n. calcium hydrogen carbonate or calcium bicarbonate |
| g. NH ₄ C ₂ H ₃ O ₂ or NH ₄ CH ₃ COO | |
| h. NH ₄ HCO ₃ | |
| i. Co(NO ₃) ₃ | |
| j. CuCl ₂ | |
| k. K ₂ SO ₃ | |
| l. NaOH | |

8.8 EXCEPTIONAL INFORMATION Naming compounds (Nomenclature) – The Complete Set of Rules

These rules go into even more detail than is needed at A level, but knowing that these rules exist is important for the very ablest students and hopefully will allow you to make sense of the names you will throughout your career in chemistry.

From: <https://chemed.chem.purdue.edu/genchem/topicreview/bp/ch2/names.html>

Long before chemists knew the formulas for chemical compounds, they developed a system of **nomenclature** that gave each compound a unique name. Today we often use chemical formulas, such as NaCl, C₁₂H₂₂O₁₁, and Co(NH₃)₆(ClO₄)₃, to describe chemical compounds. But we still need unique names that unambiguously identify each compound.

Common Names

Some compounds have been known for so long that a systematic nomenclature cannot compete with well-established common names. Examples of compounds for which common names are used include water (H₂O), ammonia (NH₃), and methane (CH₄).

Naming Ionic Compounds

(Metals with Non-metals)

The names of ionic compounds are written by listing the name of the positive ion followed by the name of the negative ion.

NaCl sodium chloride

(NH₄)₂SO₄ ammonium sulfate

NaHCO₃ sodium bicarbonate



We therefore need a series of rules that allow us to unambiguously name positive and negative ions before we can name the salts these ions form.

Naming Positive Ions

Monatomic positive ions have the name of the element from which they are formed.

Na^+	sodium	Zn^{2+}	zinc
Ca^{2+}	calcium	H^+	hydrogen
K^+	potassium	Sr^{2+}	strontium

Some metals form positive ions in more than one oxidation state. One of the earliest methods of distinguishing between these ions used the suffixes *-ous* and *-ic* added to the Latin name of the element to represent the lower and higher oxidation states, respectively.

Fe^{2+}	ferrous	Fe^{3+}	ferric
Sn^{2+}	stannous	Sn^{4+}	stannic
Cu^+	cuprous	Cu^{2+}	cupric

Chemists now use a simpler method, in which the charge on the ion is indicated by a Roman numeral in parentheses immediately after the name of the element.

Fe^{2+}	iron(II)	Fe^{3+}	iron (III)
Sn^{2+}	tin(II)	Sn^{4+}	tin(IV)
Cu^+	copper(I)	Cu^{2+}	copper(II)

Polyatomic positive ions often have common names ending with the suffix *-onium*.

H_3O^+	hydronium
NH_4^+	ammonium

Naming Negative Ions

Negative ions that consist of a single atom are named by adding the suffix *-ide* to the stem of the name of the element.

F^-	fluoride	O^{2-}	oxide
Cl^-	chloride	S^{2-}	sulfide
Br^-	bromide	N^{3-}	nitride
I^-	iodide	P^{3-}	phosphide
H^-	hydride	C^{4-}	carbide



Common Polyatomic Negative Ions

-1 ions

HCO_3^-	bicarbonate	HSO_4^-	hydrogen sulfate (bisulfate)
CH_3CO_2^-	acetate	ClO_4^-	perchlorate
NO_3^-	nitrate	ClO_3^-	chlorate
NO_2^-	nitrite	ClO_2^-	chlorite
MnO_4^-	permanganate	ClO^-	hypochlorite
CN^-	cyanide	OH^-	hydroxide

-2 ions

CO_3^{2-}	carbonate	O_2^{2-}	peroxide
SO_4^{2-}	sulfate	CrO_4^{2-}	chromate
SO_3^{2-}	sulfite	$\text{Cr}_2\text{O}_7^{2-}$	dichromate
$\text{S}_2\text{O}_3^{2-}$	thiosulfate	HPO_4^{2-}	hydrogen phosphate

-3 ions

PO_4^{3-}	phosphate	AsO_4^{3-}	arsenate
BO_3^{3-}	borate		

Naming Polyatomic Ions

At first glance, the nomenclature of the polyatomic negative ions in the table above seems hopeless. There are several general rules, however, that can bring some order out of this apparent chaos.

The name of the ion usually ends in either *-ite* or *-ate*. The *-ite* ending indicates a low oxidation state. Thus, the NO_2^- ion is the nitrite ion.

The *-ate* ending indicates a high oxidation state. The NO_3^- ion, for example, is the nitrate ion.

The prefix *hypo-* is used to indicate the very lowest oxidation state. The ClO^- ion, for example, is the hypochlorite ion.

The prefix *per-* (as in hyper-) is used to indicate the very highest oxidation state. The ClO_4^- ion is therefore the perchlorate ion.

There are only a handful of exceptions to these generalizations. The names of the hydroxide (OH^-), cyanide (CN^-), and peroxide (O_2^{2-}) ions, for example, have the *-ide* ending because they were once thought to be monatomic ions.



Naming Simple Covalent Compounds

(Non-metals with non-metals)

Oxidation states also play an important role in naming simple covalent compounds. The name of the atom in the positive oxidation state is listed first. The suffix *-ide* is then added to the stem of the name of the atom in the negative oxidation state.

HCl	hydrogen chloride
NO	nitrogen oxide
BrCl	bromine chloride

As a rule, chemists write formulas in which the element in the positive oxidation state is written first, followed by the element(s) with negative oxidation numbers.

The number of atoms of an element in simple covalent compounds is indicated by adding one of the following Greek prefixes to the name of the element.

1 mono-	6 hexa-
2 di-	7 hepta-
3 tri-	8 octa-
4 tetra-	9 nona-
5 penta-	10 deca-

The prefix *mono-* is seldom used because it is redundant. The principal exception to this rule is carbon monoxide (CO).

Naming Acids

Simple covalent compounds that contain hydrogen, such as HCl, HBr, and HCN, often dissolve in water to produce acids. These solutions are named by adding the prefix *hydro-* to the name of the compound and then replacing the suffix *-ide* with *-ic*. For example, hydrogen chloride (HCl) dissolves in water to form hydrochloric acid; hydrogen bromide (HBr) forms hydrobromic acid; and hydrogen cyanide (HCN) forms hydrocyanic acid.

Many of the oxygen-rich polyatomic negative ions in Table 2.1 form acids that are named by replacing the suffix *-ate* with *-ic* and the suffix *-ite* with *-ous*.

Acids containing ions ending with ide often become		hydro -ic acid	
Cl ⁻	chloride	HCl	hydrochloric acid
F ⁻	fluoride	HF	hydrofluoric acid
S ²⁻	sulfide	H ₂ S	hydrosulfuric acid

Acids containing ions ending with **ate** usually become **-ic acid**



CH_3CO_2^-	acetate	$\text{CH}_3\text{CO}_2\text{H}$	acetic acid
CO_3^{2-}	carbonate	H_2CO_3	carbonic acid
BO_3^{3-}	borate	H_3BO_3	boric acid
NO_3^-	nitrate	HNO_3	nitric acid
SO_4^{2-}	sulfate	H_2SO_4	sulfuric acid
ClO_4^-	perchlorate	HClO_4	perchloric acid
PO_4^{3-}	phosphate	H_3PO_4	phosphoric acid
MnO_4^-	permanganate	HMnO_4	permanganic acid
CrO_4^{2-}	chromate	H_2CrO_4	chromic acid
ClO_3^-	chlorate	HClO_3	chloric acid
Acids containing ions ending with ite usually become			-ous acid
ClO_2^-	chlorite	HClO_2	chlorous acid
NO_2^-	nitrite	HNO_2	nitrous acid
SO_3^{2-}	sulfite	H_2SO_3	sulfurous acid
ClO^-	hypochlorite	HClO	hypochlorous acid

Complex acids can be named by indicating the presence of an acidic hydrogen as follows.

NaHCO_3	sodium hydrogen carbonate (also known as sodium bicarbonate)
NaHSO_3	sodium hydrogen sulfite (also known as sodium bisulfite)
KH_2PO_4	potassium dihydrogen phosphate



8.9 Active Learning Activity 4 Word and Symbol Equations

Task 1: Complete the following word equations

- 1- Calcium carbonate + hydrochloric acid $\rightarrow$ calcium chloride + water + _____

- 2 _____ + sulfuric acid $\rightarrow$ magnesium sulfate + hydrogen
3. Magnesium + nitric acid $\rightarrow$ _____ + hydrogen
4. Zinc hydroxide + _____ $\rightarrow$ zinc chloride + water
5. _____ + hydrochloric acid $\rightarrow$ magnesium chloride + water + carbon Dioxide
6. Aluminium + hydrochloric acid $\rightarrow$ _____ + hydrogen
7. Sodium hydroxide + hydrochloric acid $\rightarrow$ _____ + _____
8. Sodium carbonate + _____ $\rightarrow$ sodium sulfate + water + _____

9. _____ + nitric acid $\rightarrow$ calcium nitrate + water + carbon dioxide
10. _____ + sulfuric acid $\rightarrow$ iron(II) sulfate + hydrogen

Task 2: Complete the following word equations

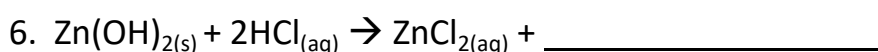
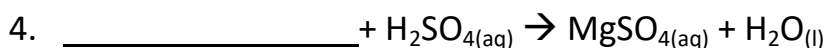
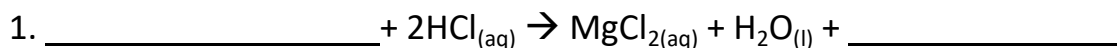
- 1- Hydrochloric acid + sodium hydroxide $\rightarrow$ +
- 2- Sodium + water $\rightarrow$ +
- 3- Magnesium + oxygen $\rightarrow$
- 4- Sulfuric acid + magnesium carbonate $\rightarrow$ + +
.....
- 5- Zinc + copper sulfate $\rightarrow$ +
- 6- Sulfuric acid + sodium hydroxide $\rightarrow$ +
- 7- Hydrogen + oxygen $\rightarrow$
- 8- Carbon + oxygen $\rightarrow$
- 9- Aluminium + nitric acid $\rightarrow$ +



10- Sodium + sulfur →

Task 3: Complete and balance the symbol equations

(you are allowed to write in the spaces only)



Task 4: Complete the following word equations and write balanced symbol equations

1- Calcium carbonate + hydrochloric acid →

Symbol equation:

.....

2- Iron (III) oxide + sulfuric acid →

Symbol equation:

.....

3- Sodium carbonate + sulfuric acid →

Symbol equation:

.....

4- Zinc + hydrochloric acid →

Symbol equation:

.....

5- Aluminium + nitric acid →

Symbol equation:

.....



Extension Word and Symbol Equations

Task 5: Read the following paragraphs about some chemical processes. Write word and balanced chemical symbol equations for reactions 1 to 8

(reactants and products are underlined):

Reaction 1:

In car engines, where the temperature is very high, nitrogen gas reacts with oxygen to form different oxides, one of these oxides is nitrogen dioxide which contributes to acid rain .

.....

..... (3)

Reaction 2

Carbon monoxide, a poisonous gas, is also formed by the reaction of oxygen and carbon (present in fuels).

Car manufactures use catalytic convertors to change these gases into the less harmful products nitrogen, oxygen and carbon dioxide.

.....

..... (3)

Reaction 3

During the process of photosynthesis, plant combine carbon dioxide gas from the atmosphere and water from the soil to produce glucose (C₆H₁₂O₆) and oxygen gas

.....

..... (3)

Reaction 4

In respiring, some living organisms burn glucose to produce carbon dioxide gas and water vapor. (Reaction4).

.....

..... (3)

Reaction 5

In an industrial process, limestone (calcium carbonate) is strongly heated to produce quicklime (calcium oxide) and carbon dioxide gas (reaction 5).

.....

..... (3)

Reaction 6



In the presence of water, iron (and steel) articles react with oxygen in the air to form iron (III) oxide (Reaction 6).

.....

..... (3)

Reaction 7

In industry, zinc metal is extracted from zinc blend (zinc sulfide) by heating the blend in air. The products are sulfur dioxide and zinc oxide (reaction7)

.....

..... (3)

Reaction 8

The metal oxide from the previous equations is then heated with carbon to produce the pure metal and a colourless gas (reaction 8)

.....

..... (3)



Task 1

1. Carbon dioxide
2. Magnesium
3. Magnesium nitrate
4. Hydrochloric acid
5. Magnesium carbonate
6. Aluminium chloride
7. Sodium chloride + water
8. Sulfuric acid → carbon dioxide
9. Calcium carbonate
10. Iron

Task 2

1. Sodium hydroxide + water
2. Sodium hydroxide + hydrogen
3. Magnesium oxide
4. Magnesium sulfate + carbon dioxide + water
5. Zinc sulfate + copper
6. Sodium sulfate + water
7. Water
8. Carbon dioxide
9. Aluminium nitrate + hydrogen
10. Sodium sulfide

Task 3

1. $\text{MgCO}_3(\text{aq}) \rightarrow \text{CO}_2(\text{g})$
2. $\text{MgSO}_4(\text{aq}) + \text{H}_2\text{O}(\text{l})$
3. $2\text{HNO}_2(\text{aq})$
4. $\text{Mg}(\text{OH})_2(\text{s})$
5. $\text{MgCO}_3(\text{s})$
6. $\text{H}_2\text{O}(\text{l})$
7. $\text{MgSO}_4(\text{s}) + \text{H}_2(\text{g})$

Task 4

1. Calcium chloride + water + carbon dioxide
 $\text{CaCO}_3(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
2. Iron (III) Sulfate + water
 $\text{Fe}_2\text{O}_3(\text{s}) + 3\text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Fe}_2(\text{SO}_4)_3 + 3\text{H}_2\text{O}(\text{l})$
3. Sodium Carbonate + Sulfuric acid → Sodium sulfate + carbon dioxide + water
 $\text{Na}_2\text{CO}_3(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
4. Zinc + hydrochloric acid → Zinc chloride + hydrogen
 $\text{Zn}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{ZnCl}_2(\text{aq}) + \text{H}_2(\text{g})$
5. Aluminium + Nitric acid → Aluminium nitrate + hydrogen
 $2\text{Al}(\text{s}) + 6\text{HNO}_3(\text{aq}) \rightarrow 2\text{Al}(\text{NO}_3)_3(\text{aq}) + 3\text{H}_2(\text{g})$

Task 6

1. $2\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}_2(\text{g})$
2. $2\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}(\text{g})$
3. $6\text{CO}_2(\text{aq}) + 6\text{H}_2\text{O}(\text{l}) \rightarrow \text{C}_6\text{H}_{12}\text{O}_6(\text{aq}) + 6\text{O}_2(\text{g})$
4. $\text{C}_6\text{H}_{12}\text{O}_6(\text{aq}) + 6\text{O}_2(\text{g}) \rightarrow 6\text{CO}_2(\text{aq}) + 6\text{H}_2\text{O}(\text{l})$
5. $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
6. $4\text{Fe}(\text{s}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{Fe}_2\text{O}_3(\text{s})$
7. $2\text{Zn}(\text{s}) \rightarrow 2\text{ZnO}(\text{s}) + \text{SO}_2(\text{g})$
8. $\text{C}(\text{s}) + 2\text{ZnO}(\text{s}) \rightarrow 2\text{Zn}(\text{s}) + 2\text{ZnCl}(\text{aq}) + \text{CO}_2(\text{g})$

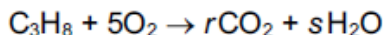


8.10 FUNDAMENTAL EXAM QUESTIONS T4.1 Paper 1 12marks

All of these questions in this section come from Paper 1, which only assesses Core syllabus material and they are designed to all be answerable by students who can only achieve a C grade.

Q# 16/ iGCSE Chemistry/2004/w/Paper 1/

- 9 When propane is burned, carbon dioxide and water are formed, as shown.



Which values of r and s balance the equation?

	r	s
A	1	3
B	1	5
C	3	4
D	3	8

- 10 Which formula represents a compound containing three atoms?

A HNO_3 B H_2O C LiF D ZnSO_4

Q# 17/ iGCSE Chemistry/2004/s/Paper 1/

- 9 The oxide Pb_3O_4 reacts with dilute nitric acid to form lead(II) nitrate, lead(IV) oxide and another product.

What is the equation for this reaction?

- A $\text{Pb}_3\text{O}_4 + 4\text{HNO}_3 \rightarrow 2\text{Pb}(\text{NO}_3)_2 + \text{PbO}_2 + 2\text{H}_2\text{O}$
 B $\text{Pb}_3\text{O}_4 + 2\text{HNO}_3 \rightarrow 2\text{PbNO}_3 + \text{PbO}_4 + \text{H}_2$
 C $\text{Pb}_3\text{O}_4 + 4\text{HNO}_3 \rightarrow \text{Pb}(\text{NO}_3)_4 + 2\text{PbO} + 2\text{H}_2\text{O}$
 D $2\text{Pb}_3\text{O}_4 + 2\text{HNO}_3 \rightarrow 2\text{Pb}_2\text{NO}_3 + 2\text{PbO}_2 + \text{H}_2$

Q# 18/ iGCSE Chemistry/2004/s/Paper 1/

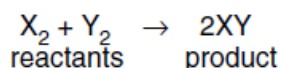
- 10 The compound ethyl mercaptan, $\text{C}_2\text{H}_5\text{SH}$, has a very unpleasant smell.

What is its relative molecular mass?

A 34 B 50 C 61 D 62

Q# 19/ iGCSE Chemistry/2003/w/Paper 1/

- 10 Two gases react as shown.



When measured at the same temperature and pressure, what is the value of

$$\frac{\text{volume of product}}{\text{volume of reactants}} ?$$



- A $\frac{1}{2}$
- B 1
- C 2
- D 4

11 Carbon and chlorine form a chloride.

What is the formula of this chloride?

- A CCl_2
- B CCl_4
- C CaCl_2
- D CaCl_4

Q# 20/ iGCSE Chemistry/2003/s/Paper 1/

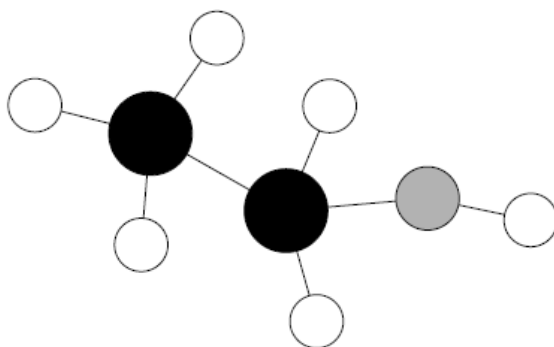
9 The relative atomic mass of oxygen is 16 and that of hydrogen is 1.

This means that ... (i) ... of oxygen has the same mass as ... (ii) ... of hydrogen.

Which words correctly complete the gaps?

	gap (i)	gap (ii)
A	an atom	thirty-two molecules
B	an atom	eight molecules
C	a molecule	sixteen atoms
D	a molecule	eight atoms

10 The diagram shows a model of a molecule containing carbon, hydrogen and oxygen.



How many atoms of each element are in the molecule?

	carbon	hydrogen	oxygen
A	1	6	2
B	2	5	1
C	2	6	1
D	6	2	1



Q# 21/ iGCSE Chemistry/2002/w/Paper 1/

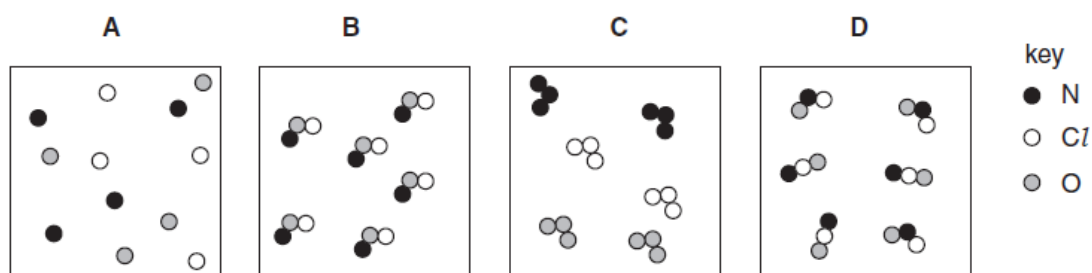
- 9 One method of producing carbon dioxide is to react calcium carbonate with dilute hydrochloric acid.

What is the balanced chemical equation for the reaction?

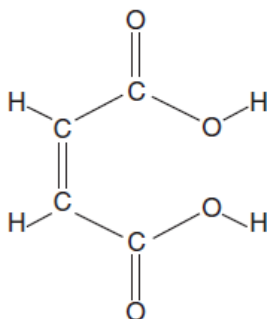
- A $\text{CaCO}_3 + \text{HCl} \rightarrow \text{CaO} + \text{CO}_2 + \text{HCl}$
 B $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$
 C $\text{CaCO}_3 + 4\text{HCl} \rightarrow \text{CaCl}_4 + \text{CO}_2 + \text{H}_2 + \text{H}_2\text{O}$
 D $\text{Ca}(\text{HCO}_3)_2 + \text{HCl} \rightarrow \text{CaCl} + 2\text{CO}_2 + \text{H}_2\text{O}$

- 10 A gas has the molecular formula NOCl.

Which diagram could show molecules of the pure gas NOCl?



- 11 Butenedioic acid has the structure shown.



What is the molecular formula of butenedioic acid?

- A CHO B $\text{C}_4\text{H}_4\text{O}_4$ C $\text{C}_6\text{H}_4\text{O}_2$ D $\text{C}_6\text{H}_4\text{O}_6$

Q# 22/ iGCSE Chemistry/2002/s/Paper 1/

- 10 What is the formula of copper(II) oxide and of sulphur hexafluoride?

	copper(II) oxide	sulphur hexafluoride
A	CuO	S_6F
B	CuO	SF_6
C	Cu_2O	S_6F
D	Cu_2O	SF_6



8.10.1 FUNDAMENTAL EXAM QUESTIONS

T4.1 Paper 1 12marks Mark Scheme

Q# 1/ iGCSE Chemistry/2012/w/Paper 11/

4 B

Q# 2/ iGCSE Chemistry/2012/s/Paper 11/

9 C

Q# 3/ iGCSE Chemistry/2011/w/Paper 11/

8 B

Q# 4/ iGCSE Chemistry/2011/s/Paper 11/

8 D

Q# 5/ iGCSE Chemistry/2010/w/Paper 11/

10 B

Q# 6/ iGCSE Chemistry/2010/s/Paper 11/

10 C

Q# 7/ iGCSE Chemistry/2009/w/Paper 11/

10 C

11 B

Q# 8/ iGCSE Chemistry/2009/s/Paper 1/

10 C

11 D

Q# 9/ iGCSE Chemistry/2008/w/Paper 1/

10 B

11 B

Q# 10/ iGCSE Chemistry/2008/s/Paper 1/

11 D

Q# 11/ iGCSE Chemistry/2007/w/Paper 1/

10 D

11 B

Q# 12/ iGCSE Chemistry/2007/s/Paper 1/

10 D

Q# 13/ iGCSE Chemistry/2007/s/Paper 1/

11 B

Q# 14/ iGCSE Chemistry/2006/w/Paper 1/

9 D

10 C

Q# 15/ iGCSE Chemistry/2005/s/Paper 1/

10 D

Q# 16/ iGCSE Chemistry/2004/w/Paper 1/

9 C

10 B

Q# 17/ iGCSE Chemistry/2004/s/Paper 1/

9 A

Q# 18/ iGCSE Chemistry/2004/s/Paper 1/

10 D

Q# 19/ iGCSE Chemistry/2003/w/Paper 1/

10 B

11 B

Q# 20/ iGCSE Chemistry/2003/s/Paper 1/

9 B

10 C

Q# 21/ iGCSE Chemistry/2002/w/Paper 1/

9 B

10 B

11 B

Q# 22/ iGCSE Chemistry/2002/s/Paper 1/

10 B



8.11 FUNDAMENTAL EXAM QUESTIONS Paper 2 9marks

Q# 1/ iGCSE Chemistry/2018/w/Paper 23/

- 9 Iron(III) chromate is a yellow solid. It contains the ions Fe^{3+} and CrO_4^{2-} .

What is the formula of iron(III) chromate?

- A FeCrO_4 B $\text{Fe}_3(\text{CrO}_4)_2$ C Fe_2CrO_4 D $\text{Fe}_2(\text{CrO}_4)_3$

Q# 2/ iGCSE Chemistry/2018/w/Paper 22/

- 9 The formulae of some ions are shown.

positive ion	negative ion
Ti^{4+}	PO_4^{3-}
Al^{3+}	SO_4^{2-}
Mg^{2+}	NO_3^-
K^+	Cl^-

Which formula is **not** correct?

- A $\text{Al}_3(\text{SO}_4)_2$ B K_3PO_4 C $\text{Mg}(\text{NO}_3)_2$ D TiCl_4

Q# 3/ iGCSE Chemistry/2018/w/Paper 21/

- 9 Iron can react with sulfur to form two ionic compounds.

The iron is present as Fe^{2+} in one compound and as Fe^{3+} in the other compound.

The sulfur ion is present as S^{2-} in both compounds.

What are the formulae of the two compounds?

- A FeS and Fe_2S_3
 B FeS and Fe_3S_2
 C FeS_2 and Fe_3S_2
 D FeS_2 and Fe_2S_3

Q# 4/ iGCSE Chemistry/2017/w/Paper 23/

- 8 A compound contains 34.5% calcium, 24.1% silicon and 41.4% oxygen by mass.

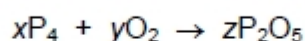
What is its empirical formula?

- A Ca_2SiO_3 B CaSiO_3 C CaSi_2O_3 D CaSiO_8



Q# 5/ iGCSE Chemistry/2017/w/Paper 22/

7 The equation for the reaction between phosphorus and oxygen is shown.



Which values of x, y and z balance the equation?

	x	y	z
A	1	5	2
B	1	10	2
C	2	5	2
D	2	10	1

Q# 6/ iGCSE Chemistry/2017/s/Paper 23/

7 Aqueous iron(III) sulfate and aqueous sodium hydroxide react to give a precipitate of iron(III) hydroxide and a solution of sodium sulfate.

What is the balanced equation for this reaction?

- A $Fe_2(SO_4)_3(aq) + 2NaOH(aq) \rightarrow Fe(OH)_3(s) + Na_2SO_4(aq)$
- B $Fe_2(SO_4)_3(aq) + 3NaOH(aq) \rightarrow Fe(OH)_3(s) + 3Na_2SO_4(aq)$
- C $Fe_2(SO_4)_3(aq) + 6NaOH(aq) \rightarrow 2Fe(OH)_3(s) + 3Na_2SO_4(aq)$
- D $2Fe_2(SO_4)_3(aq) + 6NaOH(aq) \rightarrow 4Fe(OH)_3(s) + 6Na_2SO_4(aq)$

Q# 7/ iGCSE Chemistry/2017/s/Paper 22/

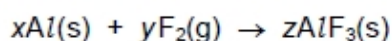
7 Which equations are balanced?

- 1 $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
- 2 $ZnCO_3 + 2HCl \rightarrow ZnCl_2 + CO_2 + 2H_2O$
- 3 $Mg(NO_3)_2 + NaOH \rightarrow Mg(OH)_2 + 2NaNO_3$
- 4 $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$

- A 1 and 2 B 1 and 4 C 2 and 3 D 3 and 4

Q# 8/ iGCSE Chemistry/2017/s/Paper 21/

7 Aluminium reacts with fluorine.



Which values of x, y and z balance the equation?

	x	y	z
A	1	2	1
B	2	3	2
C	3	2	3
D	4	3	4



Q# 9/ iGCSE Chemistry/2016/m/Paper 22/

9 Magnesium nitride is formed when magnesium burns in air. Magnesium nitride is an ionic compound.

What is the formula of magnesium nitride?

- A MgN_2 B Mg_2N_2 C Mg_2N_3 D Mg_3N_2

8.11.1 FUNDAMENTAL EXAM QUESTIONS Paper 2 9marks mark Scheme

Q# 1/ iGCSE Chemistry/2018/w/Paper 23/

9	D
---	---

Q# 2/ iGCSE Chemistry/2018/w/Paper 22/

9	A
---	---

Q# 3/ iGCSE Chemistry/2018/w/Paper 21/

9	A
---	---

Q# 4/ iGCSE Chemistry/2017/w/Paper 23/

8	B
---	---

Q# 5/ iGCSE Chemistry/2017/w/Paper 22/

7	A
---	---

Q# 6/ iGCSE Chemistry/2017/s/Paper 23/

7	C
---	---

Q# 7/ iGCSE Chemistry/2017/s/Paper 22/

8	A
---	---

Q# 8/ iGCSE Chemistry/2017/s/Paper 21/

7	B
---	---

Q# 9/ iGCSE Chemistry/2016/m/Paper 22/

9	D
---	---

8.12 ESSENTIAL EXAM QUESTIONS T4.1 Paper 4 9marks

Q# 1/ iGCSE Chemistry/2014/w/Paper 31/

7 Nitrogen can form ionic compounds with reactive metals and covalent compounds with non-metals.

(a) Nitrogen reacts with lithium to form the ionic compound lithium nitride, Li_3N .

(i) Write the equation for the reaction between lithium and nitrogen.

..... [2]

Q# 2/ iGCSE Chemistry/2013/s/Paper 31/ Q6

Ammonia is a compound with the molecular formula NH_3

(c) Another compound which contains only nitrogen and hydrogen is hydrazine, N_2H_4 .

Complete the equation for the preparation of hydrazine from ammonia.



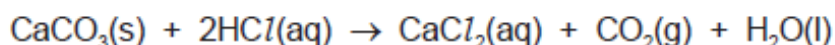
Q# 3/ iGCSE Chemistry/2013/s/Paper 31/

- 3 A small piece of marble, CaCO_3 , was added to 5.0 cm^3 of hydrochloric acid, concentration 1.0 mol/dm^3 , at 25°C . The time taken for the reaction to stop was measured. The experiment was repeated using 5.0 cm^3 of different solutions of acids. The acid was in excess in all of the experiments.

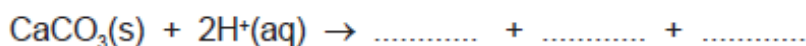
Typical results are given in the table.

experiment	temperature / $^\circ\text{C}$	acid solution	time / min
1	25	hydrochloric acid 1.0 mol/dm^3	3

- (b) The equation for the reaction in experiment 1 is:



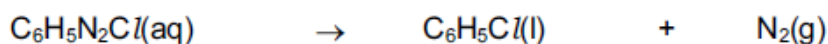
Complete the following ionic equation.



[1]

Q# 4/ iGCSE Chemistry/2004/s/Paper 3/

- 3 An organic compound decomposes to form nitrogen.



- (a) Explain the state symbols.

aq

l

g [2]

Q# 5/ iGCSE Chemistry/2002/w/Paper 3/ Q3

- (b) The following compounds contain two elements. Predict their formulae.

aluminium sulphide

silicon phosphide [2]

8.12.1 EXAM QUESTIONS T4.1 Paper 4 9marks Mark Scheme

Q# 1/ iGCSE Chemistry/2014/w/Paper 31/

- 7 (a) (i) $6\text{Li} + \text{N}_2 = 2\text{Li}_3\text{N}$
species (1) balancing (1)

Q# 2/ iGCSE Chemistry/2013/s/Paper 31/ Q6

- (c) $2\text{NH}_3 + \text{NaClO} \rightarrow \text{N}_2\text{H}_4 + \text{NaCl} + \text{H}_2\text{O}$ [2]
not balanced only 1

Q# 3/ iGCSE Chemistry/2013/s/Paper 31/ Q3

- (b) experiment 1 $\text{Ca}^{2+} + \text{CO}_2 + \text{H}_2\text{O}$ [1]

Q# 4/ iGCSE Chemistry/2004/s/Paper 3/



3. (a) dissolved or solution in water [1]
 NOT aqueous NOT soluble in water
 I liquid and g gas [1]

Q# 5/ iGCSE Chemistry/2002/w/Paper 3/ Q3

- (b) Al_2S_3 [1]
 Si_3P_4 [1]

8.13 FUNDAMENTAL Assessed Activity 1 Keyword Test

English	Chinese
law of conservation of mass	
molecular formula	
relative molecular mass (<i>Mr</i>)	
relative formula mass (<i>Mr</i>)	
balanced chemical (symbol) equation	
standard atom	
chemical reaction	
molecular mass	
state symbols	
symbol (chemical)	
formula (chemical)	



English	Chinese
reactants	
ionic equation	
products	
word equation	
spectator ions	

8.14 ESSENTIAL Assessed Activity 2 T4.1 Paper 1 (Core only material) 15marks

Q# 1/

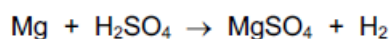
8 A compound has the formula $\text{CH}_3\text{CO}_2\text{H}$.

How should the relative molecular mass, M_r , of this compound be calculated?

- A $12 + 1 + 16$
 B $3(12 + 1) + 2(12 + 16) + 1$
 C $(4 \times 12) + (2 \times 1) + 16$
 D $(2 \times 12) + (4 \times 1) + (2 \times 16)$

Q# 2/

9 The equation for the reaction between magnesium and dilute sulfuric acid is shown.



M_r of MgSO_4 is 120

Which mass of magnesium sulfate will be formed if 12 g of magnesium are reacted with sulfuric acid?

- A 5g B 10g C 60g D 120g

Q# 3/

8 The relative formula mass, M_r , of copper(II) sulfate, CuSO_4 , is 160.

Which mass of sulfur is present in 160 g of copper(II) sulfate?

- A 16g B 32g C 64g D 128g

Q# 4/

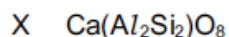
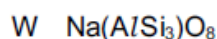
8 What is the relative molecular mass (M_r) of HNO_3 ?

- A 5 B 31 C 32 D 63



Q# 5/

10 The chemical compositions of two substances, W and X, are given.



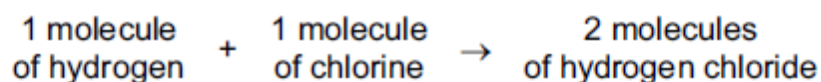
Which statements are correct?

- 1 W and X contain the same amount of oxygen.
- 2 W contains three times as much silicon as X.
- 3 X contains twice as much aluminium as W.

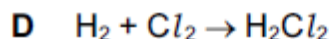
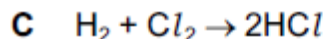
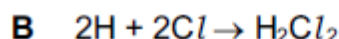
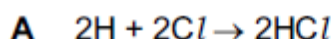
A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 1, 2 and 3

Q# 6/

10 Hydrogen and chlorine react as shown.



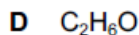
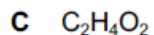
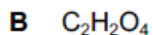
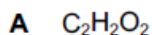
What is the equation for this reaction?



Q# 7/

10 For each atom of carbon present in a molecule, there is an equal number of atoms of oxygen but twice as many atoms of hydrogen.

What is the formula of the molecule?



11 Water is formed when 48 g of oxygen combine with 6 g of hydrogen.

What mass of oxygen combines with 2 g of hydrogen?

A 12 g

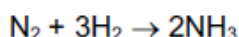
B 16 g

C 96 g

D 144 g

Q# 8/

10 Nitrogen and hydrogen react together to form ammonia.



When completely converted, 7 tonnes of nitrogen gives 8.5 tonnes of ammonia.

How much nitrogen will be needed to produce 34 tonnes of ammonia?

A 7 tonnes

B 8.5 tonnes

C 28 tonnes

D 34 tonnes

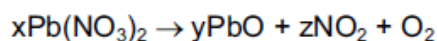


11 Which relative molecular mass, M_r , is **not** correct for the molecule given?

	molecule	M_r
A	ammonia, NH_3	17
B	carbon dioxide, CO_2	44
C	methane, CH_4	16
D	oxygen, O_2	16

Q# 9/

10 Lead(II) nitrate can be decomposed as shown.



Which numbers x, y and z balance the equation?

	x	y	z
A	2	2	2
B	2	2	4
C	2	4	4
D	4	4	2

11 Carbon and chlorine form a chloride.

What is the formula of this chloride?

- A** CCl_2 **B** CCl_4 **C** CaCl_2 **D** CaCl_4

Q# 10/

11 The diagram shows a molecule of vinyl chloride (used to make pvc).



key

- a carbon atom
- a chlorine atom
- a hydrogen atom

What is the formula of vinyl chloride?

- A** CH_2Cl_3 **B** CH_3Cl_2 **C** C_2HCl_3 **D** $\text{C}_2\text{H}_3\text{Cl}$



Q# 11/

10 The diagram shows a model of a molecule of an organic acid.



What is the relative molecular mass of this acid?

- A 11 B 40 C 58 D 74

11 For complete combustion, one molecule of an organic compound needs 8 molecules of oxygen.

What could the formula of this compound be?

- A $C_5H_{11}OH$
 B C_6H_9OH
 C $C_6H_{11}OH$
 D C_6H_{12}

Q# 12/

10 Boron, B, forms an oxide.

Which equation is correctly balanced?

- A $2B + 3O_2 \rightarrow B_2O_3$
 B $2B + 3O_2 \rightarrow 2B_2O_3$
 C $4B + 2O_2 \rightarrow 2B_2O_3$
 D $4B + 3O_2 \rightarrow 2B_2O_3$

Q# 13/

11 Students are asked to state

- the number of atoms in one molecule of ethanoic acid,
- the relative molecular mass, M_r , of this acid.

Which line is correct?

	number of atoms	M_r
A	8	32
B	8	60
C	9	26
D	9	46



Q# 14/

- 9 Magnesium and sulphur each form a chloride.

What could be the formulae of these chlorides?

	magnesium	sulphur
A	Mg_2Cl	S_2Cl
B	Mg_2Cl	SCl_2
C	MgCl_2	S_2Cl
D	MgCl_2	SCl_2

- 10 A gas has the molecular formula NOCl .

Which diagram could show molecules of the pure gas NOCl ?

A

B

C

D

key

○ Cl

● N

● O

Q# 15/

- 10 For which compound is the formula correct?

	compound	formula
A	ammonia	NH_4
B	carbon monoxide	CO_2
C	iron(III) oxide	Fe_3O_2
D	zinc hydroxide	$\text{Zn}(\text{OH})_2$



Q# 1/

(c) Deduce the formula of iron(III) sulfate.

..... [1]

Q# 2/

2 Choose from the following list of gases. A gas may be chosen once, more than once or not at all.

sulfur dioxide

hydrogen

methane

carbon monoxide

argon

ethene

butane

(b) When burned in oxygen, the only product is water. [1]

(e) When reacted with oxygen, the only product is carbon dioxide. [1]

Q# 3/

1 Use your copy of the Periodic Table to help you answer some of these questions.

(c) Use the following ions to determine the formulae of the compounds.

ions OH^- Cr^{3+} Ba^{2+} SO_4^{2-}

compounds

(i) chromium(III) sulfate

(ii) barium hydroxide

[2]

Q# 4/

5 The law of constant composition states that all pure samples of a compound contain the same elements in the same proportion by weight.

A typical experiment to test this law is to prepare the same compound by different methods and then show that the samples have the same composition.

Methods of making copper(II) oxide include:

- heating copper carbonate,
- heating copper hydroxide,
- heating copper nitrate,
- heating copper foil in air.



(c) The table below shows the results obtained by reducing the copper(II) oxide produced by different methods to copper.

(i) Complete the table.

source of copper(II) oxide	mass of copper(II) oxide / g	mass of copper / g	percentage copper / %
CuCO_3	2.37	1.89	79.7
Cu(OH)_2	2.51	1.99	
$\text{Cu(NO}_3)_2$	2.11	1.68	
Cu and O_2	2.29	1.94	

[2]

(ii) One of the samples of copper(II) oxide is impure.

Identify this sample and suggest an explanation why the percentage of copper in this sample is bigger than in the other three samples.

.....

..... [2]

Q# 5/

(b) In the lattice of calcium nitride, the ratio of calcium ions to nitride ions is 3 : 2.

(ii) In terms of ionic charges, explain why the ratio of ions is 3 : 2.

.....

..... [2]

8.16 Extension Mind Map for Topic 4.1 Chemical equations



8.17 Essential End of Topic 4.1 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?



8.18 Exceptional Stretch and Challenge Activities and Additional Reading The SI System

The Mole is the unit for amount of substance. When you are writing out chemical equations you are in fact dealing with molar amounts.

Name	Symbol	Measure	Current (2005) formal definition ^u	Historical origin / justification	<u>Dimension symbol</u>
metre	m	length	"The metre is the length of the path travelled by light in vacuum during a time interval of $1/299792458$ of a second." <i>17th CGPM (1983, Resolution 1, CR, 97)</i>	$1/10,000,000$ of the distance from the Earth's equator to the North Pole measured on the circumference through Paris .	L
kilogram	kg	mass	"The kilogram is the unit of mass; it is equal to the mass of the international prototype of the kilogram." <i>3rd CGPM (1901, CR, 70)</i>	The mass of one litre of water at the temperature of melting ice. A litre is one thousandth of a cubic metre.	M
second	s	time	"The second is the duration of 9192631770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom." <i>13th CGPM (1967/68, Resolution 1; CR, 103)</i> "This definition refers to a caesium atom at rest at a temperature of 0 K." <i>(Added by CIPM in 1997)</i>	The day is divided in 24 hours, each hour divided in 60 minutes, each minute divided in 60 seconds. A second is $1/(24 \times 60 \times 60)$ of the day .	T
ampere	A	electric current	"The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 metre apart in vacuum, would produce between these conductors a force equal to 2×10^{-7} newton per metre of length." <i>9th CGPM (1948)</i>	The original "International Ampere" was defined electrochemically as the current required to deposit 1.118 milligrams of silver per second from a solution of silver nitrate . Compared to the SI ampere, the difference is 0.015%.	I
kelvin	K	thermodynamic temperature	"The kelvin, unit of thermodynamic temperature, is the fraction $1/273.16$ of the thermodynamic temperature of the triple point of water." <i>13th CGPM (1967/68, Resolution 4; CR, 104)</i> "This definition refers to water having the isotopic composition defined exactly by the following amount of substance ratios: 0.000 155 76 mole of ^2H per mole of ^1H , 0.000 379 9 mole of ^{17}O per mole of ^{16}O , and 0.002 005 2 mole of ^{18}O per mole of ^{16}O ." <i>(Added by CIPM in 2005)</i>	The Celsius scale : the Kelvin scale uses the degree Celsius for its unit increment, but is a thermodynamic scale (0 K is absolute zero).	Θ

Name	Symbol	Measure	Current (2005) formal definition ^[1]	Historical origin / justification	<u>Dimension symbol</u>
<u>mole</u>	mol	<u>amount of substance</u>	"1. The mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon 12; its symbol is 'mol'. 2. When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles." <i>14th CGPM (1971, Resolution 3; CR, 78)</i> "In this definition, it is understood that unbound atoms of carbon 12, at rest and in their ground state, are referred to." <i>(Added by CIPM in 1980)</i>	<u>Atomic weight</u> or <u>molecular weight</u> divided by the <u>molar mass constant</u> , 1 g/mol.	N
<u>candela</u>	cd	<u>luminous intensity</u>	"The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540×10^{12} hertz and that has a radiant intensity in that direction of 1/683 watt per <u>steradian</u>." <i>16th CGPM (1979, Resolution 3; CR, 100)</i>	The <u>candlepower</u> , which is based on the light emitted from a burning candle of standard properties.	J

To find out more about the SI system click on this link: <https://www.nist.gov/pml/weights-and-measures/metric-si/si-units> Or scan this QR code:

Exceptional Reflection

Why do you think the SI units exist? Do any countries not use this system? Who gets to decide on these standards?

One of these, until 2019 is not based on a universal law, the Kilogram. To find out more about this exceptional unit and how and why it changed in 2019 read these articles:

- <https://www.theverge.com/2018/11/13/18087002/kilogram-new-definition-kg-metric-unit-ipk-measurement>
- <https://www.nist.gov/pml/weights-and-measures/si-units-mass>
- <https://www.sciencealert.com/it-s-official-the-definition-of-a-kilogram-has-changed>

For an alternate version of the kilogram, which was not adopted can be found by finding out about the world's roundest object:

- <https://www.heason.com/news-media/technical-blog-archive/world-s-roundest-object#:~:text=World's%20Roundest%20Object,in%20measurement%3B%20defining%20the%20kilogram.>
- <https://www.newscientist.com/article/dn14229-roundest-objects-in-the-world-created/>

Exceptional Activity – Create a short 2-3 minute presentation about any part of an SI unit you find most interesting. You should try to explain as much as possible, rather than just describing facts to show analysis, which is a higher order thinking skill that becomes increasingly important as you progress through your education.



9 Topic 4.2 The Mole Concept

9.1 End of Topic 4.2 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTENSION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTENSION
	Scored over 95%		SMASHING!!!



Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book <u>you enjoy</u> (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book <u>you enjoy</u> in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book <u>you enjoy</u> in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

9.2 Topic 4.2 Syllabus

4 Stoichiometry

4.2 The mole concept

Supplement

- Define the *mole* and the *Avogadro constant*
- Use the molar gas volume, taken as 24 dm^3 at room temperature and pressure
- Calculate stoichiometric reacting masses, volumes of gases and solutions, and concentrations of solutions expressed in g/dm^3 and mol/dm^3 . (Calculations involving the idea of limiting reactants may be set. Questions on the gas laws and the conversion of gaseous volumes to different temperatures and pressures will **not** be set.)
- Calculate empirical formulae and molecular formulae
- Calculate percentage yield and percentage purity



9.3 ESSENTIAL Glossary for Keywords for this topic

Many words used in science have a meaning that is slightly different to their common everyday English meaning, for instance a salt is the product of an acid and base reacting together in chemistry, but normally thought of as table salt (NaCl) in common use.

The keywords have been auto translated into Chinese, so the translations will not be perfect but they should hopefully make sense. If there is a better translation you can simply write it out yourself on a Post-it note and stick it over the printed one.

Topic #	English	Chinese
4	balanced chemical (symbol) equation a summary of a chemical reaction using chemical formulae – the total number of any of the atoms involved is the same on both the reactant and product sides of the equation	平衡化学（符号）方程式-使用化学式进行化学反应的摘要 –涉及的任何原子总数在方程式的反应物和产物侧均相同
4	chemical reaction a change in which a new substance is formed	化学反应形成新物质的变化
4	concentration a measure of how much solute is dissolved in a solvent. Solutions can be dilute (with a high proportion of the solvent), or concentrated (with a high proportion of the solute)	浓度衡量溶质溶解在溶剂中的量度。溶液可以是稀溶液（高比例的溶剂），也可以是浓缩液（高比例的溶质）
4	empirical formula a formula for a compound which shows the simplest ratio of atoms present	经验公式化合物的公式，显示存在的最简单的原子比
4	formula (chemical) a shorthand method of representing chemical elements and compounds using the symbols of the elements	公式（化学）：使用元素符号表示化学元素和化合物的简写方法
4	hydrated salts ionic compounds that contain water of crystallisation between the ions within the solid	在固体中离子之间含有结晶水的水合盐离子化合物
4	ionic equation the simplified equation for a reaction involving ionic substances: only those ions which take part in the reaction are shown	离子方程式涉及离子物质的反应的简化方程式：仅显示那些参与反应的离子
4	law of conservation of mass matter cannot be lost or gained in a chemical reaction – the total mass of the reactants equals the total mass of the products	物质守恒定律在化学反应中不会丢失或获得–反应物的总质量等于产物的总质量
4	molar concentration the measure of the concentration of a solution in terms of the number of moles of the solute dissolved per cubic decimetre of solution (mol/dm ³)	摩尔浓度溶液浓度的量度，以每立方米溶液中溶解的溶质的摩尔数表示（mol / dm ³ ）
4	molar mass the mass, in grams, of one mole of a substance	摩尔质量—摩尔物质的质量，以克为单位
4	molar volume of a gas one mole of any gas has the same volume under the same conditions of temperature and pressure (24 dm ³ at one atmosphere and room temperature)	气体的摩尔体积—摩尔的任何气体在相同的温度和压力条件下（在一个大气压和室温下为24 dm ³ ）具有相同的体积
4	mole the measure of amount of substance in chemistry; one mole of a substance has a mass equal to its relative formula mass in grams – that amount of substance contains	摩尔化学中物质含量的量度；一摩尔物质的质量等于其相对分子式的质量（以克为单位）–该物质的数量包含



	6.02×10^{23} (the Avogadro constant) atoms, molecules or formula units depending on the substance considered	6.02×10^{23} (Avogadro常数) 原子, 分子或分子式, 具体取决于所考虑的物质
4	molecular formula a formula which shows the actual number of atoms of each element present in a molecule of the compound	分子式, 表示化合物分子中存在的每种元素的实际原子数的分子式
4	molecular mass another, less precise, name for relative molecular mass	分子量相对不太精确的另一个称呼是相对分子量
4	percentage purity a measure of the purity of the product from a reaction carried out experimentally: $\text{percentage purity} = \frac{\text{mass of pure product}}{\text{mass of impure product}} \times 100$	纯度百分比衡量通过实验进行的反应的产物纯度的度量: 纯度百分比 = $\frac{\text{纯产物的质量}}{\text{不纯产物的质量}} \times 100$
4	percentage yield a measure of the actual yield of a reaction when carried out experimentally compared to the theoretical yield calculated from the equation: $\text{percentage yield} = \frac{\text{actual yield}}{\text{predicted yield}} \times 100$	产率百分比相对于根据等式计算出的理论产率, 通过实验进行的反应实际产率的量度: 产率百分比 = $\frac{\text{实际产率}}{\text{预测产率}} \times 100$
4	products (in a chemical reaction) the substance(s) produced by a chemical reaction	产品 (在化学反应中) 由化学反应产生的物质
4	reactants (in a chemical reaction) the chemical substances that react together in a chemical reaction	反应物 (在化学反应中) 在化学反应中一起反应的化学物质
4	relative formula mass (<i>M_r</i>) the sum of all the relative atomic masses of the atoms present in a 'formula unit' of a substance	相对公式质量 (<i>M_r</i>) 物质“公式单位”中存在的所有原子的相对原子质量的总和
4	relative molecular mass (<i>M_r</i>) the sum of all the relative atomic masses of the atoms present in a molecule	相对分子质量 (<i>M_r</i>) 分子中所有原子的所有相对原子质量的总和
4	spectator ions these are present in a chemical reaction but take no part in it. They are not included in ionic equations	这些离子存在于化学反应中, 但不参与其中。它们不包含在离子方程式中
4	standard atom the atom against which the relative atomic masses of all other atoms are measured using the mass spectrometer; one atom of the carbon-12 isotope is given a mass of exactly 12	标准原子使用质谱仪测量所有其他原子的相对原子质量的原子; 碳-12同位素的一个原子的质量刚好为12
4	standard solution a solution whose concentration is known precisely – this solution is then used to find the concentration of another solution by titration	标准溶液一种浓度精确已知的溶液—然后将该溶液用于通过滴定找到另一种溶液的浓度
4	state symbols these are used to show the physical state of the reactants and products in a chemical reaction: they are (s) solid, (l) liquid, (g) gas and (aq) dissolved in solution in water	状态符号, 用于显示化学反应中反应物和产物的物理状态: 它们是 (s) 固体, (l) 液体, (g) 气体和 (aq) 溶解在水中的溶液
4	structural formula the structural formula of an organic molecule shows how the atoms and bonds in a molecule are arranged in space: all the atoms and covalent bonds must be shown	结构分子式: 有机分子的结构式表明分子中的原子和键如何在空间中排列: 必须显示所有原子和共价键
4	symbol (chemical) a simple letter, or group of letters, that represents an element in a chemical formula	符号 (化学) 一个简单的字母或一组字母, 代表化学式中的元素



4	titration a method of quantitative analysis using solutions: one solution is slowly added to a known volume of another solution using a burette until an end-point is reached	使用溶液进行滴定的定量分析方法：使用滴定管将一种溶液缓慢添加到已知体积的另一种溶液中，直至达到终点
4	water of crystallisation water included in the structure of certain salts as they crystallise; for example, copper(II) sulfate pentahydrate (CuSO ₄ ·5H ₂ O) contains five molecules of water of crystallisation per molecule of copper(II) sulfate	结晶水某些盐的结晶过程中所含的水；例如，五水合硫酸铜(II) (CuSO ₄ ·5H ₂ O) 每分子硫酸铜(II) 包含五分子结晶水
4	word equation a summary of a chemical reaction using the chemical names of the reactants and products	词方程式，是使用反应物和产物的化学名称进行的化学反应的摘要

9.4 ESSENTIAL EXAM QUESTIONS Topic 4.2 Paper 3/4 148marks

Subtopic Chem 4.2 Q# 1/ iGCSE Chemistry/2015/w/Paper 31/

5 (a) A compound, X, contains 55.85% carbon, 6.97% hydrogen and 37.18% oxygen.

(i) How does this prove that compound X contains only carbon, hydrogen and oxygen?

..... [1]

(ii) Use the above percentages to calculate the empirical formula of compound X.

..... [2]

(iii) The M_r of X is 86.

What is its molecular formula?

..... [2]

Subtopic Chem 4.2 Q# 2/ iGCSE Chemistry/2015/s/Paper 31/ Q3

(d) Calculate the maximum mass of zinc which will react with 50 cm³ of hydrochloric acid, of concentration 2.0 mol/dm³.



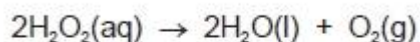
Show your working.

[3]



6 Hydrogen peroxide decomposes to form water and oxygen. This reaction is catalysed by manganese(IV) oxide.

- (d) In the first experiment, the maximum volume of oxygen produced was 96 cm³ measured at r.t.p. Calculate the concentration of the aqueous hydrogen peroxide in mol/dm³.

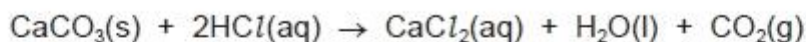


number of moles of O₂ formed = [1]

number of moles of H₂O₂ in 40 cm³ of solution = [1]

concentration of the aqueous hydrogen peroxide in mol/dm³ =
..... [1]

- (d) Calculate the maximum mass of carbon dioxide given off when 20.0 g of small lumps of calcium carbonate react with 40 cm³ of hydrochloric acid, concentration 2.0 mol/dm³.



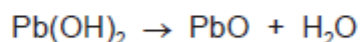
number of moles of HCl used =

mass of carbon dioxide = g [4]



- (c) Basic lead(II) carbonate has a formula of the type $x\text{PbCO}_3 \cdot y\text{Pb(OH)}_2$ where x and y are whole numbers.

Determine x and y from the following information.



When heated, the basic lead(II) carbonate gave 2.112 g of carbon dioxide and 0.432 g of water.

Mass of one mole of $\text{CO}_2 = 44 \text{ g}$

Mass of one mole of $\text{H}_2\text{O} = 18 \text{ g}$

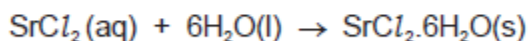
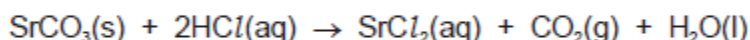
Number of moles of CO_2 formed = [1]

Number of moles of H_2O formed = [1]

x = and y =

Formula of basic lead(II) carbonate is [1]

Strontium chloride-6-water can be made from the insoluble compound, strontium carbonate, by the following reactions.



The following method was used to prepare the crystals.

- (c) In the above experiment, 50.0 cm^3 of hydrochloric acid of concentration 2.0 mol/dm^3 was used. 6.4 g of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ was made.

Calculate the percentage yield.

number of moles of HCl used =

number of moles of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ which could be formed =

mass of one mole of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ is 267 g

theoretical yield of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O} = \dots\dots\dots \text{g}$

percentage yield =% [4]



- (c) Fluorine, the most reactive halogen, forms compounds with the other halogens. It forms two compounds with bromine.

Deduce their formulae from the following information.

compound 1

The mass of one mole of this compound is 137 g.

Its formula is

[1]

compound 2

0.02 moles of this compound contain 0.02 moles of bromine atoms and 0.1 moles of fluorine atoms.

Its formula is

[1]

- 8** Iron and steel rust when exposed to water and oxygen. Rust is hydrated iron(III) oxide.

(b) A sample of rust had the following composition:

51.85 g of iron 22.22 g of oxygen 16.67 g of water.

Calculate the following and then write the formula for this sample of rust.

number of moles of iron atoms, Fe =

[1]

number of moles of oxygen atoms, O =

[1]

number of moles of water molecules, H₂O =

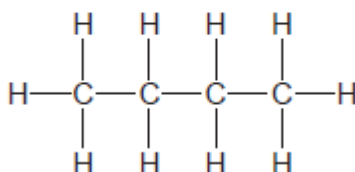
[1]

simplest mole ratio Fe : O : H₂O is : :

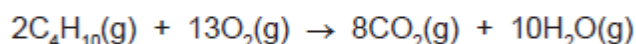
formula for this sample of rust is

[1]

- 6** Butane is an alkane. It has the following structural formula.



- (a) The equation for the complete combustion of butane is given below. Insert the two missing volumes.

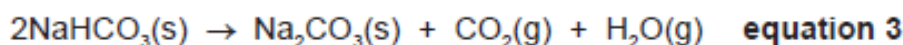
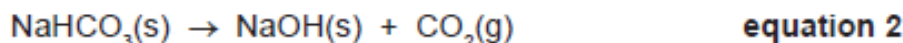
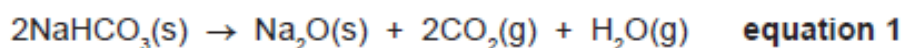


..... 40 volume of gas / cm³

[2]



- (c) There are three possible equations for the thermal decomposition of sodium hydrogencarbonate.



The following experiment was carried out to determine which one of the above is the correct equation.

A known mass of sodium hydrogencarbonate was heated for ten minutes. It was then allowed to cool and weighed.

Results

Mass of sodium hydrogencarbonate = 3.36 g

Mass of the residue = 2.12 g

Calculation

M_r for $\text{NaHCO}_3 = 84 \text{ g}$; M_r for $\text{Na}_2\text{O} = 62 \text{ g}$; M_r for $\text{NaOH} = 40 \text{ g}$

M_r for $\text{Na}_2\text{CO}_3 = 106 \text{ g}$

(i) Number of moles of NaHCO_3 used = [1]

(ii) If residue is Na_2O , number of moles of $\text{Na}_2\text{O} = \dots\dots\dots$

If residue is NaOH , number of moles of $\text{NaOH} = \dots\dots\dots$

If residue is Na_2CO_3 , number of moles of $\text{Na}_2\text{CO}_3 = \dots\dots\dots$ [2]

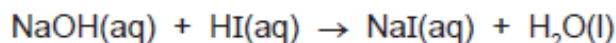
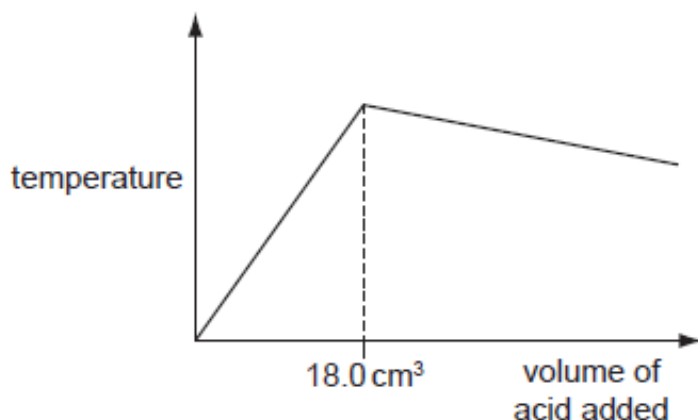
(iii) Use the number of moles calculated in (i) and (ii) to decide which one of the three equations is correct. Explain your choice.

.....

 [2]



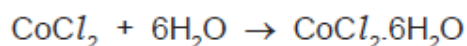
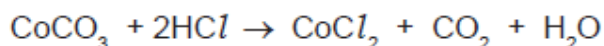
- (d) 20.0 cm³ of aqueous sodium hydroxide, 2.00 mol / dm³, was placed in a beaker. The temperature of the alkali was measured and 1.0 cm³ portions of hydriodic acid were added. After each addition, the temperature of the mixture was measured. Typical results are shown on the graph.



- (iii) In another experiment, it was shown that 15.0 cm³ of the acid neutralised 20.0 cm³ of aqueous sodium hydroxide, 1.00 mol / dm³. Calculate the concentration of the acid.

.....
 [2]

- (b) 6.0 g of cobalt(II) carbonate was added to 40 cm³ of hydrochloric acid, concentration 2.0 mol / dm³. Calculate the maximum yield of cobalt(II) chloride-6-water and show that the cobalt(II) carbonate was in excess.



Maximum yield

Number of moles of HCl used =

Number of moles of CoCl₂ formed =

Number of moles of CoCl₂·6H₂O formed =

Mass of one mole of CoCl₂·6H₂O = 238 g

Maximum yield of CoCl₂·6H₂O = g [4]



To show that cobalt(II) carbonate is in excess

Number of moles of HCl used = (use value from above)

Mass of one mole of $\text{CoCO}_3 = 119 \text{ g}$

Number of moles of CoCO_3 in 6.0 g of cobalt(II) carbonate = [1]

Explain why cobalt(II) carbonate is in excess
..... [1]

Subtopic Chem 4.2 **Q# 13/** iGCSE Chemistry/2010/s/Paper 31/ Q7

(e) The titanium ore contains 36.8% iron, 31.6% titanium and the remainder is oxygen.

(i) Determine the percentage of oxygen in this titanium compound.

percentage of oxygen = % [1]

(ii) Calculate the number of moles of atoms for each element.

The number of moles of Fe is shown as an example.

number of moles of Fe = $36.8/56 = 0.66$

number of moles of Ti =

number of moles of O = [1]

(iii) What is the simplest ratio for the moles of atoms?

Fe : Ti : O

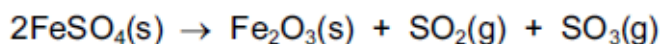
.....
..... [1]

(iv) What is the formula of this titanium compound?

..... [1]



- (c) 9.12g of anhydrous iron(II) sulfate was heated. Calculate the mass of iron(III) oxide formed and the volume of sulfur trioxide, at r.t.p., formed.



mass of one mole of $\text{FeSO}_4 = 152\text{g}$

number of moles of FeSO_4 used =

number of moles of Fe_2O_3 formed =

mass of one mole of $\text{Fe}_2\text{O}_3 = \dots\dots\dots \text{g}$

mass of iron(III) oxide formed =

number of moles of SO_3 formed =

volume of sulfur trioxide formed =

[6]

- 9 Quantities of chemicals, expressed in moles, can be used to find the formula of a compound, to establish an equation and to determine reacting masses.

- (a) A compound contains 72% magnesium and 28% nitrogen. What is its empirical formula?

.....

 [2]

- (b) A compound contains only aluminium and carbon. 0.03 moles of this compound reacted with excess water to form 0.12 moles of $\text{Al}(\text{OH})_3$ and 0.09 moles of CH_4 .

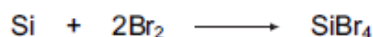
Write a balanced equation for this reaction.

.....

 [2]



(c) 0.07 moles of silicon reacts with 25g of bromine.



(i) Which one is the limiting reagent? Explain your choice.

.....
.....
.....
.....
..... [3]

(ii) How many moles of SiBr_4 are formed?

..... [1]

Subtopic Chem 4.2 Q# 16/ iGCSE Chemistry/2008/w/Paper 31/

4 Across the world, food safety agencies are investigating the presence of minute traces of the toxic hydrocarbon, benzene, in soft drinks. It is formed by the reduction of sodium benzoate by vitamin C.

(b) Benzene contains 92.3% of carbon and its relative molecular mass is 78.

(i) What is the percentage of hydrogen in benzene?

..... [1]

(ii) Calculate the ratio of moles of C atoms: moles of H atoms in benzene.

.....
..... [2]

(iii) Calculate its empirical formula and then its molecular formula.

The empirical formula of benzene is

The molecular formula of benzene is [2]

Subtopic Chem 4.2 Q# 17/ iGCSE Chemistry/2008/w/Paper 31/

3 Steel is an alloy made from impure iron.

(a) Both iron and steel rust. The formula for rust is $\text{Fe}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$.
It is hydrated iron(III) oxide.



(c) (i) Calculate the mass of one mole of $\text{Fe}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$.

[1]

(ii) Use your answer to (i) to calculate the percentage of iron in rust.

[2]

Subtopic Chem 4.2 Q# 18/ iGCSE Chemistry/2008/w/Paper 31/

7 The alkanes are generally unreactive. Their reactions include combustion, substitution and cracking.

(a) The complete combustion of an alkane gives carbon dioxide and water.

(i) 10 cm^3 of butane is mixed with 100 cm^3 of oxygen, which is an excess. The mixture is ignited. What is the volume of unreacted oxygen left and what is the volume of carbon dioxide formed?

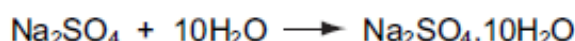


Volume of oxygen left = cm^3

Volume of carbon dioxide formed = cm^3 [2]

Subtopic Chem 4.2 Q# 19/ iGCSE Chemistry/2008/s/Paper 31/ Q7

(b) Using 25.0 cm^3 of aqueous sodium hydroxide, 2.24 mol / dm^3 , 3.86 g of crystals were obtained. Calculate the percentage yield.



Number of moles of NaOH used =

Maximum number of moles of $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ that could be formed =

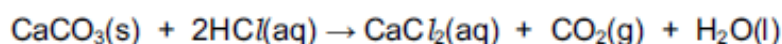
Mass of one mole of $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O} = 322 \text{ g}$

Maximum yield of sodium sulphate-10-water = g

Percentage yield = % [4]

Subtopic Chem 4.2 Q# 20/ iGCSE Chemistry/2007/w/Paper 3/

7 (a) A small piece of marble, calcium carbonate, was added to 5 cm^3 of hydrochloric acid at 25°C . The time taken for the reaction to stop was measured.



Similar experiments were performed always using 5 cm^3 of hydrochloric acid.



(b)

- (ii) One piece of marble, 0.3 g, was added to 5 cm³ of hydrochloric acid, concentration 1.00 mol / dm³. Which reagent is in excess? Give a reason for your choice.

mass of one mole of CaCO₃ = 100 g

number of moles of CaCO₃ =

number of moles of HCl =

reagent in excess is

reason [4]

- (iii) Use your answer to (ii) to calculate the maximum volume of carbon dioxide produced measured at r.t.p.

..... [1]

Subtopic Chem 4.2 Q# 21/ iGCSE Chemistry/2007/s/Paper 3/ Q7

- (d) A better way of measuring the degree of unsaturation is to find the iodine number of the unsaturated compound. This is the mass of iodine that reacts with all the double bonds in 100 g of the fat.

Use the following information to calculate the number of double bonds in one molecule of the fat.

Mass of one mole of the fat is 884 g.

One mole of I₂ reacts with one mole $\begin{array}{c} \diagup \quad \diagdown \\ \text{C}=\text{C} \\ \diagdown \quad \diagup \end{array}$

The iodine number of the fat is 86.2 g.

Complete the following calculation.

100 g of fat reacts with 86.2 g of iodine.

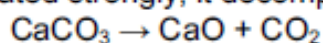
884 g of fat reacts with g of iodine.

One mole of fat reacts with moles of iodine molecules.

Number of double bonds in one molecule of fat is [3]

Subtopic Chem 4.2 Q# 22/ iGCSE Chemistry/2006/w/Paper 3/ Q3

- (b) When calcium carbonate is heated strongly, it decomposes.



- (i) Calculate the relative formula mass of:

CaCO₃

CaO [2]



- (ii) 7.00 kg of calcium oxide was formed. What mass of calcium carbonate was heated?

[2]

Subtopic Chem 4.2 Q# 23/ iGCSE Chemistry/2006/w/Paper 3/

6 An ore of copper is the mineral, chalcopyrite. This is a mixed sulphide of iron and copper.

- (a) Analysis of a sample of this ore shows that 13.80 g of the ore contained 4.80 g of copper, 4.20 g of iron and the rest sulphur.

Complete the table and calculate the empirical formula of chalcopyrite.

	copper	iron	sulphur
composition by mass /g	4.80	4.20	
number of moles of atoms			
simplest mole ratio of atoms			

[3]

The empirical formula is

[1]

Subtopic Chem 4.2 Q# 24/ iGCSE Chemistry/2006/s/Paper 3/ Q7

- (d) Propene reacts with hydrogen iodide to form 2-iodopropane.



1.4 g of propene produced 4.0 g of 2-iodopropane.

Calculate the percentage yield.

moles of $\text{CH}_3\text{-CH=CH}_2$ reacted =

maximum moles of $\text{CH}_3\text{-CHI-CH}_3$ that could be formed =

mass of one mole of $\text{CH}_3\text{-CHI-CH}_3 = 170 \text{ g}$

maximum mass of 2-iodopropane that could be formed =

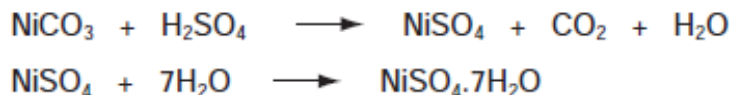
percentage yield %

[4]



- 6 (a) The following method is used to make crystals of hydrated nickel sulphate.

An excess of nickel carbonate, 12.0 g, was added to 40 cm³ of sulphuric acid, 2.0 mol/dm³. The unreacted nickel carbonate was filtered off and the filtrate evaporated to obtain the crystals.



Mass of one mole of NiSO₄·7H₂O = 281 g

Mass of one mole of NiCO₃ = 119 g

- (i) Calculate the mass of unreacted nickel carbonate.

Number of moles of H₂SO₄ in 40 cm³ of 2.0 mol/dm³ acid = 0.08

Number of moles of NiCO₃ reacted =

Mass of nickel carbonate reacted = g

Mass of unreacted nickel carbonate = g [3]

- (ii) The experiment produced 10.4 g of hydrated nickel sulphate. Calculate the percentage yield.

The maximum number of moles of NiSO₄·7H₂O that could be formed =

.....

The maximum mass of NiSO₄·7H₂O that could be formed = g

The percentage yield = % [3]

Subtopic Chem 4.2 Q# 26/ iGCSE Chemistry/2005/s/Paper 3/ QIGCSE Chemistry/201

- (c) 0.015 moles of iodine react with 0.045 moles of chlorine to form 0.030 moles of a single product. Complete the equation.



Subtopic Chem 4.2 Q# 27/ iGCSE Chemistry/2005/s/Paper 3/ Q4

- (d) Gypsum is hydrated calcium sulphate, CaSO₄·xH₂O. It contains 20.9% water by mass. Calculate x.

M_r: CaSO₄, 136; H₂O, 18.

79.1 g of CaSO₄ = moles

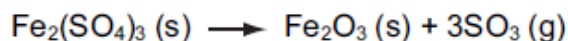
20.9 g of H₂O = moles

x = [3]



- (c) Iron(III) sulphate decomposes when heated. Calculate the mass of iron(III) oxide formed and the volume of sulphur trioxide produced when 10.0 g of iron(III) sulphate was heated.

Mass of one mole of $\text{Fe}_2(\text{SO}_4)_3$ is 400g.



Number of moles of $\text{Fe}_2(\text{SO}_4)_3 =$	
Number of moles of Fe_2O_3 formed =	
Mass of iron(III) oxide formed =	g
Number of moles of SO_3 produced =	
Volume of sulphur trioxide at r.t.p. =	dm^3

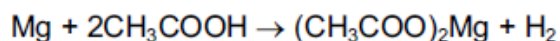
[5]

- 7 Chemists use the concept of the mole to calculate the amounts of chemicals involved in a reaction.

- (a) Define *mole*.

..... [1]

- (b) 3.0 g of magnesium was added to 12.0 g of ethanoic acid.



The mass of one mole of Mg is 24 g.

The mass of one mole of CH_3COOH is 60g.

- (i) Which one, magnesium or ethanoic acid, is in excess? You must show your reasoning.

..... [3]

- (ii) How many moles of hydrogen were formed?

..... [1]

- (iii) Calculate the volume of hydrogen formed, measured at r.t.p.

..... [2]



- (c) In an experiment, 25.0 cm³ of aqueous sodium hydroxide, 0.4 mol/dm³, was neutralised by 20.0 cm³ of aqueous oxalic acid, H₂C₂O₄.



Calculate the concentration of the oxalic acid in mol/dm³.

- (i) Calculate the number of moles of NaOH in 25.0 cm³ of 0.4 mol/dm³ solution.

..... [1]

- (ii) Use your answer to (i) and the mole ratio in the equation to find out the number of moles of H₂C₂O₄ in 20 cm³ of solution.

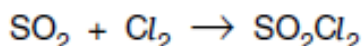
..... [1]

- (iii) Calculate the concentration, mol/dm³, of the aqueous oxalic acid.

..... [2]

Subtopic Chem 4.2 Q# 30/ iGCSE Chemistry/2003/w/Paper 3/ Q5

- (d) Sulphur dioxide reacts with chlorine in an addition reaction to form sulphuryl chloride.



8.0 g of sulphur dioxide was mixed with 14.2 g of chlorine. The mass of one mole of SO₂Cl₂ is 135 g.

Calculate the mass of sulphuryl chloride formed by this mixture.

Calculate the number of moles of SO₂ in the mixture =

Calculate the number of moles of Cl₂ in the mixture =

Which reagent was not in excess?

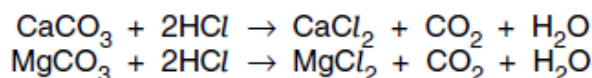
How many moles of SO₂Cl₂ were formed =

Calculate the mass of sulphuryl chloride formed = g [5]

Subtopic Chem 4.2 Q# 31/ iGCSE Chemistry/2003/s/Paper 3/

- 2 Calcium and other minerals are essential for healthy teeth and bones. Tablets can be taken to provide these minerals.

- (c) Each tablet contains the same number of moles of CaCO₃ and MgCO₃. One tablet reacted with excess hydrochloric acid to produce 0.24 dm³ of carbon dioxide at r.t.p.



- (i) Calculate how many moles of CaCO₃ there are in one tablet.

number of moles CO₂ =

number of moles of CaCO₃ and MgCO₃ =

number of moles of CaCO₃ =

[3]



- (ii) Calculate the volume of hydrochloric acid, 1.0 mol/dm^3 , needed to react with one tablet.

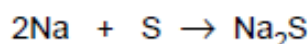
number of moles of CaCO_3 and MgCO_3 in one tablet =
Use your answer to (c)(i).

number of moles of HCl needed to react with one tablet =

volume of hydrochloric acid, 1.0 mol/dm^3 , needed to react with one tablet =
[2]

Subtopic Chem 4.2 Q# 32/ iGCSE Chemistry/2002/w/Paper 3/ Q3

- (f) Sodium reacts with sulphur to form sodium sulphide.



An 11.5 g sample of sodium is reacted with 10 g of sulphur. All of the sodium reacted but there was an excess of sulphur.
Calculate the mass of sulphur left unreacted.

- (i) Number of moles of sodium atoms reacted =
[2 moles of Na react with 1 mole of S]

- (ii) Number of moles of sulphur atoms that reacted =

- (iii) Mass of sulphur reacted =g

- (iv) Mass of sulphur left unreacted =g [4]

Subtopic Chem 4.2 Q# 33/ iGCSE Chemistry/2002/s/Paper 3/ Q5

- (c) A 20 cm^3 sample of butyne, C_4H_6 , is burnt in 150 cm^3 of oxygen. This is an excess of oxygen.



- (i) What volume of oxygen reacts?

.....[1]

- (ii) What volume of carbon dioxide is produced?

.....[1]

- (iii) What is the total volume of gases left at the end of the reaction?

.....[1]



- (d) Calculate the mass of water formed when 9.0 g of butyne is burnt. The mass of one mole of butyne is 54 g.

from the above equation, 1 mole of butyne forms 3 moles of water

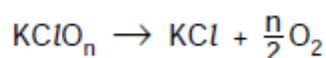
number of moles of butyne reacted

number of moles of water formed

mass of water formed g [3]

Subtopic Chem 4.2 Q# 34/ iGCSE Chemistry/2001/w/Paper 3/ Q2

- (c) Potassium chlorate, which has a formula of the type, KClO_n , decomposes to form oxygen. 2.45 g of the chlorate produced 1.49 g of potassium chloride and 0.72 dm^3 of oxygen at r.t.p. Find the value of n.



Mass of one mole of KCl = 74.5 g

Number of moles of KCl formed =

Number of moles of oxygen molecules formed =

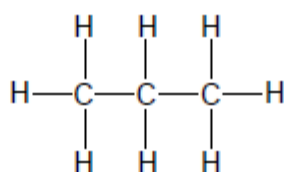
Number of moles of oxygen atoms =

Mole ratio KCl: O is

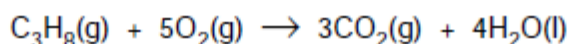
n = [4]

Subtopic Chem 4.2 Q# 35/ iGCSE Chemistry/2001/w/Paper 3/

- 3 Propane is an alkane. It has the structural formula:



- (a) The equation for the complete combustion of propane is given below. Insert the two missing volumes.



volume of gas/cm³ 15 [2]

9.4.1 ESSENTIAL EXAM QUESTIONS Topic 4.2 Paper 3/4 148marks Mark Scheme



Q# 1/ iGCSE Chemistry/2015/w/Paper 31/

5(a)(i)	adds up to 100%;	1
5(a)(ii)	M1 55.85/12 and 6.97/(1) and 37.2/16; or evaluation 4.650 6.970 2.325; M2 C ₂ H ₃ O; correct answer with no working = [2]	1 1
5(a)(iii)	M1 (86/43; M2 C ₄ H ₆ O ₂ ; correct answer with no working = [2]	1 1

Q# 2/ iGCSE Chemistry/2015/s/Paper 31/ Q3

3(d)	M1 moles of HCl = 0.1(mol); M2 moles of Zn = 0.05 (mol); mass of zinc = 3.25 g;	3 A ECF for M1 × ½ A ECF for M2 × 65 Unit required for M3
------	---	--

Q# 3/ iGCSE Chemistry/2014/s/Paper 31/ Q6

- (d) number of moles of O₂ formed = 0.096/24 = 0.004 (1)
 number of moles of H₂O₂ in 40cm³ of solution = 0.004 × 2 = 0.008 (1)
 concentration of the hydrogen peroxide in mol/dm³ = 0.008/0.04 = 0.2 (1) [3]

Q# 4/ iGCSE Chemistry/2013/w/Paper 31/ Q4

- (d) number of moles of HCl in 40 cm³ of hydrochloric acid,
 concentration 2.0 mol / dm³ = 0.04 × 2.0 = 0.08 [1]
 maximum number of moles of CO₂ formed = 0.04 [1]
 mass of one mole of CO₂ = 44 g [1]
 maximum mass of CO₂ lost = 0.04 × 44 = 1.76 g [1]

Q# 5/ iGCSE Chemistry/2013/w/Paper 31/ Q6

- (c) number of moles of CO₂ formed = 2.112 / 44 = 0.048 [1]
 number of moles of H₂O formed = 0.432 / 18 = 0.024 [1]
 x = 2 and y = 1 **NOT:** ecf from this line
 formula is 2PbCO₃.Pb(OH)₂ / Pb(OH)₂. 2PbCO₃ [1]

Q# 6/ iGCSE Chemistry/2012/w/Paper 31/ Q7

- (c) number of moles of HCl used = 0.05 × 2 = 0.1 [1]
 number of moles of SrCl₂.6 H₂O which could be formed. = 0.05 [1]
 mass of one mole of SrCl₂.6H₂O is 267 g
 theoretical yield of SrCl₂.6H₂O = 0.05 × 267 = 13.35 g [1]
 percentage yield = 6.4/13.35 × 100 = 47.9% [1]
accept: 48%
allow: ecf

Q# 7/ iGCSE Chemistry/2012/w/Paper 31/ Q2

- (c) BrF₃ / F₃Br; [1]
 BrF₅ / F₅Br; [1]

Q# 8/ iGCSE Chemistry/2012/s/Paper 31/

- (b) moles of Fe = 51.85/56 = 0.926 (0.93); [1]
 moles of O = 22.22/16 = 1.389 (1.39); [1]
 moles of H₂O = 16.67/18 = 0.926 (0.93); [1]
 if given as 0.9 1.4 0.9
three of the above correct = [2]
two of the above correct = [1]
 simplest whole number mole ratio Fe : O : H₂O is 2: 3: 2 / Fe₂O₃.2H₂O; [1]
allow: ecf for a formula based on an incorrect whole number ratio



Q# 9/ iGCSE Chemistry/2012/s/Paper 31/

- 6 (a) 10 cm^3 ; [1]
 65 cm^3 ; [1]

Q# 10/ iGCSE Chemistry/2011/w/Paper 31/ Q7

(c) calculation:

M_r for $\text{NaHCO}_3 = 84\text{ g}$; M_r for $\text{Na}_2\text{O} = 62\text{ g}$; M_r for $\text{NaOH} = 40\text{ g}$
 M_r for $\text{Na}_2\text{CO}_3 = 106\text{ g}$

(i) number of moles of NaHCO_3 used = $3.36/84 = 0.04$ [1]

(ii) if residue is Na_2O , number of moles of $\text{Na}_2\text{O} = 2.12/62$
 $= 0.034 / 0.03$

if residue is NaOH , number of moles of $\text{NaOH} = 2.12/40$
 $= 0.053 / 0.05$

if residue is Na_2CO_3 , number of moles of $\text{Na}_2\text{CO}_3 = 2.12/106 = 0.02$ all three correct [2]
note: two correct = 1

(iii) equation 3 [1]
mole ratio 2:1 agrees with equation [1]

Q# 11/ iGCSE Chemistry/2011/s/Paper 31/ Q5 (d)

- (iii) $1.33 / 1.3 / 1.3333\text{ (mol/dm}^3\text{)}$ scores both marks [2]
not 1.34
for a correct method – $M_1 V_1 / \text{moles of NaOH} = 0.02$
with an incorrect answer only [1]

Q# 12/ iGCSE Chemistry/2010/w/Paper 31/ Q5

- (b) number of moles of HCl used = $0.04 \times 2 = 0.08$
number of moles CoCl_2 formed = 0.04
number of moles $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ formed = 0.04
mass of one mole of $\text{CoCl}_2 \cdot 6\text{H}_2\text{O} = 238\text{ g}$
maximum yield of $\text{CoCl}_2 \cdot 6\text{H}_2\text{O} = 9.52\text{ g}$ [4]
accept 9.5 g
mark ecf to moles of HCl
do not mark ecf to integers

to show that cobalt(II) carbonate is in excess

number of moles of HCl used = 0.08 must use value above ecf
mass of one mole of $\text{CoCO}_3 = 119\text{ g}$
number of moles of CoCO_3 in 6.0g of cobalt(II) carbonate = $6.0/119 = 0.050$ [1]
reason why cobalt(II) carbonate is in excess $0.05 > 0.08/2$ [1]



Q# 13/ iGCSE Chemistry/2010/s/Paper 31/ Q7

- (e) (i) percentage of oxygen = 31.6% [1]
- (ii) calculate the number of moles of atoms for each element
- number of moles of Ti = $31.6/48 = 0.66$
- number of moles of O = $31.6/16 = 1.98$ **accept 2** [1]
both correct for one mark
- (iii) the simplest whole number ratio for moles of atoms:
- | | | | | |
|----|---|----|---|---|
| Fe | : | Ti | : | O |
| 1 | | 1 | | 3 |
- [1]
- (iv) formula is FeTiO_3 **accept** TiFeO_3 [1]
must be whole numbers from (iii) or cancelled numbers from (iii)
mark **ecf** throughout

Q# 14/ iGCSE Chemistry/2009/w/Paper 3/ Q6

- (c) number of moles of FeSO_4 used = $9.12/152 = 0.06$ [1]
number of moles of Fe_2O_3 formed = 0.03* [1]
mass of one mole of Fe_2O_3 = 160 g [1]
mass of iron(III) oxide formed = $0.03 \times 160 = 4.8$ g [1]
number of moles of SO_3 formed = 0.03 [1]
volume of sulfur trioxide formed = $0.03 \times 24 = 0.72 \text{ dm}^3$ [1]
If mass of iron(III) oxide greater than 9.12 g, then only marks 1 and 2 available

Apply **ecf** to number of moles of Fe_2O_3^* when calculating volume of sulfur trioxide.
Do not apply **ecf** to integers

Q# 15/ iGCSE Chemistry/2009/s/Paper 31/

- 9 (a) $72/24 = 3$ and $28/14 = 2$ [1]
 Mg_3N_2 [1]
accept just formula for [2] even with incorrect or no working
NOT **ecf**
- (b) $\text{Al}_4\text{C}_3 + 12\text{H}_2\text{O} = 4\text{Al}(\text{OH})_3 + 3\text{CH}_4$ [2]
For Al_4C_3 ONLY [1]
- (c) (i) silicon is limiting reagent [1]
0.07 moles of Si and $25/160 = 0.156$ moles of Br_2 [1]
because $0.14 (2 \times 0.07) < 0.156$ [1]
If 80 used to find moles of Br_2 the mark 1 and 3 still available
arguments based on masses can be used
- (ii) 0.07 [1]
NOT **ecf**

Q# 16/ iGCSE Chemistry/2008/w/Paper 31/ Q4

- (b) (i) 7.7% [1]
- (ii) for any number: equal number ratio [2]
for example 1:1 or 6:6
- (iii) empirical formula is CH [1]
molecular formula is C_6H_6 [1]
no e.c.f., award of marks not dependent on (ii)



Q# 17/ iGCSE Chemistry/2008/w/Paper 31/ Q3

(c) (i) 196 [1]

(ii) $112/196 \times 100$ [1]

= 57(.1)% **ACCEPT** 57 to nearest whole number [1]

mark e.c.f. to (c)(i) provided percentage not greater than 100%

ONLY ACCEPT 112/answer (c)(i) $\times 100$

otherwise [0]

Q# 18/ iGCSE Chemistry/2008/w/Paper 31/

7 (a) (i) 35cm^3 [1]
 40cm^3 [1]

Q# 19/ iGCSE Chemistry/2008/s/Paper 31/ Q7

(b) number of moles of NaOH used = $0.025 \times 2.24 = 0.056$ [1]

maximum number of moles of $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ that could be formed = 0.028 [1]

mass of one mole of $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O} = 322\text{g}$

maximum yield of sodium sulphate – 10 - water = 9.02g [1]

percentage yield = 42.8% [1]

mark ecf but NOT to simple integers

if ecf marking, mark to at least one place of decimals

if percentage > 100% then 3/4 maximum

Q# 20/ iGCSE Chemistry/2007/w/Paper 3/ Q7 (b)

(ii) mass of one mole of $\text{CaCO}_3 = 100$

number of moles of $\text{CaCO}_3 = 0.3/100 = 0.003$ [1]

moles of $\text{HCl} = 5/1000 \times 1 = 0.005$ [1]

reagent in excess is CaCO_3 [1]

ecf from above

would need 0.006 moles of HCl

or hydrochloric acid only reacts with 0.0025 moles of CaCO_3 [1]

NOTE this mark needs to show recognition of the 1:2 ratio

(iii) mark ecf to (ii), that is from moles of limiting reagent in (ii)

moles of $\text{CO}_2 = 0.005 \times 0.5 \times 24 = 0.06 \text{ dm}^3$ [1]

NOT cm^3 unless numerically correct. 60 cm^3

Ignore other units

NOTE If both number of moles integers then no ecf for (ii) and (iii)

Q# 21/ iGCSE Chemistry/2008/s/Paper 31/ Q7

(d) 100g of fat react with 86.2g of iodine
884g of fat react with 762 g of iodine [1]

limit 762×2

one mole of fat reacts with 762/254 moles of iodine molecules

one mole of fat reacts with 3 moles of iodine molecules [1]

number of double bonds in one molecule of fat is 3 [1]

limit 6

consequential marking allowed provided the number of double bonds is an integer.

Q# 22/ iGCSE Chemistry/2006/w/Paper 3/ Q3

(b) (i) 100 [1]

56 ignore units in both cases [1]

(ii) 7.00kg is 1/8 of 56 [1]

1/8 of 100kg is 12.5kg [1]

Give both marks for correct answer without explanation. Ignore missing units

but penalise wrong units



6 (a)

	copper	iron	sulphur
composition by mass/g	(4.80)	(4.20)	4.8 [1]
number of moles of atoms	0.075	0.075	0.15 [1]
simplest mole ratio of atoms	1	1	2 [1]

The empirical formula is CuFeS_2

[3]

[1]

Q# 24/ iGCSE Chemistry/2006/s/Paper 3/ Q7

(d) moles of $\text{CH}_3\text{-CH=CH}_2$ reacted = $1.4/42 = 0.033$

[1]

conseq

maximum moles of $\text{CH}_3\text{-CH(I)-CH}_3$ that could be formed = 0.033

[1]

conseq

maximum mass of 2-iodopropane that could be formed = 5.61 g

[1]

accept $170 \times 0.033 = 5.61$ and $170 \times 0.033333 = 5.67$

conseq unless greater than 100%

percentage yield $4.0/5.67 \times 100 = 70.5\%$

[1]

Do not mark consequently to a series of small integers. There has to be a serious attempt to answer the question, then consequential marking is appropriate.

Q# 25/ iGCSE Chemistry/2005/w/Paper 3/

Question 6

(a)(i) moles of NiCO_3 reacted = 0.08

[1]

mass of nickel carbonate reacted = 9.52 g

[1]

mass of nickel carbonate unreacted = 2.48 g

[1]

(ii) maximum number of moles of hydrated salt = 0.08

[1]

maximum mass of salt = $0.08 \times 281 = 22.48$ g

[1]

percentage yield $10.4/22.48 \times 100 = 46.3\%$

[1]

Q# 26/ iGCSE Chemistry/2005/s/Paper 3/ Q# iGCSE Chemistry/201

(c) $\text{I}_2 + 3\text{Cl}_2 = 2\text{ICl}_3$

[2]

For having either reactants or products correct ONLY [1]

Q# 27/ iGCSE Chemistry/2005/s/Paper 3/ Q4

(d) mass of one mole of $\text{CaSO}_4 = 136$

moles of CaSO_4 in 79.1g = 0.58 accept 0.6

[1]

moles of H_2O in 20.9 g = 1.16 accept 1.2

[1]

conseq x = 2 x given as an integer

[1]

Q# 28/ iGCSE Chemistry/2004/w/Paper 3/ 7 (c)

Mark consequentially to any error but not involving simple integers

There has to be some evidence that the candidate has attempted to work through the calculation and not merely inserted whole numbers.

For example 2, 1, 160 or 1, 0.5, 80

number of moles of $\text{Fe}_2(\text{SO}_4)_3 = 1/40$ or 0.025

number of moles of Fe_2O_3 formed = $1/40$ or 0.025

mass of iron(III) oxide formed = $0.025 \times 160 = 4\text{g}$

number of moles of SO_3 produced = $3/40$ or 0.075

volume of sulphur trioxide at r.t.p. = 0.075×25

= 1.8dm^3

[5]



- 7 (a) Avogadro's Number of particles
or formula mass in grams
or 6×10^{23} particles accept atoms, ions and molecules
or as many particles as there are carbon atoms in 12.00g of ^{12}Ca
ANY one [1]
- (b) (i) moles of Mg = $3/24 = 0.125$
moles of $\text{CH}_3\text{COOH} = 12/60 = 0.200$
magnesium is in excess

OR 3.0g of magnesium react with 15g of acid
only 12.0 g of acid present
magnesium is in excess [3]
- (ii) Mark conseq to (i) but NOT to any simple integer
moles of $\text{H}_2 = 0.1$ [1]
- (iii) Mark conseq to (ii) but NOT to any simple integer
Volume of hydrogen = 0.1×24
= 2.4 dm^3 [2]
- (c) (i) moles of NaOH = $25/1000 \times 0.4 = 0.01$ [1]
- (ii) Mark conseq to (i) but NOT to any simple integer
moles of acid = $0.01/2 = 0.005$ [1]
- (iii) Mark conseq to (ii) max 10M
concentration of acid = $0.005 \times 1000/20$
= 0.25 mol/dm^3 [1]
[1]

Q# 30/ iGCSE Chemistry/2003/w/Paper 3/ Q5

- (d) the number of moles of SO_2 in the mixture = 0.125
the number of moles of Cl_2 in the mixture = 0.2
cond reagent was not in excess? SO_2
cond moles of SO_2Cl_2 formed = 0.125
cond the mass of sulphuryl chloride formed = 16.9g
[5]

Q# 31/ iGCSE Chemistry/2003/s/Paper 3/ Q2

- (c) (i) number of moles $\text{CO}_2 = 0.24/24 = 0.01$
conseq number of moles of CaCO_3 and $\text{MgCO}_3 = 0.01$
conseq number of moles of $\text{CaCO}_3 = 0.005$ [3]
- (ii) Calculate the volume of hydrochloric acid, 1.0 mole/dm^3 , needed to react with one tablet.
number of moles of CaCO_3 and MgCO_3 in one tablet = 0.01
Expect same as answer to (c)(i). NO marks to be awarded. Just mark consequentially to this response
conseq number of moles of HCl needed
to react with one tablet = 0.02 [1]
- conseq volume of hydrochloric acid, 1.0 mole/dm^3 , needed to react with one tablet = 0.02 dm^3 or 20 cm^3 [1]



Q# 32/ iGCSE Chemistry/2002/w/Paper 3/ Q3

(f) (i) $11.5/23 = 0.5$ [1]

(ii) 0.25 [1]
conseq to (i)

(iii) $0.25 \times 32 = 8 \text{ g}$ [1]
conseq

(iv) 2.0 g [1]
only conseq to (iii) if answer to (iii) is less than 10

NB If (ii) is 0.3(125), no excess is possible, (iv) **ZERO**

Q# 33/ iGCSE Chemistry/2002/s/Paper 3/ Q5 (c)

(i) 110 (cm³)

(ii) 80 (cm³)

(iii) Starting gases (170) of which 130 was used, so 40 left of O₂, 80 made of CO₂ and H₂O is a liquid therefore 80

(d)

0.167

0.5 mol water

9g of water

3 marks

Q# 34/ iGCSE Chemistry/2001/w/Paper 3/ Q2

(c) *0.02 [1]
0.03 not conseq [1]
*0.06 conseq to above [1]
3 accept either as ratio or on n = [1]
Accept ratio conseq to answers designated by *

Q# 35/ iGCSE Chemistry/2001/w/Paper 3/

3 (a) 5 [1]
25 [1]



9.1 Essential End of Topic 5 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?



10 Topic 7.4 Redox

10.1 End of Topic 7.4 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTENSION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTENSION
	Scored over 95%		SMASHING!!!



Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book <u>you enjoy</u> (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book <u>you enjoy</u> in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book <u>you enjoy</u> in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL



7.4 Redox

Core

- Define *oxidation* and *reduction* in terms of oxygen loss/gain. (Oxidation state limited to its use to name ions, e.g. iron(II), iron(III), copper(II), manganate(VII).)

Supplement

- Define *redox* in terms of electron transfer
- Identify redox reactions by changes in oxidation state and by the colour changes involved when using acidified potassium manganate(VII), and potassium iodide. (Recall of equations involving KMnO_4 is **not** required.)
- Define *oxidising agent* as a substance which oxidises another substance during a redox reaction. Define *reducing agent* as a substance which reduces another substance during a redox reaction.
- Identify oxidising agents and reducing agents from simple equations

10.3 ESSENTIAL Glossary for Keywords for this topic

Topic #	English	Chinese
7	oxidation state a number given to show whether an element has been oxidised or reduced; the oxidation state of an ion is simply the charge on the ion	氧化态表示元素是否被氧化或还原的数字；离子的氧化态只是离子上的电荷
7	oxidation there are three definitions of oxidation: (i) a reaction in which oxygen is added to an element or compound; (ii) a reaction involving the loss of electrons from an atom, molecule or ion; (iii) a reaction in which the oxidation state of an element is increased	氧化氧化具有三个定义：(i) 将氧添加到元素或化合物中的反应；(ii) 涉及原子，分子或离子失去电子的反应；(iii) 增加元素的氧化态的反应
7	oxidising agent a substance which will oxidise another in a redox reaction	氧化剂一种在氧化还原反应中会氧化另一种物质的物质
7	redox reaction a reaction involving both reduction and oxidation reducing agent a substance which will reduce another in a redox reaction	氧化还原反应一种同时涉及还原剂和氧化还原剂的反应，一种物质将在氧化还原反应中还原另一种物质
7	reduction there are three definitions of reduction: (i) a reaction in which oxygen is removed from a compound; (ii) a reaction involving the gain of electrons by an atom, molecule or ion; (iii) a reaction in which the oxidation state of an element is decreased	还原有三种还原的定义：(i) 从化合物中除去氧的反应；(ii) 涉及通过原子，分子或离子获得电子的反应；(iii) 使元素的氧化态降低的反应



10.4 ESSENTIAL Classroom Active Learning Task 1 Assigning Oxidation States

Oxidation number rules:

Elements have an oxidation number of 0

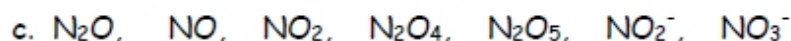
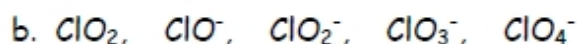
Group I and II – In addition to the elemental oxidation state of 0, Group I has an oxidation state of +1 and Group II has an oxidation state of +2.

Hydrogen – usually +1, except when bonded to Group I or Group II, when it forms hydrides, -1.

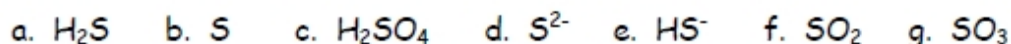
Oxygen – usually -2, except when it forms a O-O single bond, a peroxide, when it is -1.

Fluorine is always -1. Other halogens are usually -1, except when bonded to O.

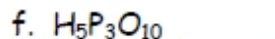
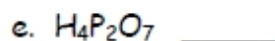
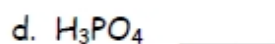
1. Give the oxidation numbers of all the elements in the following molecules and ions:



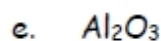
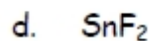
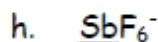
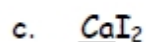
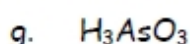
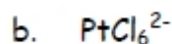
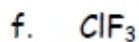
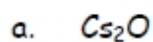
2. Determine the oxidation number of the sulfur atom:



3. Indicate the oxidation number of phosphorus in each of the following compounds:



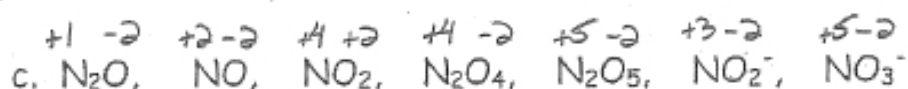
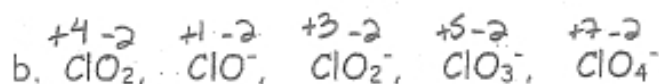
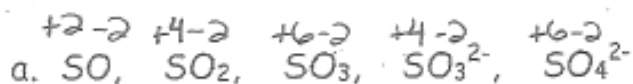
4. Give oxidation numbers for the underlined atoms in these molecules and ions:



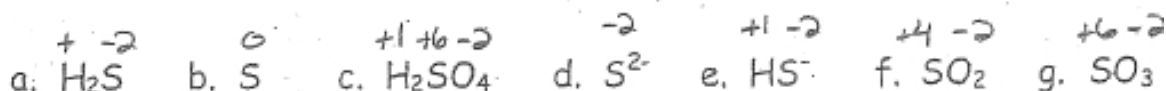
10.4.1 ESSENTIAL Classroom Active Learning Task 1 Assigning Oxidation States Mark Scheme

NOTE: The both terms Oxidation State and Oxidation Number effectively mean the same thing at iGCSE and A Level, although Oxidation Number in fact refers to the Roman numerals in the names of transition metal containing compounds, like Iron (III) oxide

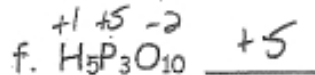
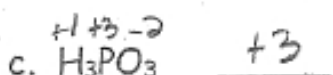
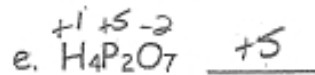
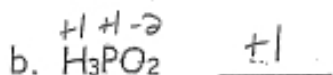
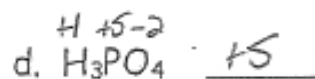
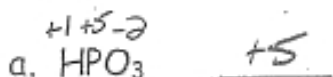
1. Give the oxidation numbers of all the elements in the following molecules and ions:



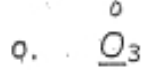
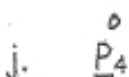
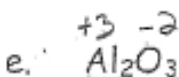
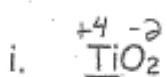
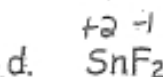
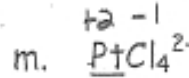
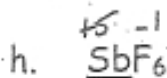
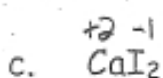
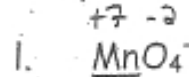
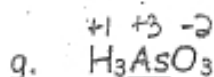
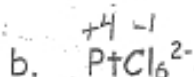
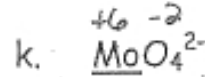
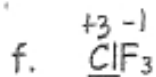
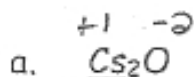
2. Determine the oxidation number of the sulfur atom:



3. Indicate the oxidation number of phosphorus in each of the following compounds:

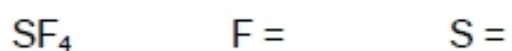
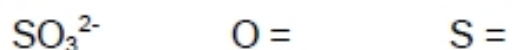
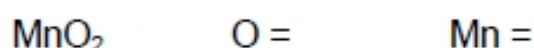
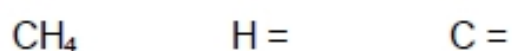
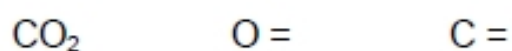


4. Give oxidation numbers for the underlined atoms in these molecules and ions:



10.1 ESSENTIAL Classroom Active Learning Task 2 Assigning Oxidation States

1. Assign **oxidation numbers** to each of the atoms in the following compounds:



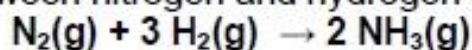
- a. What is the range of oxidation states for **carbon**?
- b. Which compound has C in a +4 state?
- c. Which compound has C in a -4 state?

2. Nitrogen has 5 valence electrons (Group V). It can gain up to 3 electrons (-3), or lose up to 5 (+5) electrons. Fill in the missing names or formulas and assign an oxidation state to each of the following nitrogen containing compounds:

name	formula	oxidation state of N
	NH_3	
nitrogen		
nitrite		
	NO_3^-	
dinitrogen monoxide		
	NO_2	
hydroxylamine	NH_2OH	
nitrogen monoxide		
hydrazine	N_2H_4	



3. During chemical reactions, the **oxidation state** of atoms can change. This occurs when compounds gain or lose electrons, or when the **bonds** to an atom change. This is illustrated by the reaction between nitrogen and hydrogen to make ammonia:



a. Assign **oxidation numbers** to each of the atoms in this reaction.

N (in N_2) = N (in NH_3) =

H (in H_2) = H (in NH_3) =

When an oxidation number **increases**, that species has been **oxidized**.

b. Which reactant undergoes an increase in its oxidation number?

When an oxidation number **decreases**, that species has been **reduced**.

c. Which reactant undergoes a decrease in its oxidation number?

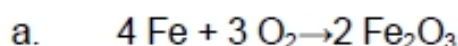
The species that is oxidized is called the **reducing agent** because it gives up an electron, so that another species can gain an electron (be reduced).

d. What is the **reducing agent** in this reaction?

The species that is reduced is called the **oxidizing agent** because it takes an electron away from another group, raising that group's oxidation number.

e. What is the **oxidizing agent** in this reaction?

4. In each of the following reactions, assign **oxidation numbers** to all of the elements and identify the **oxidizing** and **reducing agents** and the **change in oxidation number**.

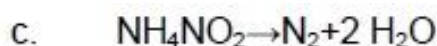


change in oxidation number

oxidizing agent

reducing agent

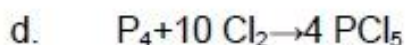




change in oxidation number

oxidizing agent

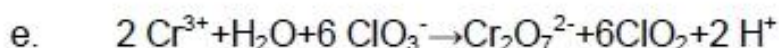
reducing agent



change in oxidation number

oxidizing agent

reducing agent



change in oxidation number

oxidizing agent

reducing agent

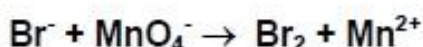
10.3 EXCEPTIONAL Active Learning Activity 4 Balancing Redox Reactions

The material here does beyond the iGCSE syllabus, but if you are really interested in this topic this is what you would go on to cover at A Level.

Balancing Redox Reactions

Oxidation/Reduction (Redox) reactions can be balanced using the oxidation state changes, as seen in the previous example. However, there is an easier method, which involves breaking a redox reaction into two **half-reactions**. This is best shown by working an example.

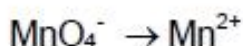
Hydrobromic acid will react with permanganate to form elemental bromine and the manganese(II) ion. The unbalanced, net reaction is shown below,



5. Break this into two **half-reactions**, one involving bromine and the other involving manganese.

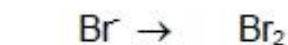
Bromine half-reaction

Manganese half-reaction

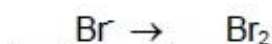


6. First balance the bromine half-reaction first.

- a. Balance the **bromine** atoms of the reaction



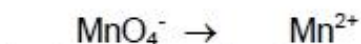
- b. Now balance **charge** by adding **electrons** (e^-)



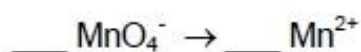
This half-reaction is **producing/consuming electrons**. This is an **oxidation/reduction** half-reaction. Confirm this by assigning oxidation numbers to the bromine species.

7. Next, balance the manganese half-reaction.

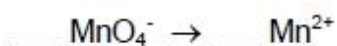
- a. Balance the **manganese** atoms of the half-reaction



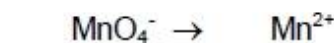
- b. Next, balance **oxygen** by adding water molecules (H_2O)



- c. Next, balance **hydrogen** by adding protons (H^+)



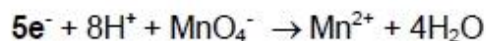
- d. Finally, balance **charge** by adding electrons (e^-).



This half-reaction is **producing/consuming electrons**. This is a **oxidation/reduction** half-reaction. Confirm this by assigning oxidation numbers to the manganese atoms.

Notice that the number of electrons equals the change in oxidation number.

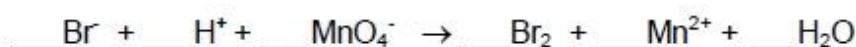
8. Now put the two **half-reactions** together. **The number of electrons produced must equal the number of electrons consumed.**



multiply this half-reaction by $\underline{\hspace{1cm}}$ multiply this half-reaction by $\underline{\hspace{1cm}}$



Add the two half-reactions, canceling out species that appear on both sides (including electrons)



Which compound is the **oxidizing agent** ?

Which compound is the **reducing agent** ?



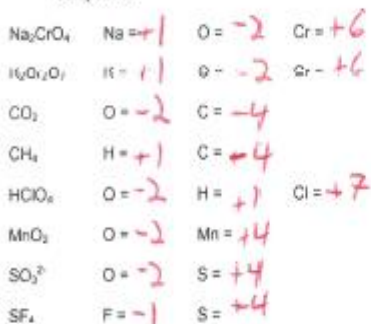
10.3.1 ESSENTIAL Classroom Active Learning Task 2,3 &4 Mark Scheme

Worksheet 25 - Oxidation/Reduction Reactions

Oxidation number rules:

- Elements have an oxidation number of 0
- Group I and II – In addition to the elemental oxidation state of 0, Group I has an oxidation state of +1 and Group II has an oxidation state of +2
- Hydrogen – usually +1, except when bonded to Group I or Group II, when it forms hydrides, -1.
- Oxygen – usually -2, except when it forms a O-O single bond, a peroxide, when it is -1.
- Fluorine is always -1. Other halogens are usually -1, except when bonded to O.

1. Assign oxidation numbers to each of the atoms in the following compounds:



- a. What is the range of oxidation states for carbon? -4 to +4
 b. Which compound has C in a +4 state? CH_4
 c. Which compound has C in a -4 state? CO_2

The species that is oxidized is called the **reducing agent** because it gives up an electron, so that another species can gain an electron (be reduced).

- d. What is the reducing agent in this reaction? N_2

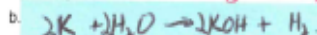
The species that is reduced is called the **oxidizing agent** because it takes an electron away from another group, raising that group's oxidation number.

- e. What is the oxidizing agent in this reaction? H_2

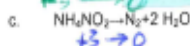
4. In each of the following reactions, assign oxidation numbers to all of the elements and identify the oxidizing and reducing agents and the change in oxidation number.



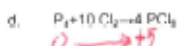
change in oxidation number
 oxidizing agent O_2 0 $\rightarrow$ -2
 reducing agent Fe 0 $\rightarrow$ +3



oxidizing agent H +1 $\rightarrow$ 0
 reducing agent K 0 $\rightarrow$ +1



change in oxidation number
 oxidizing agent NH_4^+ -3 $\rightarrow$ 0
 reducing agent NO_2^- +3 $\rightarrow$ 0



change in oxidation number
 oxidizing agent Cl_2 0 $\rightarrow$ -1
 reducing agent P_4 0 $\rightarrow$ +5

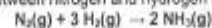


change in oxidation number
 oxidizing agent Cr^{3+} +3 $\rightarrow$ +8
 reducing agent ClO_3^- +7 $\rightarrow$ +4

2. Nitrogen has 5 valence electrons (Group V). It can gain up to 3 electrons (-3), or lose up to 5 (+5) electrons. Fill in the missing names or formulas and assign an oxidation state to each of the following nitrogen containing compounds:

name	formula	oxidation state of N
AMMONIA	NH_3	-3
nitrogen	N_2	0
nitrate	NO_3^-	+5
NITRATE	NO_3^-	+5
dinitrogen monoxide	N_2O	+1
NITROGEN DIOXIDE	NO_2	+4
hydroxylamine	NH_2OH	-1
nitrogen monoxide	NO	+2
hydrazine	N_2H_4	-2

3. During chemical reactions, the oxidation state of atoms can change. This occurs when compounds gain or lose electrons, or when the bonds to an atom change. This is illustrated by the reaction between nitrogen and hydrogen to make ammonia:



- a. Assign oxidation numbers to each of the atoms in this reaction.



When an oxidation number increases, that species has been oxidized.

- b. Which reactant undergoes an increase in its oxidation number? H_2

When an oxidation number decreases, that species has been reduced.

- c. Which reactant undergoes a decrease in its oxidation number? N_2

BEYOND IGCSE Balancing Redox Reactions EXCEPTIONAL

Oxidation/Reduction (Redox) reactions can be balanced using the oxidation state changes, as seen in the previous example. However, there is an easier method, which involves breaking a redox reaction into two half-reactions. This is best shown by working an example.

Hydrobromic acid will react with permanganate to form elemental bromine and the manganese(II) ion. The unbalanced, net reaction is shown below.



5. Break this into two half-reactions, one involving bromine and the other involving manganese.

Bromine half-reaction

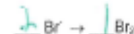


Manganese half-reaction



6. First balance the bromine half-reaction first.

- a. Balance the bromine atoms of the reaction



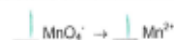
- b. Now balance charge by adding electrons (e^-)



This half-reaction is producing/consuming electrons. This is an oxidation/reduction half-reaction. Confirm this by assigning oxidation numbers to the bromine species.

7. Next, balance the manganese half-reaction.

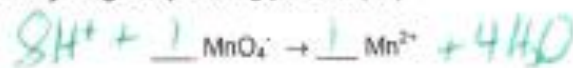
- a. Balance the manganese atoms of the half-reaction



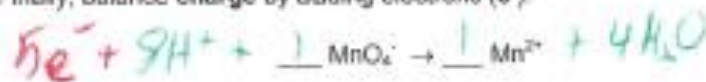
- b. Next, balance oxygen by adding water molecules (H_2O)



- c. Next, balance hydrogen by adding protons (H^+)



- d. Finally, balance charge by adding electrons (e^-).



This half-reaction is producing/consuming electrons. This is a oxidation/reduction half-reaction. Confirm this by assigning oxidation numbers to the manganese atoms.

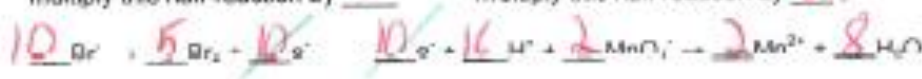
Notice that the number of electrons equals the change in oxidation number.

8. Now put the two half-reactions together. The number of electrons produced must equal the number of electrons consumed.

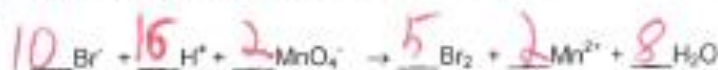


multiply this half-reaction by 5

multiply this half-reaction by 2



Add the two half-reactions, canceling out species that appear on both sides (including electrons)



Which compound is the oxidizing agent?



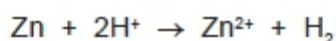
Which compound is the reducing agent?



10.4 ESSENTIAL EXAM QUESTIONS Paper 3/4 48marks

Q# 1/ iGCSE Chemistry/2015/s/Paper 31/

- 3 (a) The reactions between metals and acids are redox reactions.



- (i) Which change in the above reaction is oxidation, Zn to Zn^{2+} or 2H^+ to H_2 ? Give a reason for your choice.

.....
 [2]

- (ii) Which reactant in the above reaction is the oxidising agent? Give a reason for your choice.

.....
 [2]

Q# 2/ iGCSE Chemistry/2012/s/Paper 31/

- 4 Vanadium is a transition element. It has more than one oxidation state. The element and its compounds are often used as catalysts.



(d) The oxidation states of vanadium in its compounds are V(+5), V(+4), V(+3) and V(+2). The vanadium(III) ion can behave as a reductant or an oxidant.

(i) Indicate on the following equation which reactant is the oxidant.



[1]

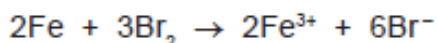
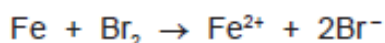
(ii) Which change in the following equation is oxidation?
Explain your choice.



.....
..... [2]

Q# 3/ iGCSE Chemistry/2011/w/Paper 31/ Q5

(b) Iron has two oxidation states +2 and +3. There are two possible equations for the redox reaction between iron and bromine.



(i) Indicate, on the first equation, the change which is oxidation. Give a reason for your choice.

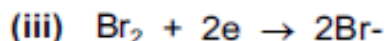
.....
..... [2]

(ii) Which substance in the first equation is the reductant (reducing agent)?

..... [1]

Q# 4/ iGCSE Chemistry/2010/w/Paper 31/Q3

This equation is needed for the question that follows:



(iv) Is the change in (iii) oxidation or reduction? Give a reason for your choice.

.....
..... [1]

(v) Complete the following description of the reaction in the right hand beaker.

Fe^{2+} changes into [1]



- 6 The table below shows the elements in the second period of the Periodic Table and some of their oxidation states in their most common compounds.

element	Li	Be	B	C	N	O	F	Ne
number of outer electrons	1	2	3	4	5	6	7	8
oxidation state	+1	+2	+3	+4	-3	-2	-1	0

- (a) (i) What does it mean when the only oxidation state of an element is zero?

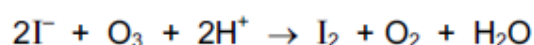
.....
 [1]

- (ii) Explain why some elements have positive oxidation states but others have negative ones.

.....
 [2]

Q# 6/ iGCSE Chemistry/2009/w/Paper 3/ Q4

- (b) Ozone is an oxidant. It can oxidise an iodide to iodine.



- (ii) Explain in terms of electron transfer why the change from iodide ions to iodine molecules is oxidation.

.....
 [1]

- (iii) Explain, using your answer to b(ii), why ozone is the oxidant in this reaction.

.....
 [1]

Q# 7/ iGCSE Chemistry/2007/w/Paper 3/ Q2 (b)

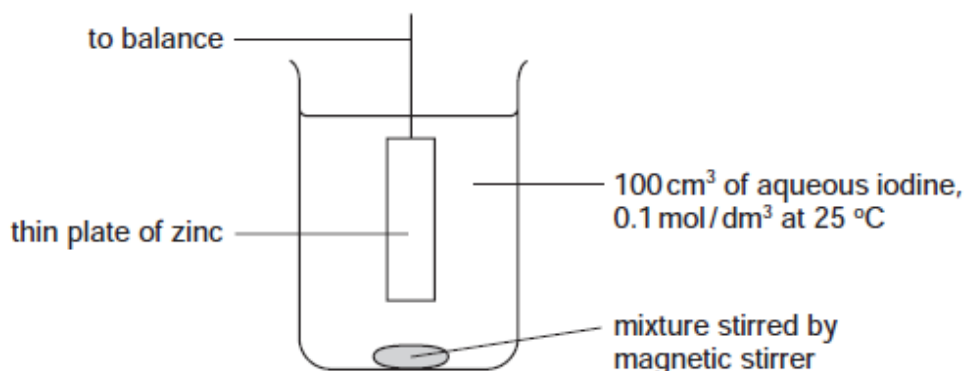
- (iii) The reaction between magnesium and bromine is redox. Complete the sentences.

Magnesium is the agent because it has
 electrons.

Bromine has been because it has
 electrons. [4]



- 2 The following apparatus was used to measure the rate of the reaction between zinc and iodine.



The mass of the zinc plate was measured every minute until the reaction was complete.

- (a) Write an ionic equation for the redox reaction that occurred between zinc atoms and iodine molecules.

[2]

- (c) Silicon is made by the carbon reduction of the macromolecular compound, silicon(IV) oxide.

- (i) Balance the equation for the reduction of silicon(IV) oxide.

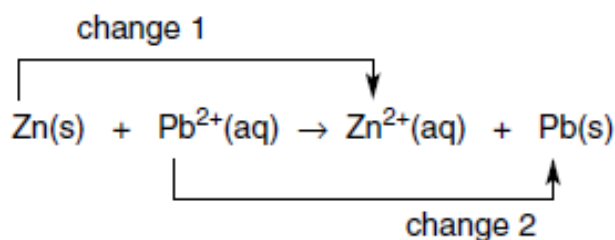


- (ii) Explain why the silicon(IV) oxide is said to be reduced.

[1]

- (c) A solution of an impure zinc ore contained zinc, lead and silver(I) ions. The addition of zinc dust will displace both lead and silver.

- (i) The ionic equation for the displacement of lead is as follows.



Which change is reduction? Explain your answer.

[2]



(ii) Write an ionic equation for the reaction between zinc atoms and silver(I) ions.

.....[2]

Q# 11/ iGCSE Chemistry/2002/w/Paper 3/

3 The elements in Period 3 and some of their common oxidation states are shown below.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Oxidation State	+1	+2	+3	+4	-3	-2	-1	0

(a) (i) Why do the oxidation states increase from sodium to silicon?

.....[1]

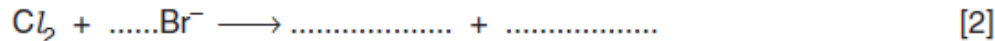
(ii) After Group(IV) the oxidation states are negative and decrease across the period. Explain why.

.....[2]

Q# 12/ iGCSE Chemistry/2002/s/Paper 3/ Q4

(b) Bromine is obtained from the bromide ions in sea water. Sea water is concentrated by evaporation. Chlorine gas is bubbled through the solution. Chlorine oxidises the bromide ion to bromine.

(i) Complete the following equation.



(ii) Explain using the idea of electron transfer why the bromide ion is oxidised by chlorine.

The bromide ion is oxidised because

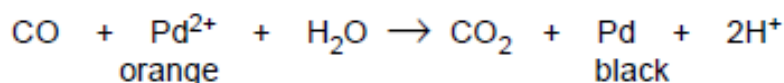
Chlorine is the oxidising agent because[2]

(iii) Name a reagent that can be oxidised by bromine molecules.

.....[1]

Q# 13/ iGCSE Chemistry/2001/w/Paper 3/ Q iGCSE Chemistry/201 (a)

(iii) The following reaction is used to detect carbon monoxide.



What type of chemical reaction is the change Pd^{2+} to Pd? Give a reason for your answer.

.....[2]



Q# 1/ iGCSE Chemistry/2015/s/Paper 31/

3(a)(i)	Zn to Zn^{2+} ; because electron loss;	2	A because oxidation number has increased for M2
3(a)(ii)	(2)H ⁺ or 'hydrogen ion(s)'; it accepts electrons or takes electrons (from zinc atoms);	2	R H ₂ or 'hydrogen' A because it is reduced or because it decreases in oxidation number A it causes zinc to lose electrons

Q# 2/ iGCSE Chemistry/2012/s/Paper 31/Q4

- (d) (i) V^{3+} is oxidant; [1]
- (ii) V^{3+} to V^{4+} ; [1]
increase in oxidation number / electron loss; [1]

Q# 3/ iGCSE Chemistry/2011/w/Paper 31/ Q5

- (b) (i) Fe to Fe^{2+} [1]
because oxidation is electron loss / increase in oxidation number [1]
- (ii) Fe [1]

Q# 4/ iGCSE Chemistry/2010/w/Paper 31/

- (iv) reduction because electron gain [1]
/ because oxidation number decreases
need both points
- (v) Fe^{3+} [1]

Q# 5/ iGCSE Chemistry/2010/w/Paper 31/

- 6 (a) (i) does not form compounds / does not accept and does not lose electrons / has full outer shell/has 8e in outer shell / it is a Noble Gas / it is in Group 0/8 [1]
- (ii) small number of outer electrons / lose electrons then positive [1]
large number of outer electrons / gain electrons then negative [1]

Q# 6/ iGCSE Chemistry/2009/w/Paper 3/ Q4

- (ii) I⁻ loses electrons (to form iodine molecules) [1]
must be in terms of electron transfer **NOT** oxidation number
- (iii) they (electrons) are accepted by ozone [1]
or it is an electron acceptor [1]

Q# 7/ iGCSE Chemistry/2007/w/Paper 3/ Q3 (b)

- (iii) reducing **or** reduction **or** reductant [1]
lost electrons **or** given **or** donated electrons **or** transferred (to bromine) [1]
reduced [1]
gained **or** accepted electrons [1]

Q# 8/ iGCSE Chemistry/2005/s/Paper 3/

- 2 (a) $\text{Zn} + \text{I}_2 = \text{Zn}^{2+} + 2\text{I}^-$ [2]
For having either reactants **or** products correct ONLY [1]

Q# 9/ iGCSE Chemistry/2004/s/Paper 3/

- (c) (i) correctly balanced [1]
- (ii) lost oxygen [1]
or decrease in oxidation number
NOT accepts electrons unless valid explanation



- (c) (i) one involving lead – change 2 [1]
cond because electrons are gained [1]
or oxidation number less
- (ii) correct equation [2]

$$\text{Zn} + 2\text{Ag}^+ = 2\text{Ag} + \text{Zn}^{2+}$$

 not balanced **ONLY** [1]

- 3 (a) (i) number of outer electrons increases [1]
or number of electrons more than complete energy level
or number of electrons to be lost
or accept clear examples
NOT just different groups or valencies
- (ii) gain electrons [1]
 number of electrons to be gained is less across period [1]
or number of outer electrons increases

- 4 (a) (i) fluorine [1]
- (ii) iodine and astatine [1]
- (b) (i) $\text{Cl}_2 + 2\text{Br}^- \Rightarrow 2\text{Cl}^- + \text{Br}_2$ [2]
 not balanced **ONLY** [1]
- (ii) because it has lost electron(s) (Must be electron transfer) [1]
Not conseq because it took electrons from the bromide [1]
or chlorine gained electrons
or because chlorine was reduced
- (iii) Iodide **or** metals **or** iron(II) etc [1]
not iodine **accept** iodine ions **or** alkene

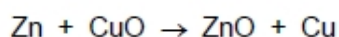
- (iii) reduction [1]
COND electron gain **or** decrease in oxidation number [1]



10.5 ESSENTIAL EXAM QUESTIONS Paper 2 18marks

Q# 1/ iGCSE Chemistry/2018/w/Paper 23/

16 The equation for the reaction between zinc and copper(II) oxide is shown.



Which row shows the oxidising agent and the reducing agent?

	oxidising agent	reducing agent
A	CuO	Cu
B	CuO	Zn
C	Zn	CuO
D	Zn	ZnO

Q# 2/ iGCSE Chemistry/2018/w/Paper 22/

16 The thermite reaction can be used to produce iron from iron(III) oxide.

The equation for the reaction is shown.



Which statements about this reaction are correct?

- 1 Aluminium is the oxidising agent.
- 2 Aluminium is less reactive than iron.
- 3 Electrons are transferred from aluminium to iron.
- 4 The iron in the iron(III) oxide is reduced.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

Q# 3/ iGCSE Chemistry/2018/w/Paper 21/

16 An excess of iron(II) chloride is added to acidified potassium manganate(VII).

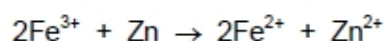
Which statements are correct?

- 1 The purple colour disappears.
- 2 Iron(II) is reduced to iron(III).
- 3 Manganate(VII) ions are oxidised to manganese(II) ions.
- 4 Potassium manganate(VII) is an oxidising agent.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

Q# 4/ iGCSE Chemistry/2018/s/Paper 23/

16 The equation for a redox reaction is shown.



Which statements are correct?

- 1 Fe^{3+} is reduced to form Fe^{2+} .
- 2 Zn oxidises the Fe^{3+} ions.
- 3 Fe^{3+} is an oxidising agent.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

Q# 5/ iGCSE Chemistry/2018/s/Paper 22/

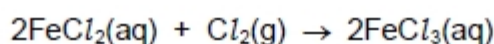
Patrick Brannac www.SmashingScience.org & for China www.SmashingScienceCN.org

Page 288 of 585



16 Iron(II) chloride solution reacts with chlorine gas.

The equation is shown.



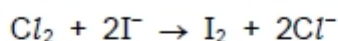
Which statements about this reaction are correct?

- 1 Fe^{2+} ions are reduced to Fe^{3+} ions.
- 2 Chlorine acts as a reducing agent.
- 3 Fe^{2+} ions each lose an electron.
- 4 Cl_2 molecules are reduced to Cl^- ions.

A 1 and 2 B 2 and 3 C 2 and 4 D 3 and 4

Q# 6/ iGCSE Chemistry/2018/s/Paper 21/

16 Chlorine displaces iodide ions from potassium iodide.



What is the oxidising agent?

- A chloride ions
B chlorine
C iodide ions
D iodine

Q# 7/ iGCSE Chemistry/2018/m/Paper 22/

18 The reaction between magnesium and carbon dioxide is shown in the equation.



Which statement describes what happens in this reaction?

- A Carbon is oxidised.
B Magnesium is reduced.
C Neither oxidation nor reduction happens.
D The carbon in carbon dioxide is reduced.

19 Which changes involve reduction?

- 1 $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^-$
- 2 $\text{CuO} + \text{H}_2 \rightarrow \text{Cu} + \text{H}_2\text{O}$
- 3 $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$
- 4 $\text{Pb}^{2+} + \text{SO}_4^{2-} \rightarrow \text{PbSO}_4$

A 1 and 2 B 1 and 4 C 2 and 3 D 3 and 4

Q# 8/ iGCSE Chemistry/2017/w/Paper 23/



14 Silver chloride reacts when it is exposed to light.

Which row shows what happens to the silver in this process?

	half-equation	type of reaction
A	$\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$	oxidation
B	$\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$	reduction
C	$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	oxidation
D	$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	reduction

Q# 9/ iGCSE Chemistry/2017/w/Paper 22/

14 Copper metal donates electrons to silver ions.

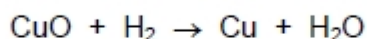
Zinc metal donates electrons to copper ions.

What is the strongest reducing agent?

- A copper ions
- B copper metal
- C silver ions
- D zinc metal

Q# 10/ iGCSE Chemistry/2017/w/Paper 21/

14 Copper(II) oxide reacts with hydrogen.

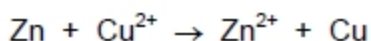


Which row is correct?

	oxidising agent	reducing agent
A	H_2	CuO
B	CuO	H_2
C	H_2O	Cu
D	Cu	H_2O

Q# 11/ iGCSE Chemistry/2017/s/Paper 21/

17 An example of a redox reaction is shown.



Which statement about the reaction is correct?

- A Zn is the oxidising agent and it oxidises Cu^{2+} .
- B Zn is the oxidising agent and it reduces Cu^{2+} .
- C Zn is the reducing agent and it oxidises Cu^{2+} .
- D Zn is the reducing agent and it reduces Cu^{2+} .

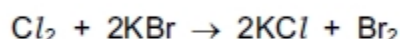
Q# 12/ iGCSE Chemistry/2017/m/Paper 22/

Patrick Brannac www.SmashingScience.org & for China www.SmashingScienceCN.org

Page 290 of 585



17 Chlorine displaces bromine from a solution of potassium bromide.



What is the oxidising agent in this reaction?

- A bromide ions
- B bromine
- C chloride ions
- D chlorine

Q# 13/ iGCSE Chemistry/2016/w/Paper 23/

17 Which change represents an oxidation reaction?

- A chlorine changes to chlorate(I) ions
- B chlorine changes to chloride ions
- C copper(II) ions change to copper
- D potassium manganate(VII) ions change to potassium manganate(VI) ions

Q# 14/ iGCSE Chemistry/2016/w/Paper 22/

17 Chromium forms the compound chromium(III) sulfate.

What does the (III) represent?

- A the charge on a sulfate ion
- B the number of chromium ions combined with one sulfate ion
- C the number of sulfate ions combined with one chromium ion
- D the oxidation state of chromium

Q# 15/ iGCSE Chemistry/2016/w/Paper 21/

17 Four ionic half-equations are shown.

- 1 $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$
- 2 $2\text{I}^-(\text{aq}) \rightarrow \text{I}_2(\text{aq}) + 2\text{e}^-$
- 3 $\text{Fe}^{2+}(\text{aq}) \rightarrow \text{Fe}^{3+}(\text{aq}) + \text{e}^-$
- 4 $\text{Cl}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{Cl}^-(\text{aq})$

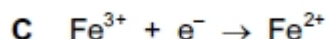
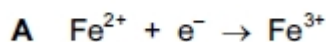
Which statement is correct?

- A In equation 1, copper(II) ions are oxidised to copper.
- B In equation 2, iodide ions are reduced to iodine.
- C In equation 3, iron(II) ions are oxidised to iron(III) ions.
- D In equation 4, chlorine is oxidised to chloride ions.



Q# 16/ iGCSE Chemistry/2016/s/Paper 21/

17 Which equation represents a reduction reaction?

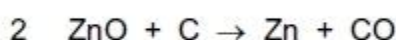
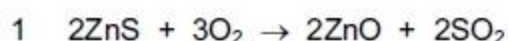


Q# 17/ iGCSE Chemistry/2016/m/Paper 22/

16 Zinc is extracted from zinc blende by roasting it in air to form zinc oxide.

The zinc oxide is then heated with carbon to form zinc.

The equations for the reactions are shown.



Which statement about reactions 1 and 2 is **not** correct?

A In reaction 1 the oxidation state of sulfur increases and it is oxidised.

B In reaction 1 the oxidation state of zinc increases and it is oxidised.

C In reaction 2 the carbon acts as a reducing agent and it is oxidised.

D In reaction 2 the oxidation state of zinc decreases and it is reduced.

10.5.1 ESSENTIAL EXAM QUESTIONS T7.4 Paper 2 Mark Scheme

Q# 1/ iGCSE Chemistry/2018/w/Paper 23/

16	B
----	---

Q# 2/ iGCSE Chemistry/2018/w/Paper 22/

16	D
----	---

Q# 3/ iGCSE Chemistry/2018/w/Paper 21/

16	B
----	---

Q# 4/ iGCSE Chemistry/2018/s/Paper 23/

16	C
----	---

Q# 5/ iGCSE Chemistry/2018/s/Paper 22/

16	D
----	---

Q# 6/ iGCSE Chemistry/2018/s/Paper 21/

16	B
----	---

Q# 7/ iGCSE Chemistry/2018/m/Paper 22/

18	D
----	---

19	C
----	---

Q# 8/ iGCSE Chemistry/2017/w/Paper 23/

14	D
----	---

Q# 9/ iGCSE Chemistry/2017/w/Paper 22/

14	D
----	---

Q# 10/ iGCSE Chemistry/2017/w/Paper 21/

14	B
----	---

Q# 11/ iGCSE Chemistry/2017/s/Paper 21/

17	D
----	---

Q# 12/ iGCSE Chemistry/2017/m/Paper 22/

17	D
----	---

Q# 13/ iGCSE Chemistry/2016/w/Paper 23/

17	A
----	---

Q# 14/ iGCSE Chemistry/2016/w/Paper 22/

17	D
----	---

Q# 15/ iGCSE Chemistry/2016/w/Paper 21/

17	C
----	---

Q# 16/ iGCSE Chemistry/2016/s/Paper 21/

17	C
----	---

Q# 17/ iGCSE Chemistry/2016/m/Paper 22/

16	B
----	---



10.6 FUNDAMENTAL Assessed Activity 1 Keyword Test

English	Meaning
oxidation state	
oxidation	
oxidising agent	
redox reaction	
reduction	

10.7 FUNDAMENTAL Assessed Activity 2 Paper 1 17marks

Q# 1/

14 Which change is an oxidation?

- A FeO to Fe₂O₃
- B Fe₂O₃ to FeO
- C H₂O₂ to H₂O
- D H₂O to H₂

Q# 2/

14 The element vanadium, V, forms several oxides.

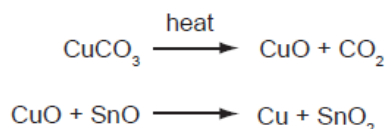
In which change is oxidation taking place?

- A VO₂ → V₂O₃
- B V₂O₅ → VO₂
- C V₂O₃ → VO
- D V₂O₃ → V₂O₅



Q# 3/

- 18 The red colour in some pottery glazes may be formed as a result of the reactions shown.



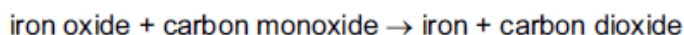
These equations show that1..... is oxidised and2..... is reduced.

Which substances correctly complete gaps 1 and 2 in the above sentence?

	1	2
A	CO ₂	SnO ₂
B	CuCO ₃	CuO
C	CuO	SnO
D	SnO	CuO

Q# 4/

- 18 Iron is extracted from iron oxide using carbon monoxide as shown in the equation.



What does the equation show?

- A** Carbon monoxide is oxidised to carbon dioxide.
- B** Carbon monoxide is reduced to carbon dioxide.
- C** Iron is oxidised to iron oxide.
- D** Iron oxide is oxidised to iron.

Q# 5/

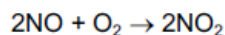
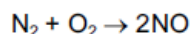
- 18 The equations represent redox reactions.

In which equation is the underlined substance acting as a reducing agent?

- A** CaO + H₂O → Ca(OH)₂
- B** CO₂ + C → 2CO
- C** CuO + H₂ → Cu + H₂O
- D** 3CO + Fe₂O₃ → 2Fe + 3CO₂

Q# 6/

- 18 The reactions shown may occur in the air during a thunder storm.



Which line shows what happens to the reactant molecules in each of these reactions?

	N ₂	NO	O ₃
A	oxidised	oxidised	oxidised
B	oxidised	oxidised	reduced
C	reduced	reduced	oxidised
D	reduced	reduced	reduced



Q# 7/

17 In which of the following reactions is the substance printed in **bold** oxidised?

- A burning the **wax** in a candle
- B dissolving **hydrogen chloride** in water
- C making glucose from **carbon dioxide** and water by photosynthesis
- D reacting **sodium hydroxide** with sulphuric acid

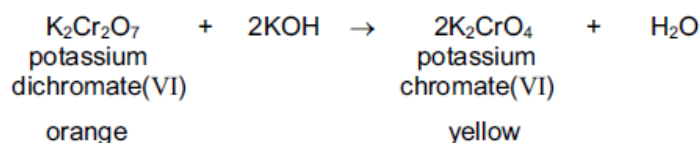
Q# 8/

18 When written as formulae, which compound has the greatest number of oxygen atoms?

- A calcium oxide
- B copper(II) oxide
- C iron(III) oxide
- D potassium oxide

Q# 9/

19 The equation explains the colour change that occurs when aqueous potassium hydroxide is added to aqueous potassium dichromate(VI).



As a result of adding an excess of aqueous potassium hydroxide to aqueous potassium dichromate(VI), what happens to the oxidation state of the chromium and the pH of the reaction mixture?

	oxidation state of the chromium	pH of the mixture
A	decreases	decreases
B	decreases	increases
C	stays the same	decreases
D	stays the same	increases

Q# 10/

16 Which equation shows an oxidation reaction?

- A $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$
- B $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
- C $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$
- D $\text{N}_2\text{O}_4 \rightarrow 2\text{NO}_2$



Q# 11/

15 Which process does **not** involve either oxidation or reduction?

- A burning methane in the air
- B extracting iron from hematite
- C heating copper(II) oxide with carbon
- D reacting sodium carbonate with dilute hydrochloric acid

Q# 12/

29 What is used to test for the presence of water?

- A anhydrous copper(II) sulphate
- B aqueous barium chloride
- C aqueous sodium hydroxide
- D Universal indicator paper

Q# 13/

17 In which reaction does reduction of the underlined substance take place?

- A $\underline{\text{Cu}_2\text{O}} + \text{C} \rightarrow 2\text{Cu} + \text{CO}$
- B $2\underline{\text{Cu}_2\text{O}} + \text{O}_2 \rightarrow 4\text{CuO}$
- C $2\underline{\text{Cu}} + \text{O}_2 \rightarrow 2\text{CuO}$
- D $\text{CuO} + \underline{\text{CO}} \rightarrow \text{Cu} + \text{CO}_2$

Q# 14/

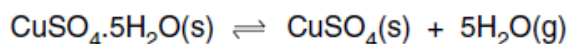
16 In an experiment, copper(II) oxide is changed to copper by a gas **X**.

What happens to the copper(II) oxide and what is **X**?

	copper(II) oxide	gas X
A	oxidised	carbon dioxide
B	oxidised	carbon monoxide
C	reduced	carbon dioxide
D	reduced	carbon monoxide

Q# 15/

17 The equation shows what happens when hydrated copper(II) sulphate is heated.



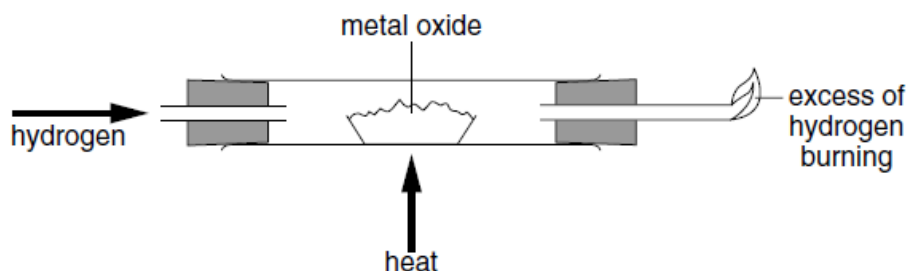
What can be deduced from the equation?

- A The hydrated copper(II) sulphate is oxidised.
- B The hydrated copper(II) sulphate is reduced.
- C The reaction is reversible.
- D There is no colour change.



Q# 16/

15 When hydrogen is passed over a heated metal oxide, the metal and steam are formed.

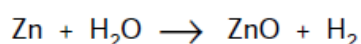


What happens to the hydrogen and to the metal oxide?

	hydrogen	metal oxide
A	oxidised	oxidised
B	oxidised	reduced
C	reduced	oxidised
D	reduced	reduced

Q# 17/

18 Zinc reacts with steam to form zinc oxide and hydrogen.



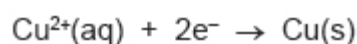
During the reaction, which substance is oxidised?

- A hydrogen
- B water
- C zinc
- D zinc oxide

10.8 Extension Assessed Activity 3 T7.4 P4 13marks

Q# 1/

(i) The chemical process taking place on the surface of the object is



Explain whether this process is oxidation or reduction.

.....

..... [1]

Q# 2/

(d) When a sample of steel is added to dilute hydrochloric acid, an aqueous solution of iron(II) chloride, FeCl_2 , is formed.

When a sample of rust is added to dilute hydrochloric acid, an aqueous solution of iron(III) chloride, FeCl_3 , is formed.



Solutions of iron(II) chloride and iron(III) chloride were added to solutions of potassium iodide and acidified potassium manganate(VII). The results are shown in the table.

	iron(II) chloride solution	iron(III) chloride solution
potassium iodide solution	no change	solution turns from colourless to brown
acidified potassium manganate(VII) solution	solution turns from purple to colourless	no change

- (ii) What **types** of substance cause potassium iodide solution to turn from colourless to brown?

..... [1]

- (iii) What **types** of substance cause acidified potassium manganate(VII) solution to turn from purple to colourless?

..... [1]

Q# 3/

- (c) When chlorine gas is bubbled through an aqueous solution of potassium iodide, a redox reaction takes place.



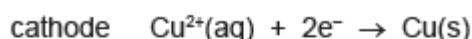
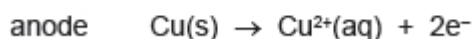
- (ii) Identify the reducing agent in this reaction. Explain your answer.

.....

 [2]

Q# 4/

- (c) The electrolysis was repeated using copper electrodes in place of carbon electrodes. The ionic half-equations for the reactions at the two electrodes are shown.



- (i) Which species is reduced during the electrolysis? Explain your answer.

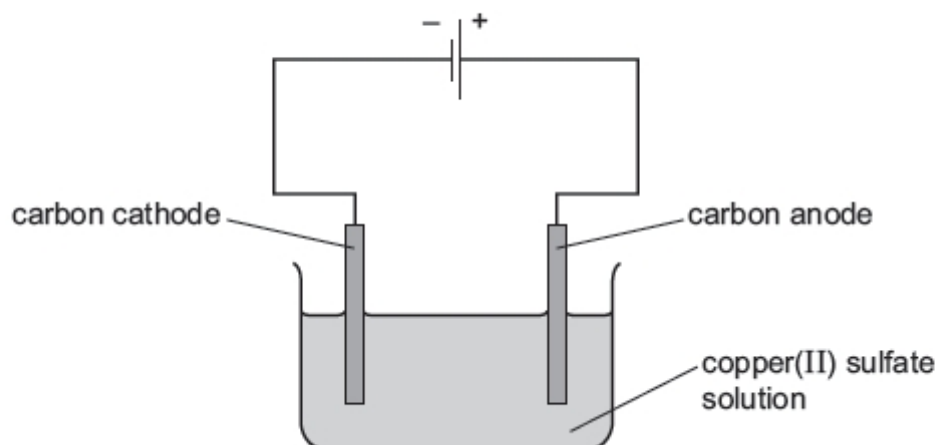
.....

 [2]



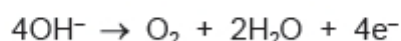
Q# 5/

4 Copper(II) sulfate solution was electrolysed using the apparatus shown.



(b) Oxygen was formed at the anode and copper was formed at the cathode.

(i) The ionic half-equation for the formation of oxygen is shown.



Explain why this reaction is oxidation.

..... [1]

(ii) Write the ionic half-equation for the formation of copper at the cathode.

..... [2]

Q# 6/

3 (a) When magnesium is added to aqueous copper(II) sulfate a reaction occurs. The ionic equation for the reaction is shown.



(i) Give **one** change you would observe during this reaction.

..... [1]

(ii) Explain why this is a redox reaction.

.....
..... [1]

(iii) Identify the oxidising agent in this reaction. Give a reason for your answer.

.....
..... [2]



10.9 Extension Mind Map for Topic 7.4 Redox



10.10 Essential End of Topic 7.4 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?

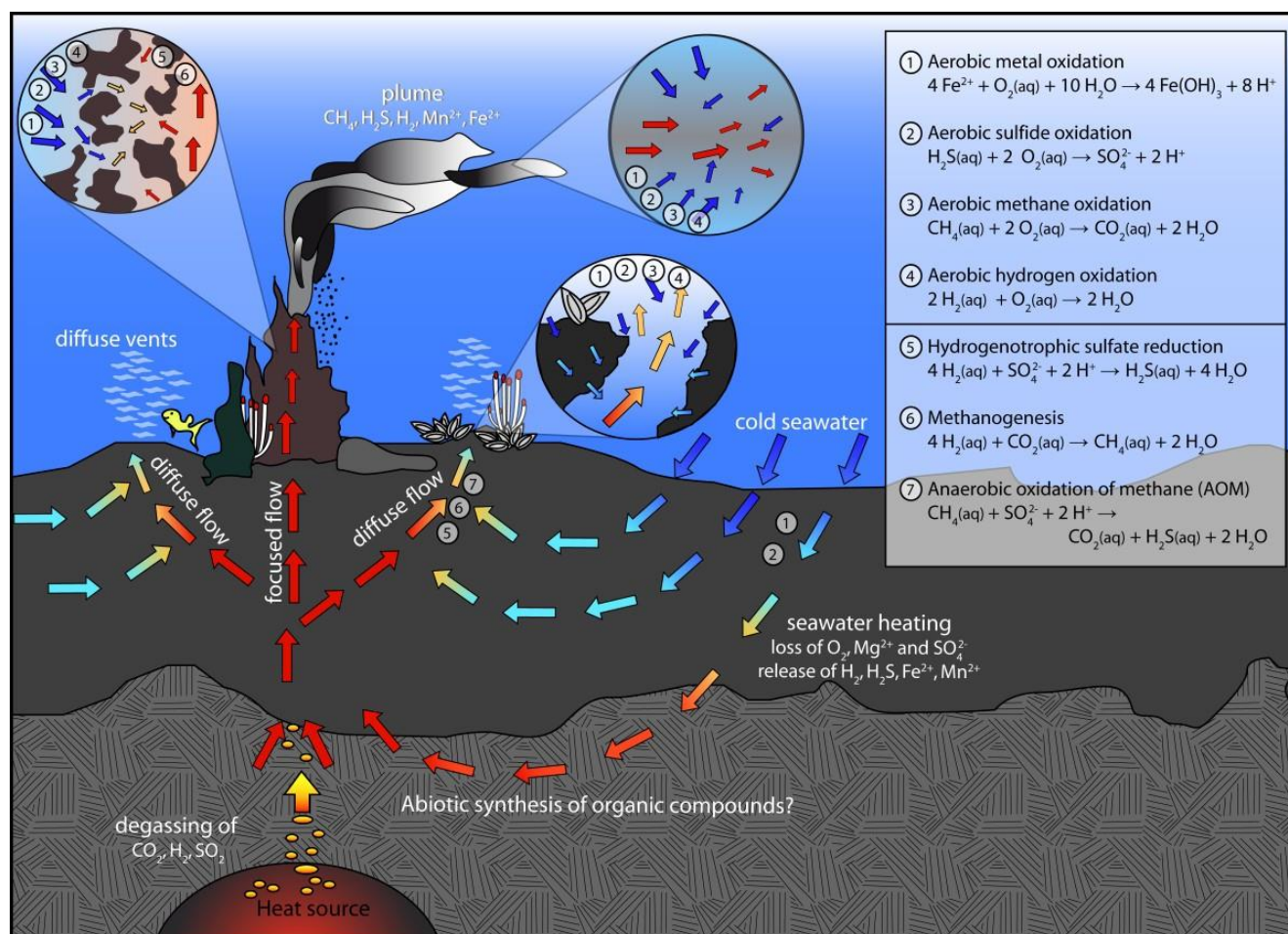


10.11 Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus

10.12 Topic 7.4 Exceptional Redox Reactions and the Origins of Life

Redox processes are essential for all life that we have ever discovered and can ever imagine, the redox processes provide the necessary energy to allow the life processes to persist. There are a variety of articles about life discovered underground (it the soil and rocks of the Earth's crust may in fact be where the majority, by dry mass, of life on Earth exists, not on the land, in the air or in the sea). Increasingly biologists understand life on earth started deep under water, and did not rely on energy from the sun, but instead energy from redox processes where the energy source is volcanic vents. It is even believed that this kind of life may in fact exist on other planets and moons, not only in our solar systems, or even in any solar system: perhaps half of all planets that are made in early solar systems are ejected out of the gravity field of their star or stars, and wander the astronomically empty spaces between solar systems, but if they are young enough, so just a few billion years old, they may have enough inner heat to support this kind of life beneath their icy surface.

All of these articles are available here: <https://www.smashingsciencecn.org/igcse-chem-additional-resources>



From: <https://geochemicaltransactions.biomedcentral.com/articles/10.1186/1467-4866-13-2>



11 Topic 5 Electrochemistry

11.1 End of Topic 6 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTENSION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTENSION
	Scored over 95%		SMASHING!!!



Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book <u>you enjoy</u> (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book <u>you enjoy</u> in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book <u>you enjoy</u> in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

11.2 Topic 5 Syllabus

5 Electricity and chemistry

5.1 Electricity and chemistry

Core

- Define electrolysis as the breakdown of an ionic compound, molten or in aqueous solution, by the passage of electricity
- Describe the electrode products and the observations made during the electrolysis of:
 - molten lead(II) bromide
 - concentrated hydrochloric acid
 - concentrated aqueous sodium chloride
 - dilute sulfuric acid
 between inert electrodes (platinum or carbon)
- State the general principle that metals or hydrogen are formed at the negative electrode (cathode), and that non-metals (other than hydrogen) are formed at the positive electrode (anode)
- Predict the products of the electrolysis of a specified binary compound in the molten state
- Describe the electroplating of metals
- Outline the uses of electroplating

Supplement

- Relate the products of electrolysis to the electrolyte and electrodes used, exemplified by the specific examples in the Core together with aqueous copper(II) sulfate using carbon electrodes and using copper electrodes (as used in the refining of copper)
- Describe electrolysis in terms of the ions present and reactions at the electrodes in the examples given
- Predict the products of electrolysis of a specified halide in dilute or concentrated aqueous solution
- Construct ionic half-equations for reactions at the cathode

continued



5.1 Electricity and chemistry continued

Core

- Describe the reasons for the use of copper and (steel-cored) aluminium in cables, and why plastics and ceramics are used as insulators

Supplement

- Describe the transfer of charge during electrolysis to include:
 - the movement of electrons in the metallic conductor
 - the removal or addition of electrons from the external circuit at the electrodes
 - the movement of ions in the electrolyte
- Describe the production of electrical energy from simple cells, i.e. two electrodes in an electrolyte. (This should be linked with the reactivity series in section 10.2 and redox in section 7.4.)
- Describe, in outline, the manufacture of:
 - aluminium from pure aluminium oxide in molten cryolite (refer to section 10.3)
 - chlorine, hydrogen and sodium hydroxide from concentrated aqueous sodium chloride
 (Starting materials and essential conditions should be given but not technical details or diagrams.)

11.3 ESSENTIAL Glossary for Keywords for this topic

English	Chinese
anion a negative ion which would be attracted to the anode in electrolysis	阴离子 负离子，在电解中会被吸引到阳极
anode the electrode in any type of cell at which oxidation (the loss of electrons) takes place – in electrolysis it is the positive electrode.	在发生氧化（电子损失）的任何类型的电池中，使电极阳极化-在电解中，它为正电极。
brine a concentrated solution of sodium chloride in water	盐水在水中的氯化钠浓缩溶液
cathode the electrode in any type of cell at which reduction (the gain of electrons) takes place; in electrolysis it is the negative electrode	使任何类型的发生还原（电子增益）的电池中的电极阴极；在电解中它是负极
cation a positive ion which would be attracted to the cathode in electrolysis. Remember smiling cats: cats are positive!	阳离子在电解中会被吸引到阴极的阳离子。记住微笑的猫：猫是积极的！
electrochemical cell a system for converting chemical energy to electrical energy, made by connecting two metals of different reactivity via an electrolyte;	电化学电池一种将化学能转化为电能的系统，通过将两种反应性不同的金属通过电解质连接制成。
electrode the point where the electric current enters or leaves a battery or electrolytic cell	电极电流进入或离开电池或电解池的位置
electrolysis a process in which a chemical reaction is caused by the passage of an electric current	电解一种通过电流通过引起化学反应的过程
electrolyte an ionic compound which will conduct electricity when it is molten or dissolved in water; electrolytes will not conduct electricity when solid	电解质是一种离子化合物，当熔融或溶于水时会导电。固体时电解质不会导电
electrolytic cell a cell consisting of an electrolyte and two electrodes (anode and cathode) connected to an external DC power source where positive and negative ions in the electrolyte are separated and discharged	电解池一种由电解质和两个与外部直流电源相连的电极（阳极和阴极）组成的电池，电解质中的正负离子被分离并放电
electroplating a process of electrolysis in which a metal object is coated (plated) with a layer of another metal	电镀一种电解过程，其中金属物体被另一种金属层覆盖（电镀）



11.4 ESSENTIAL Active Learning Tasks Electrolysis 1

Match the following words with their meanings

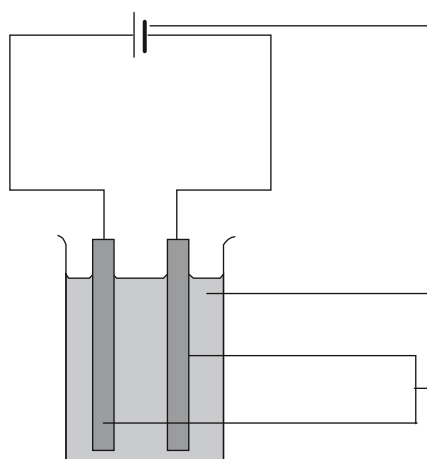
Word

Meaning

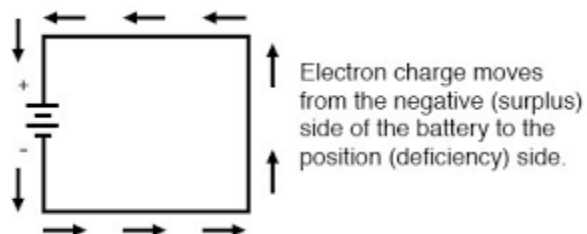
Electrode	1	Breaking up a substance by passing electricity through it	A
Electrolyte	2	Adding oxygen to, or removing electrons from, a substance	B
Reduction	3	Positive electrode	C
Oxidation	4	When one element is pushed out of its compound by a more reactive element	D
Cathode	5	Substance that is broken up when electricity is passed through it – usually a liquid	E
Anode	6	The percentage of the reactants that end up in the desired products of a reaction	F
Electrolysis	7	Removing oxygen from, or adding electrons to, a substance	G
Displacement	8	Negative electrode	H
Atom economy	9	A conductor made of a metal or graphite used in electrolysis	I

Word	Meaning
1	
2	
3	
4	
5	
6	
7	
8	D
9	

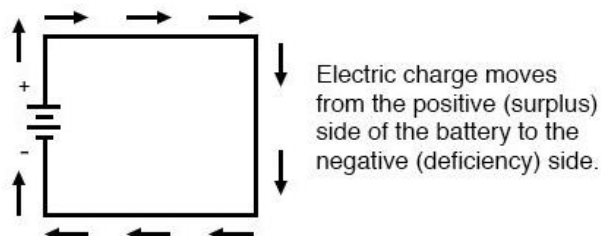
Essential Now label this diagram showing electrolysis



Electron Flow Notation



Conventional Flow Notation



Extension activity

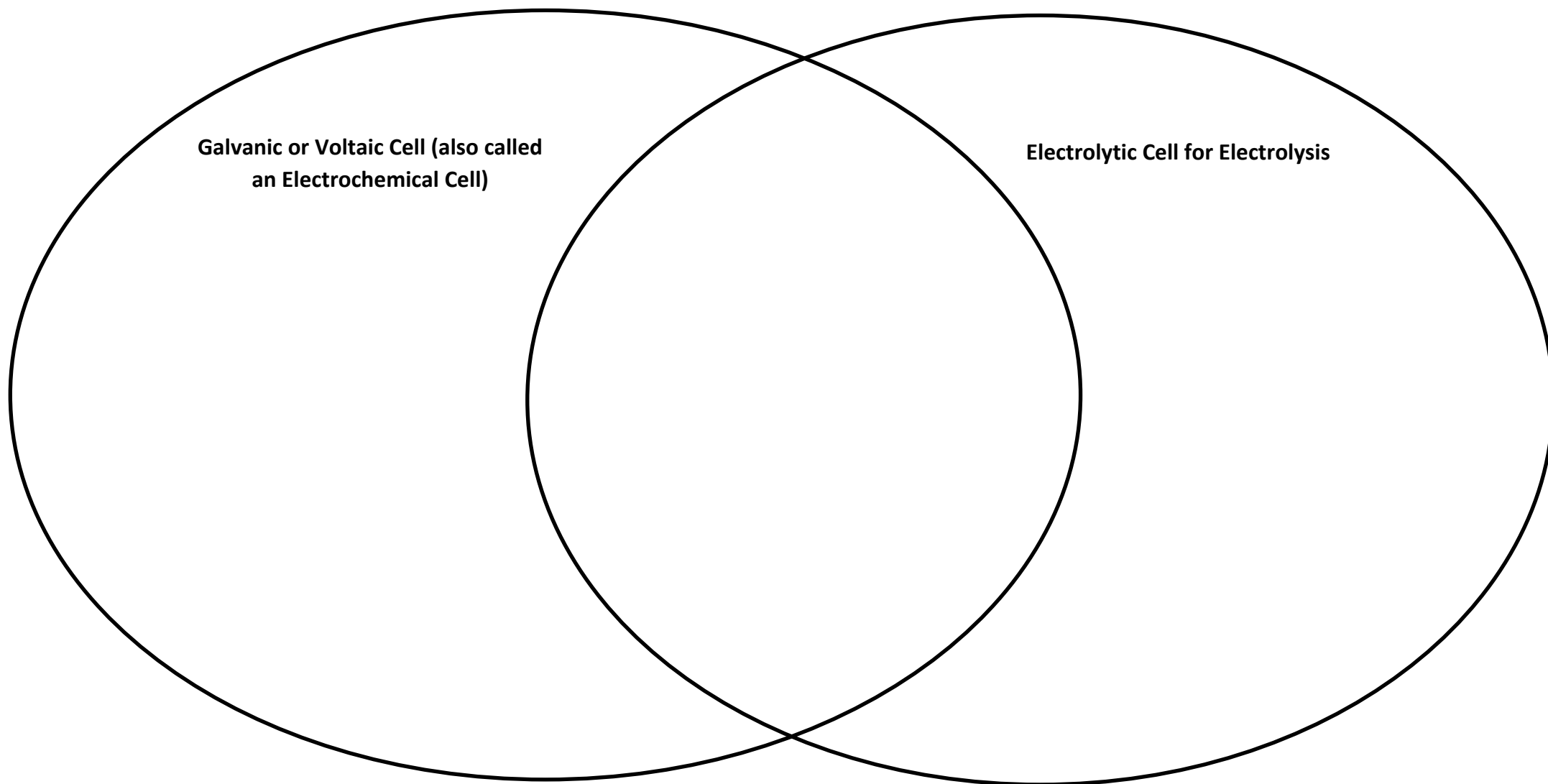
Assume that the substance being electrolysed is Lead (II) Bromide use the information above about Electron Flow Notation to label the electrodes with the ionic half equation that is happening at each side.

Exceptional activity

Why is the electron flow notation different from the conventional flow notation?



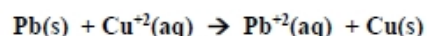
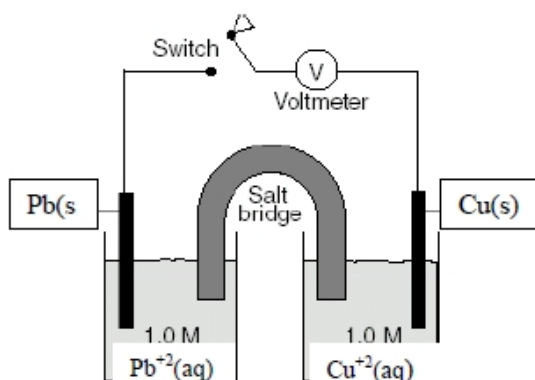
Compare and contrast what these two processes have in common and how are they different to each other



11.6 Extension Classroom Active Learning Task 3

- What is the oxidation number of chlorine in HClO_4 ?
1. -1 2. +1 3. +7 4. +8
- What is the oxidation number of carbon in C_2H_6 ?
1. -6 2. -3 3. +3 4. +6
- Given the reaction: $\text{Mg} + \text{CuSO}_4 \rightarrow \text{MgSO}_4 + \text{Cu}$ Which equation represents the oxidation that takes place?
1. $\text{Mg}^{+2} + 2\text{e}^- \rightarrow \text{Mg}$ 2. $\text{Mg} \rightarrow \text{Mg}^{+2} + 2\text{e}^-$
3. $\text{Cu}^{+2} + 2\text{e}^- \rightarrow \text{Cu}$ 4. $\text{Cu} \rightarrow \text{Cu}^{+2} + 2\text{e}^-$
- In the following reaction: $\text{Fe} + \text{Zn}^{+2} \rightarrow \text{Fe}^{+2} + \text{Zn}$
A. Fe is reduced and Zn^{+2} is the oxidizing agent
B. Fe is reduced and Zn^{+2} is the reducing agent
C. Fe is oxidized and Zn^{+2} is the oxidizing agent
D. Fe is oxidized and Zn^{+2} is the reducing agent
- In which species does oxygen have an oxidation number of -1?
A. H_2O 2. Na_2O_2 3. Al_2O_3 4. O_2
- What is the purpose of a salt bridge in an electrochemical cell?
1. To act as a reducing agent 2. To act as an oxidizing agent
3. To provide electrons that flow between the two half cells and complete the electrical circuit
4. To provide ions that flow between the two half cells and complete the electrical circuit
- Given the equations A, B, C, and D; which two equations represent redox reactions?
A. $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$
B. $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HClO} + \text{HCl}$
C. $\text{CuO} + \text{CO} \rightarrow \text{CO}_2 + \text{Cu}$
D. $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
1. A and B 2. B and C 3. C and A 4. D and B
- Given the unbalanced equation: $___ \text{NO}_3^- + 4\text{H}^+ + ___ \text{Ag} \rightarrow ___ \text{Ag}^+ + ___ \text{NO} + 2\text{H}_2\text{O}$
What is the coefficient in front of Ag when the equation is correctly balanced? (Where coefficients are given, these are correct and should not be changed)
1. 1 2. 2 3. 3 4. 4

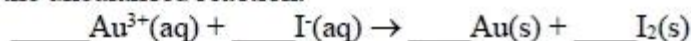
Use the diagram of the electrochemical cell below to answer the next four questions



13. When the switch is closed which electrode will become heavier?
- Pb
 - Cu
 - Both Pb and Cu will increase in mass
 - Neither Pb nor Cu will increase in mass
14. Which direction will electrons flow?
- From Pb through the voltmeter to Cu
 - From Cu through the voltmeter to Pb
 - From Pb through the salt bridge to Cu
 - From Cu through the salt bridge to Pb
15. Which metal ion will increase in concentration as the cell runs
- Cu^{+2} only
 - Pb^{+2} only
 - Both Cu^{+2} and Pb^{+2}
 - Neither Cu^{+2} nor Pb^{+2}
18. In the following reaction, how many **total** electrons are transferred between chlorine and oxygen?
- $$2 \text{ClO}_2 \rightarrow \text{Cl}_2 + 2\text{O}_2$$
- 1
 - 2
 - 8
 - 4
19. In the following reaction what is the reducing agent?
- $$\text{Mg} + 2\text{HNO}_3 \rightarrow \text{Mg}(\text{NO}_3)_2 + \text{H}_2$$
- Mg
 - H^+
 - O^{2-}
 - N^{+5}

Answer the next four questions from the reaction below:

Given the unbalanced reaction:



21. Write the reduction half reaction

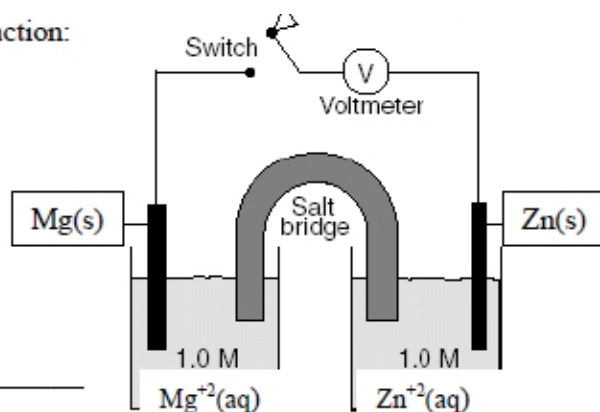
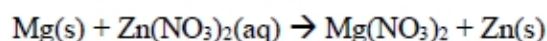
22. Write the oxidation half reaction

23. Write the balanced reaction

23. How many **total** electrons are **transferred** when the reaction is balanced _____



The diagram below represents an electrochemical cell for the reaction:

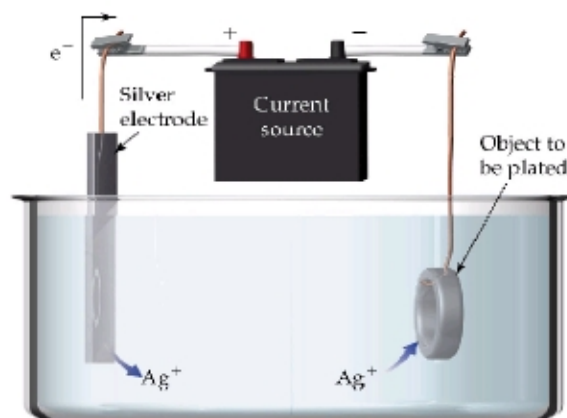


24. Label the cathode
25. Label the anode
26. Write the half reaction which occurs at the cathode

-
27. Write the half reaction which occurs at the anode
-

28. Show the direction of movement of Mg^{+2} ions on the diagram above
29. Show the direction of Zn^{+2} ions on the diagram above
30. Label and show the direction of movement of electrons
31. The diagram at right shows a cell for silver plating jewelry, adding a thin coat of silver on top of a cheaper metal such as steel.

- A. There are two electrodes in the diagram, the silver electrode and the copper wire that holds the object to be plated. Label correctly in the diagram with anode or cathode.
- B. Write the half reaction next to each electrode.
- C. In what two ways does this differ from the other type of cell you have studied?



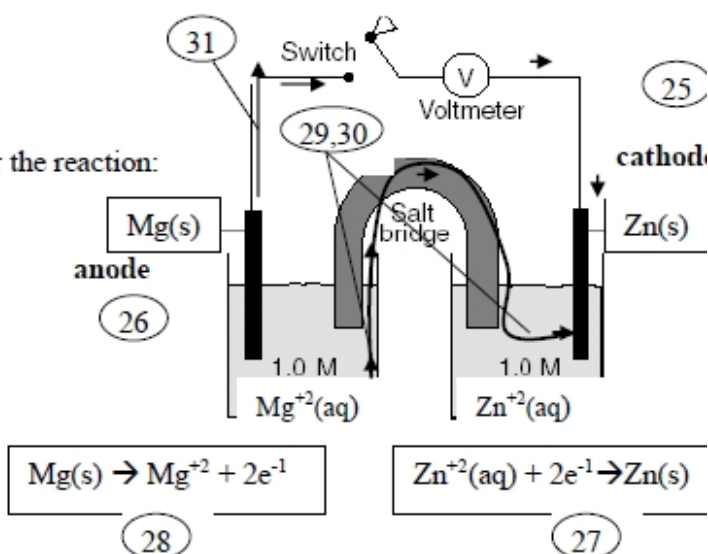
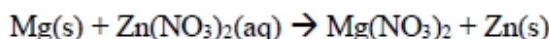
Answers to Electrochemistry: Practice Questions

1. 3 2. 2 4. 2 5. 3 6. 2
 9. 4 11. 2 12. 3
 13. 2 14. 1 15. 2 18. 3
 19. 1

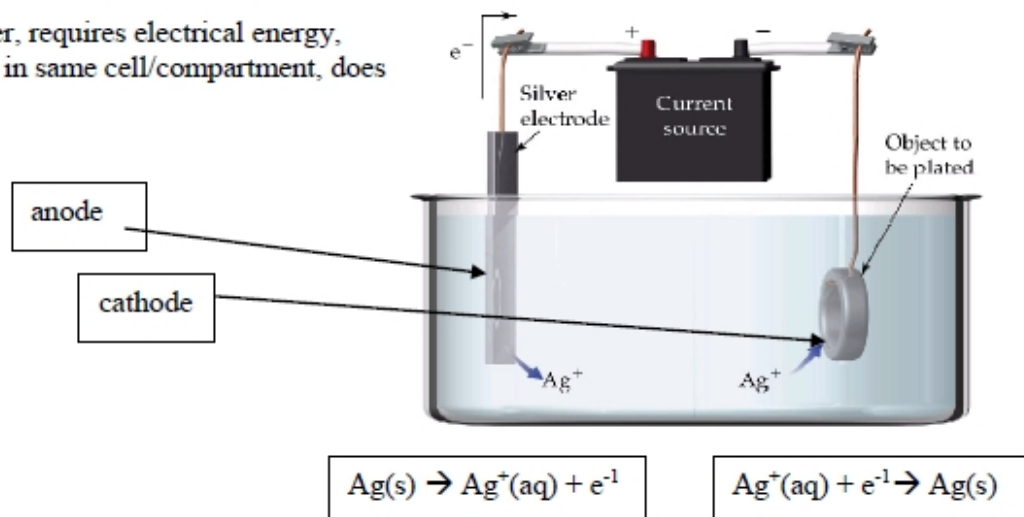
Given the unbalanced reaction: $\text{Au}^{3+}(\text{aq}) + \text{I}^{-}(\text{aq}) \rightarrow \text{Au}(\text{s}) + \text{I}_2(\text{s})$

21. Write the reduction half reaction $\text{Au}^{3+} + 3\text{e}^{-} \rightarrow \text{Au}(\text{s}) \Rightarrow 2\text{Au}^{3+} + 6\text{e}^{-} \rightarrow 2\text{Au}(\text{s})$
 22. Write the oxidation half reaction: $2\text{I}^{-} \rightarrow \text{I}_2(\text{s}) + 2\text{e}^{-} \Rightarrow 6\text{I}^{-} \rightarrow 3\text{I}_2(\text{s}) + 6\text{e}^{-}$
 23. Write the balanced reaction $2\text{Au}^{3+} + 6\text{I}^{-} \rightarrow 3\text{I}_2(\text{s}) + 2\text{Au}(\text{s})$
 24. How many total electrons are transferred when the reaction is balanced? 6 electrons
 (Not 12 electrons! The 6 electrons lost by 6I^{-} are the same ones gained by 2Au^{3+} — don't double count them)

The diagram below represents an electrochemical cell for the reaction:

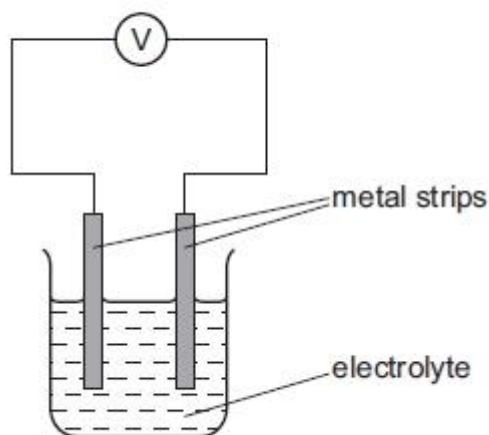


32. D. requires power, requires electrical energy, the cathode and anode are all in same cell/compartment, does have a salt bridge



Q# 1/ iGCSE Chemistry/2016/w/Paper 23/

11 The diagram shows two different metal strips dipped into an electrolyte.



Which pair of metals produces the highest voltage?

- A copper and iron
- B copper and magnesium
- C copper and zinc
- D magnesium and iron

Q# 2/ iGCSE Chemistry/2016/w/Paper 22/

11 A student sets up a number of simple cells by putting strips of two different metals into dilute sulfuric acid.

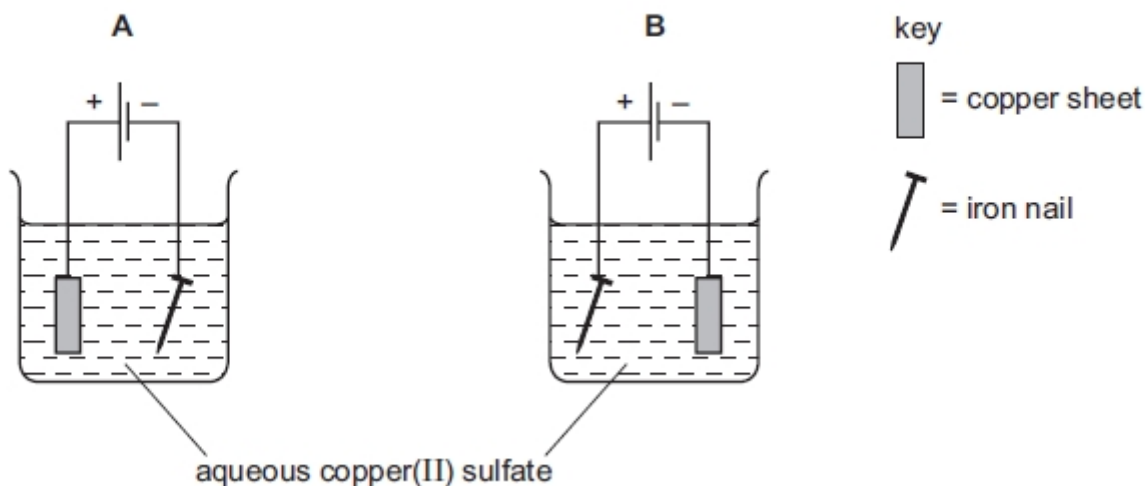
Which cell produces the highest voltage?

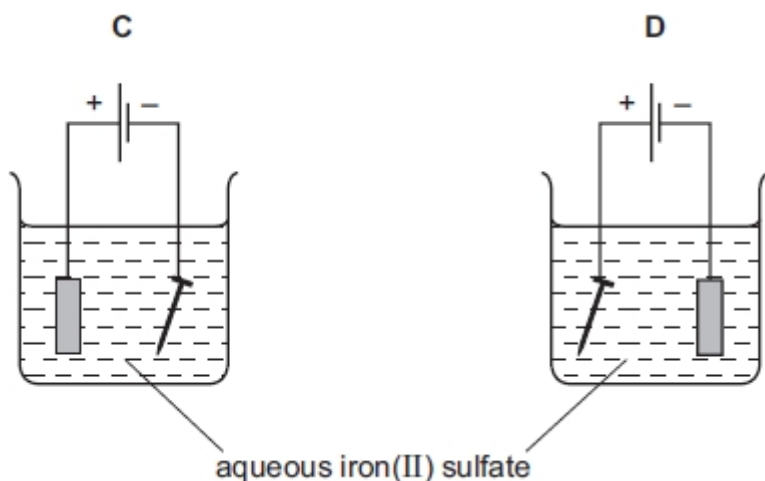
- A copper and magnesium
- B copper and zinc
- C iron and copper
- D magnesium and zinc

Q# 3/ iGCSE Chemistry/2016/w/Paper 21/

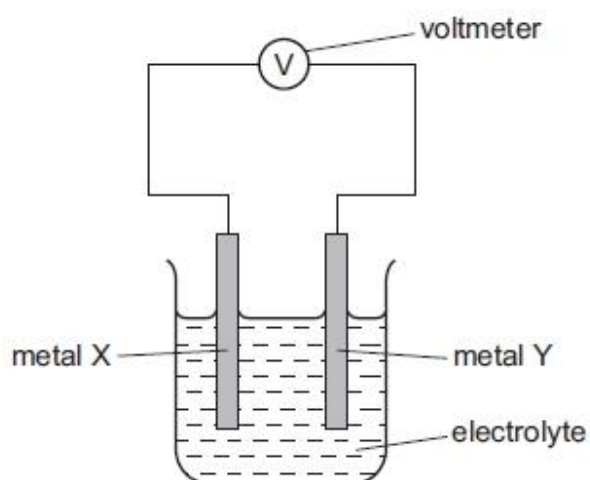
C

10 Which apparatus could be used to electroplate an iron nail with copper?





11 The diagram shows a simple cell.

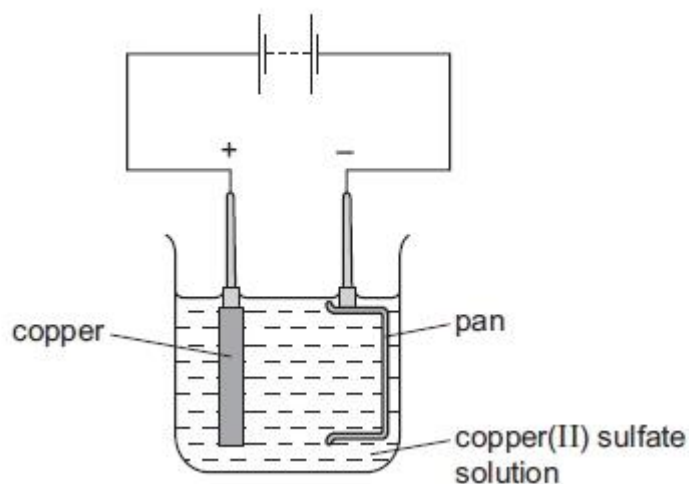


Which two metals produce the highest reading on the voltmeter?

	X	Y
A	magnesium	copper
B	magnesium	iron
C	zinc	copper
D	zinc	iron

Q# 4/ iGCSE Chemistry/2016/s/Paper 23/

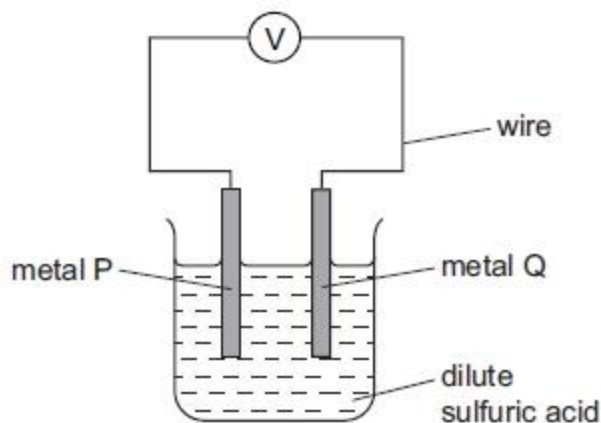
10 The diagram shows a method used to copper-plate a pan



Which equation represents the reaction at the cathode?

- A $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$
- B $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$
- C $4\text{OH}^- \rightarrow \text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^-$
- D $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$

12 The diagram shows a simple cell.

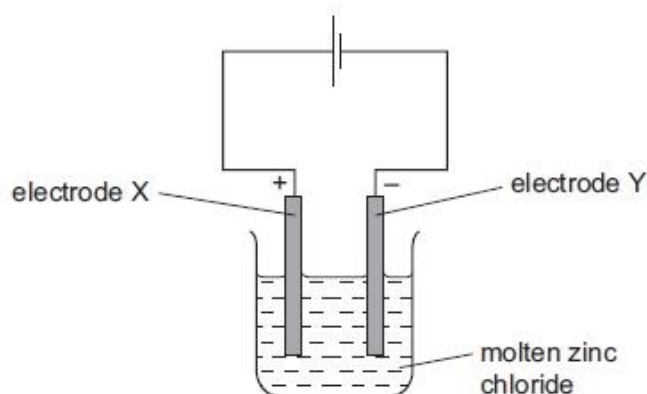


Which pair of metals produces the largest voltage?

	metal P	metal Q
A	iron	copper
B	magnesium	copper
C	magnesium	zinc
D	zinc	copper

Q# 5/ iGCSE Chemistry/2016/s/Paper 22/

10 The diagram shows the electrolysis of molten zinc chloride, ZnCl_2 .

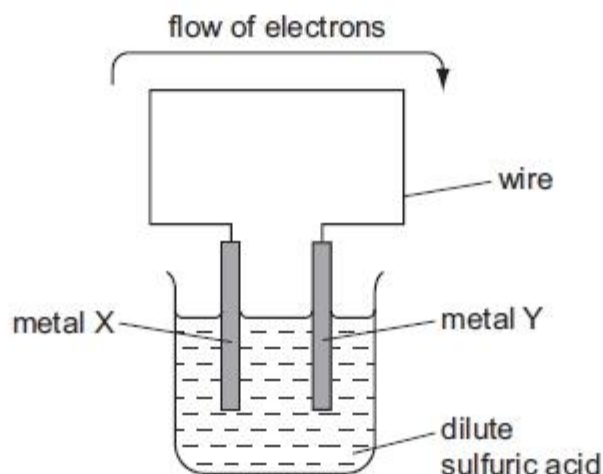


Which statement is correct?

- A Oxidation occurs at electrode X and the equation is: $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$.
- B Oxidation occurs at electrode Y and the equation is: $\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$.
- C Reduction occurs at electrode X and the equation is: $\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$.
- D Reduction occurs at electrode Y and the equation is: $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$.



12 The diagram shows a simple cell.



For which pair of metals would electrons flow from metal X to metal Y?

	X	Y
A	copper	iron
B	copper	zinc
C	iron	zinc
D	zinc	iron

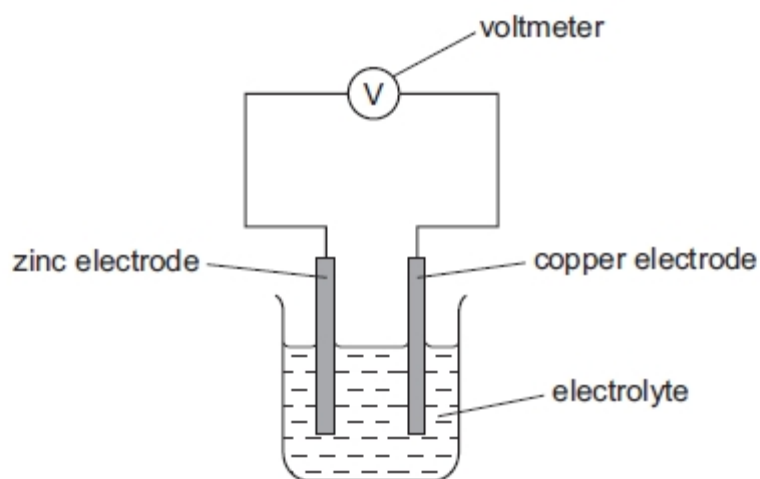
Q# 6/ iGCSE Chemistry/2016/s/Paper 21/

10 Which reactions could take place at the anode during electrolysis?

- 1 $4\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g}) + 4\text{e}^-$
- 2 $2\text{Cl}^-(\text{aq}) \rightarrow \text{Cl}_2(\text{g}) + 2\text{e}^-$
- 3 $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$
- 4 $2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$

A 1 and 2 **B** 1 and 4 **C** 2 and 4 **D** 3 and 4

12 The diagram shows a simple cell.

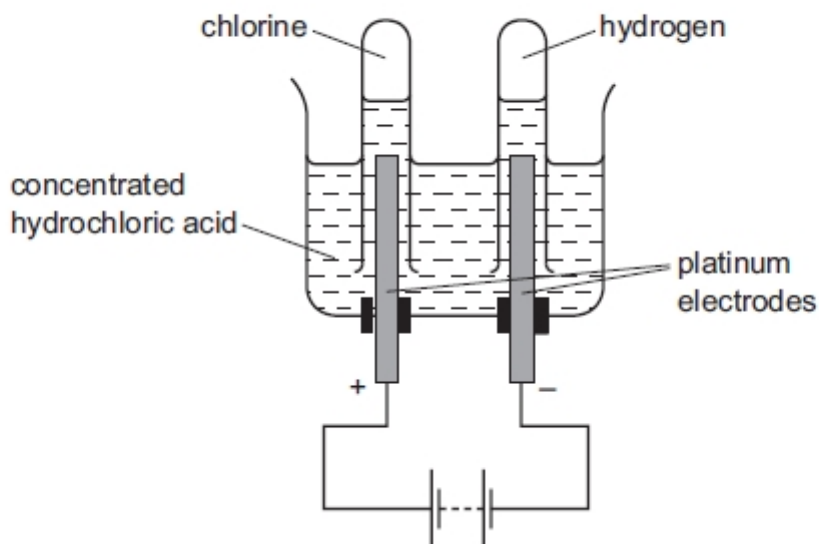


Which statement about the process occurring when the cell is in operation is correct?

- A Cu^{2+} ions are formed in solution.
- B Electrons travel through the solution.
- C The reaction $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$ occurs.
- D The zinc electrode increases in mass.

Q# 7/ iGCSE Chemistry/2016/m/Paper 22/

10 The electrolysis of concentrated hydrochloric acid is shown.



Which statement describes what happens to the electrons during the electrolysis?

- A They are added to chloride ions.
- B They are added to hydrogen ions.
- C They move through the circuit from positive to negative.
- D They move through the solution from negative to positive.

11.7.1 ESSENTIAL EXAM QUESTIONS Paper 2 T5 11marks MARK SCHEME

Q# 1/ iGCSE Chemistry/2016/w/Paper 23/

11 B

Q# 2/ iGCSE Chemistry/2016/w/Paper 22/

10 A

11 A

Q# 3/ iGCSE Chemistry/2016/w/Paper 21/

10 A

11 A

Q# 4/ iGCSE Chemistry/2016/s/Paper 23/

10 A

12 B

Q# 5/ iGCSE Chemistry/2016/s/Paper 22/

10 A

12 D

Q# 6/ iGCSE Chemistry/2016/s/Paper 21/

10 A 12 C

Q# 7/ iGCSE Chemistry/2016/m/Paper 22/

10 B

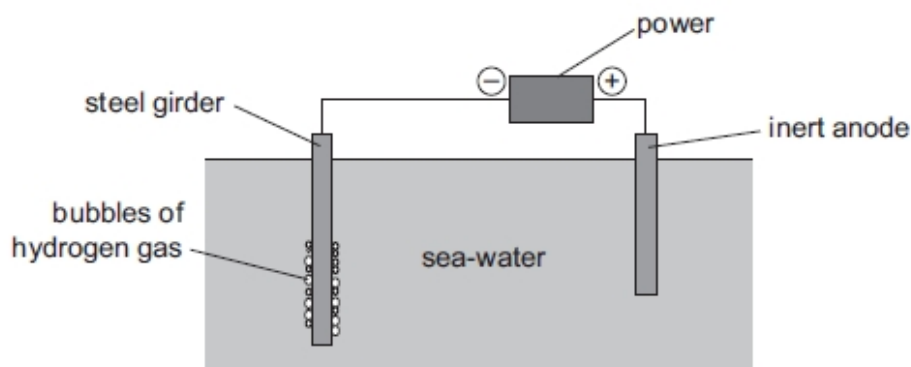


Q# 1/ iGCSE Chemistry/2014/w/Paper 31/ Q4

(d) There are two electrochemical methods of rust prevention.

(i) The first method is sacrificial protection.

The second method is to make the steel article the cathode in a circuit for electrolysis.



(ii) Mark on the diagram the direction of the electron flow. [1]

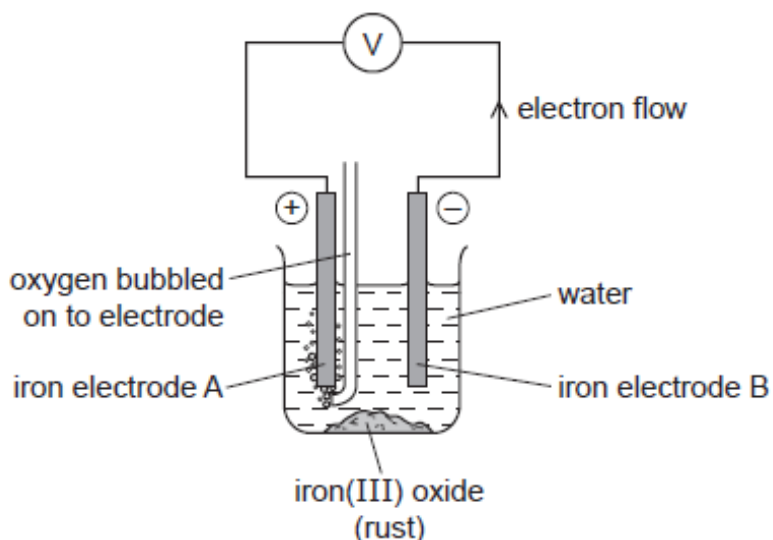
(iii) The steel girder does not rust because it is the cathode. Reduction takes place at the cathode. Give the equation for the reduction of hydrogen ions.

..... [2]

Q# 2/ iGCSE Chemistry/2012/s/Paper 31/

8 Iron and steel rust when exposed to water and oxygen. Rust is hydrated iron(III) oxide.

(a) The following cell can be used to investigate rusting.



(i) What is a cell?

..... [2]



(ii) Which electrode will be oxidised and become smaller? Explain your choice.

.....
.....
..... [3]

(iii) What measurements would you need make to find the rate of rusting of the electrode you have chosen in (ii)?

.....
..... [2]

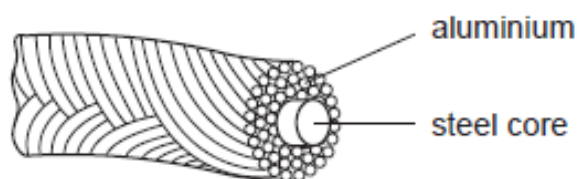
(iv) Suggest an explanation why the addition of salt to the water increases the rate of rusting.

..... [1]

Q# 3/ iGCSE Chemistry/2011/w/Paper 31/ Q3

(c) The uses of a metal are determined by its properties.

(ii) Explain why overhead electrical power cables are made from aluminium with a steel core.



.....
.....
..... [3]

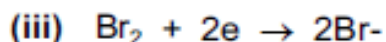
Q# 4/ iGCSE Chemistry/2011/s/Paper 31/ Q2 (a)

(ii) Name a device which can change chemical energy into electrical energy.

..... [2]

Q# 5/ iGCSE Chemistry/2010/w/Paper 31/Q3

This equation is needed for the question that follows:



(vi) When a solution of bromine is replaced by a solution of chlorine, the voltage increases. When a solution of bromine is replaced by a solution of iodine, the voltage decreases.

Suggest an explanation for this difference.

.....
..... [1]

Q# 6/ iGCSE Chemistry/2010/w/Paper 31/ Q5 (b)

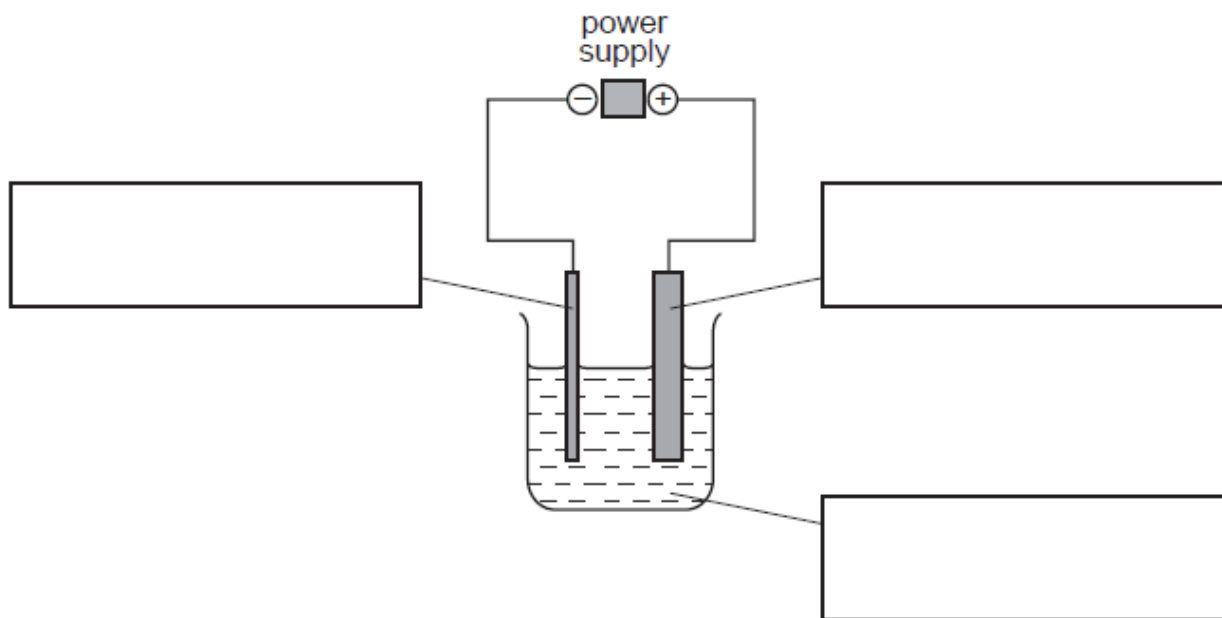


(iii) Describe an industrial method of making chlorine.

[2]

Q# 7/ iGCSE Chemistry/2010/w/Paper 31/ Q2c

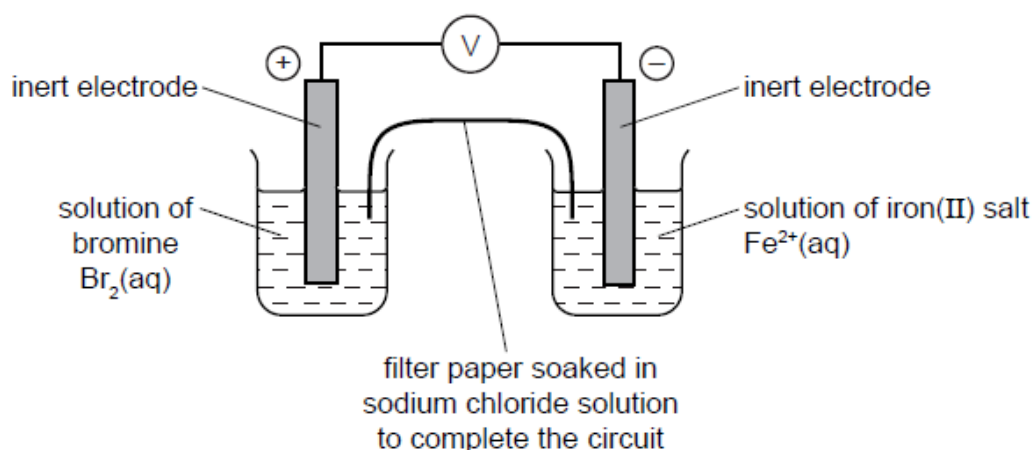
(iii) Copper oxide is reduced to copper which is then refined by electrolysis.
Label the diagram of the apparatus which could be used to refine copper.



[3]

Q# 8/ iGCSE Chemistry/2010/w/Paper 31/

3 The diagram shows a cell. This is a device which produces electrical energy. The reaction in a cell is a redox reaction and involves electron transfer.



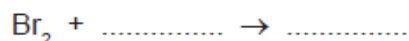
(i) Complete the sentence.

A cell will change energy into electrical energy. [1]

(ii) Draw an arrow on the diagram to show the direction of the electron flow. [1]



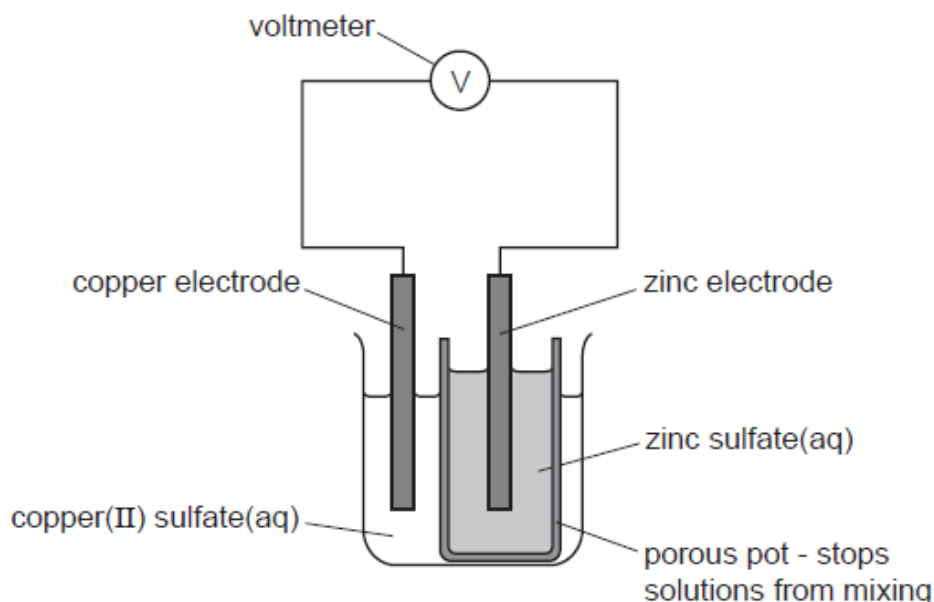
- (iii) In the left hand beaker, the colour changes from brown to colourless.
Complete the equation for the reaction.



[2]

Q# 9/ iGCSE Chemistry/2009/w/Paper 3/ Q3

- (c) Zinc electrodes have been used in cells for many years, one of the first was the Daniel cell in 1831.



- (i) Give an explanation for the following in terms of atoms and ions.

observation at zinc electrode – *the electrode becomes smaller*

explanation
..... [1]

observation at copper electrode – *the electrode becomes bigger*

explanation
..... [1]

- (ii) When a current flows, charged particles move around the circuit.

What type of particle moves through the electrolytes?

..... [1]

Which particle moves through the wires and the voltmeter?

..... [1]



2 The results of experiments on electrolysis using inert electrodes are given in the table.

Complete the table; the first line has been completed as an example.

electrolyte	change at negative electrode	change at positive electrode	change to electrolyte
molten lead(II) bromide	lead formed	bromine formed	used up
.....	potassium formed	iodine formed	used up
dilute aqueous sodium chloride	.....	.....	..... .....
aqueous copper(II) sulfate	.....	.....	..... .....
.....	hydrogen formed	bromine formed	potassium hydroxide formed

[Total: 8]

5 The electrolysis of concentrated aqueous sodium chloride produces three commercially important chemicals hydrogen, chlorine and sodium hydroxide.

(a) The ions present are $\text{Na}^+(\text{aq})$, $\text{H}^+(\text{aq})$, $\text{Cl}^-(\text{aq})$ and $\text{OH}^-(\text{aq})$.

(i) Complete the ionic equation for the reaction at the negative electrode (cathode).



(ii) Complete the ionic equation for the reaction at the positive electrode (anode).



(iii) Explain why the solution changes from sodium chloride to sodium hydroxide.

..... [1]



3 Copper is purified by electrolysis.

(a) Complete the following.

The positive electrode (anode) is made from

The negative electrode (cathode) is made from

The electrolyte is aqueous [3]

(b) Write an ionic equation for the reaction at the positive electrode (anode).

..... [2]

Q# 13/ iGCSE Chemistry/2007/w/Paper 3/ Q4

(c) The remaining zinc oxide reacts with sulphuric acid to give aqueous zinc sulphate. This is electrolysed with inert electrodes (the electrolysis is the same as that of copper(II) sulphate with inert electrodes).

ions present: $\text{Zn}^{2+}(\text{aq})$ $\text{SO}_4^{2-}(\text{aq})$ $\text{H}^+(\text{aq})$ $\text{OH}^-(\text{aq})$

(i) Zinc forms at the negative electrode (cathode). Write the equation for this reaction.

..... [1]

(ii) Write the equation for the reaction at the positive electrode (anode).

..... [2]

(iii) The electrolyte changes from aqueous zinc sulphate to

..... [1]

Q# 14/ iGCSE Chemistry/2007/w/Paper 3/



6 The alcohols form a homologous series. The first four members are methanol, ethanol, propan-1-ol and butan-1-ol.

(a) One characteristic of a homologous series is that the physical properties vary in a predictable way. The table below gives the heats of combustion of the first three alcohols.

alcohol	formula	heat of combustion in kJ/mol
methanol	CH ₃ OH	-730
ethanol	CH ₃ -CH ₂ -OH	-1370
propan-1-ol	CH ₃ -CH ₂ -CH ₂ -OH	-2020
butan-1-ol	CH ₃ -CH ₂ -CH ₂ -CH ₂ -OH	

(i) The minus sign indicates that there is less chemical energy in the products than in the reactants. What form of energy is given out by the reaction?

..... [1]

(ii) Is the reaction exothermic or endothermic?

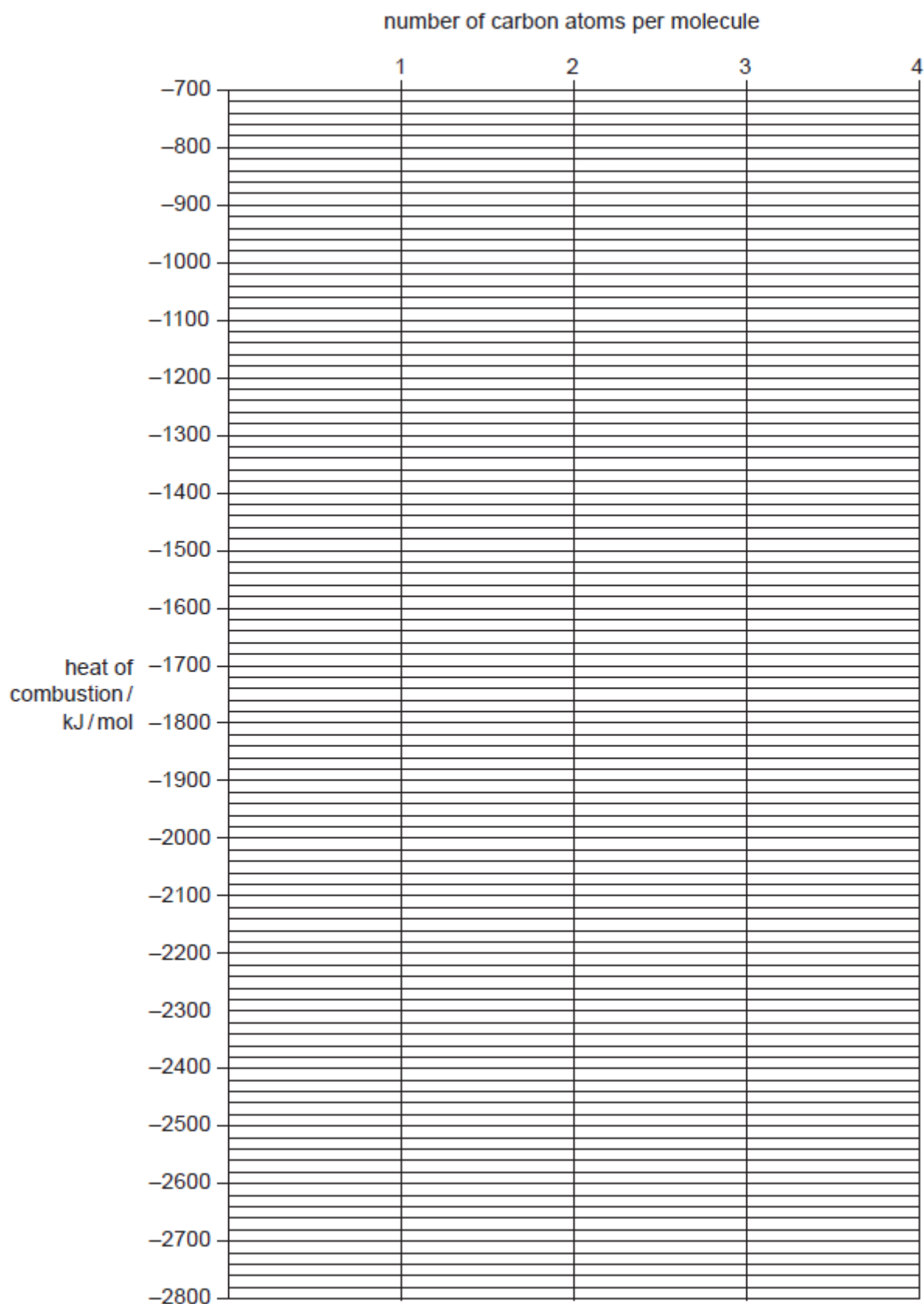
..... [1]

(iii) Complete the equation for the complete combustion of ethanol.

C₂H₅OH + O₂ → + [2]



- (iv) Determine the heat of combustion of butan-1-ol by plotting the heats of combustion of the first three alcohols against the number of carbon atoms per molecule.



The heat of combustion of butan-1-ol = kJ/mol [3]



(b) Impure copper is extracted from the ore. This copper is refined by electrolysis.

- (i) Name;
the material used for the positive electrode (anode),

.....

the material used for the negative electrode (cathode),

.....

a suitable electrolyte.

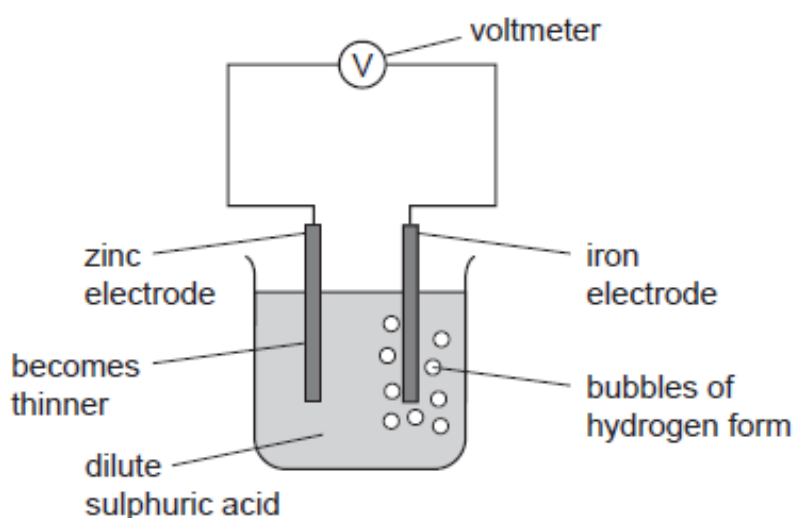
..... [3]

- (ii) Write an ionic equation for the reaction at the negative electrode.

..... [1]

(c) Cell reactions are both exothermic and redox. They produce electrical energy as well as heat energy.

- (i) The diagram shows a simple cell.



Which substance in this cell is the reductant and which ion is the oxidant?

reductant

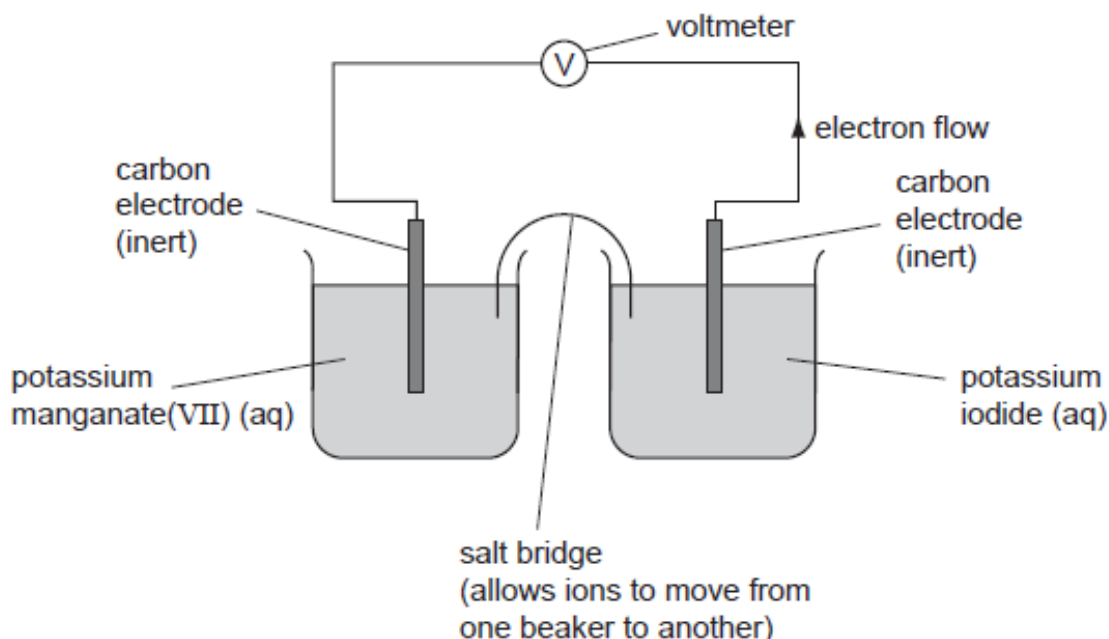
oxidant [2]

- (ii) How could the voltage of this cell be increased?

..... [1]



(d) Cells can be set up with inert electrodes and the electrolytes as oxidant and reductant.



The potassium manganate(VII) is the oxidant and the potassium iodide is the reductant.

(i) Describe the colour change that would be observed in the left hand beaker.

..... [2]

(ii) Write an ionic equation for the reaction in the right hand beaker.

..... [2]

Q# 17/ iGCSE Chemistry/2005/w/Paper 3/ Q5

(c) The major ore of strontium is its carbonate, SrCO_3 . Strontium is extracted by the electrolysis of its molten chloride.

(ii) The electrolysis of molten strontium chloride produces strontium metal and chlorine. Write ionic equations for the reactions at the electrodes.

negative electrode (cathode)

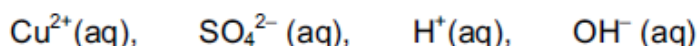
positive electrode (anode) [2]

(iii) One of the products of the electrolysis of concentrated aqueous strontium chloride is chlorine. Name the other two.

..... [2]



- (b) Aqueous copper(II) sulphate solution can be electrolysed using carbon electrodes. The ions present in the solution are as follows.



- (i) Write an ionic equation for the reaction at the negative electrode (cathode).

[1]

- (ii) A colourless gas was given off at the positive electrode (anode) and the solution changes from blue to colourless.

Explain these observations.

[2]

- (c) Aqueous copper(II) sulphate can be electrolysed using copper electrodes. The reaction at the negative electrode is the same but the positive electrode becomes smaller and the solution remains blue.

- (i) Write a word equation for the reaction at the positive electrode.

[1]

- (ii) Explain why the colour of the solution does not change.

[2]

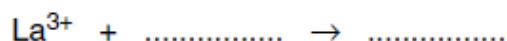
- (iii) What is the large scale use of this electrolysis?

[1]

- 5 The first three elements in Period 6 of the Periodic Table of the Elements are caesium, barium and lanthanum.

- (b) All three metals can be obtained by the electrolysis of a molten halide. The electrolysis of the aqueous halides does not produce the metal.

- (i) Complete the equation for the reduction of lanthanum ions at the negative electrode (cathode).



- (ii) Name the three products formed by the electrolysis of aqueous caesium bromide.

[4]



Q# 20/ iGCSE Chemistry/2003/s/Paper 3/

1 No one knows where iron was first isolated. It appeared in China, the Middle East and in Africa. It was obtained by reducing iron ore with charcoal.

- (e) One of the methods used to prevent iron or steel from rusting is to electroplate it with another metal, such as tin. Complete the following.

The anode is made of

The cathode is made of

The electrolyte is a solution of

[3]

Q# 21/ iGCSE Chemistry/2002/w/Paper 3/ Q4

- (b) Copper is refined by the electrolysis of aqueous copper(II) sulphate using copper electrodes. Describe the change that occurs at the electrodes.

(i) cathode (pure copper)
.....[1]

(ii) anode (impure copper)
.....[1]

(iii) Write an ionic equation for the reaction at the cathode.
.....[1]

- (iv) If carbon electrodes are used, a colourless gas is given off at the anode and the electrolyte changes from a blue to a colourless solution.

The colourless gas is

The solution changes into [2]

- (c) Electrolysis and cells both involve chemical reactions and electricity.

What is the essential difference between them?

.....
.....[2]

Q# 22/ iGCSE Chemistry/2002/s/Paper 3/

3 A major food retailer in the UK is going to distribute sandwiches using hydrogen-powered vehicles.

- (c) Outline how hydrogen is manufactured from water.

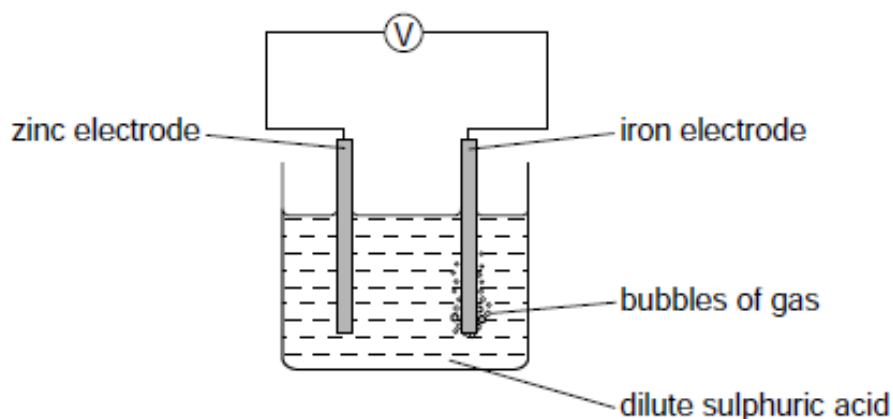
.....
.....[2]



- (ii) The main impurity in the nickel is copper. What technique is used to purify copper after it has been separated from the nickel?

.....[1]

- (e) The diagram below represents a simple cell.



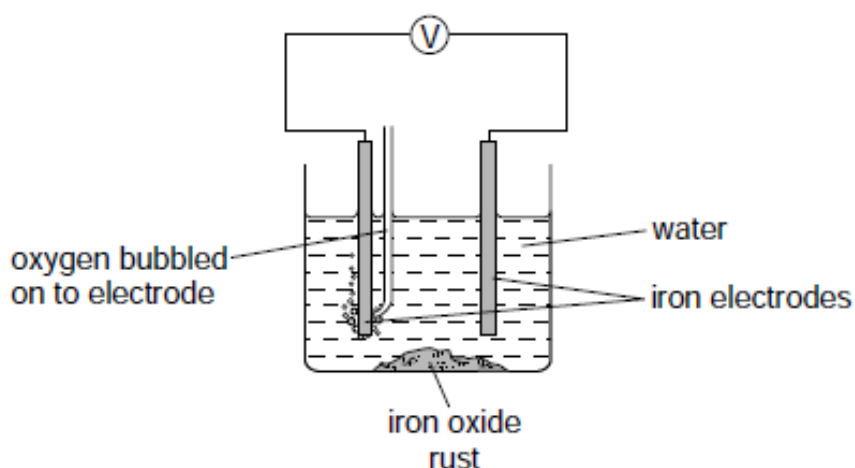
- (i) Write an ionic equation for the reaction that occurs at the zinc electrode.

.....[1]

- (ii) How could the voltage of the cell be increased?

.....[1]

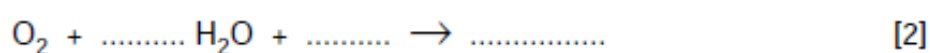
- (f) A different type of cell is drawn below.



- (i) The pH of the solution increases. Give the name of the ion formed.

.....[1]

- (ii) Complete the equation that represents the formation of this ion.



11.9 ESSENTIAL EXAM QUESTIONS T5 Paper 3/4 Mark Scheme

Q# 1/ iGCSE Chemistry/2014/w/Paper 31/ Q4 (d)

(ii) R to L in wire [1]

(iii) $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$
species (1) balancing (1) [2]

Q# 2/ iGCSE Chemistry/2012/s/Paper 31/

8 (a) (i) device which changes chemical energy; [1]
into electrical energy; [1]

OR

produces a voltage / potential difference / electricity; [1]

due to difference in reactivity of two metals; [1]

OR

produces a voltage / potential difference / electricity; [1]

by redox reactions; [1]

(ii) negative / electrode B / right electrode; [1]

accept: anode because it is the electrode which supplies electrons to external circuit

loses ions / iron ions / Fe^{2+} or Fe^{3+} ; [1]

electrons move from this electrode; [1]

(iii) change of mass of electrode / mass of rust formed; [1]

time / mention of stop watch / regular intervals; [1]

(iv) to make it a better conductor; [1]

Q# 3/ iGCSE Chemistry/2011/w/Paper 31/ Q3

(ii) aluminium low density / light [1]

aluminium is a good conductor [1]

strength / prevent sagging / allows greater separation of pylons / core made of steel because it is strong [1]

Q# 4/ iGCSE Chemistry/2011/s/Paper 31/ Q2 (a)

(ii) cell [1]

accept battery

not generator

Q# 5/ iGCSE Chemistry/2010/w/Paper 31/

(vi) any correct discussion of the reactivity of the halogens [1]

e.g. the more reactive the halogen the higher the voltage

not better conductor

Q# 6/ iGCSE Chemistry/2010/w/Paper 31/ Q5 (b)

(iii) electrolysis [1]

aqueous sodium chloride [1]

Q# 7/ iGCSE Chemistry/2010/w/Paper 31/ Q2

(c) (i) tin(IV) oxide + carbon $\rightarrow$ tin + carbon dioxide [1]

not carbon monoxide as a reductant

accept carbon monoxide as a product

not tin(IV)

accept correct symbol equation

(ii) water [1]

carbon dioxide [1]



- (iii) correct labels for
 (pure) copper cathode [1]
 impure copper anode [1]
 electrolyte copper(II) sulfate / any soluble copper(II) salt / Cu^{2+} [1]
 if labels on electrodes reversed [0]
- (iv) wires / pipes / jewellery / nails / roofing / ammunition / coins / cookware / catalyst / sculpture [1]

Q# 8/ iGCSE Chemistry/2010/w/Paper 31/

- 3 (i) chemical [1]
- (ii) from right to left [1]
 not through salt bridge
- (iii) $\text{Br}_2 + 2\text{e}^- \rightarrow 2\text{Br}^-$ [2]
 for Br^- as product [1]

Q# 9/ iGCSE Chemistry/2009/w/Paper 3/ Q3

- (c) (i) zinc atoms change into ions, (the zinc dissolves) [1]
 copper(II) ions change into atoms, (becomes plated with copper) [1]
- (ii) ions [1]
 electrons [1]

Q# 10/ iGCSE Chemistry/2009/s/Paper 31/

- 2 molten potassium iodide NOT aqueous [1]
- hydrogen [1]
 oxygen [1]
 water used up or solution becomes more concentrated or sodium chloride remains
 NOT no change [1]
 If products are given as hydrogen, chlorine and sodium hydroxide then 2/3
- copper [1]
 oxygen (and water) [1]
 sulfuric acid accept hydrogen sulfate [1]
- aqueous or dilute or concentrated potassium bromide [1]
 accept correct formulae

[Total: 8]

Q# 11/ iGCSE Chemistry/2008/w/Paper 31/

- 5 (a) (i) $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ [1]
- (ii) $2\text{Cl}^- - 2\text{e}^- \rightarrow \text{Cl}_2$ or $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$ [1]
- (iii) Na^+ and OH^- are left [1]
 OR Cl^- removed OH^- left
 NB ions by name or formula essential
 NOT any reaction of Na or Na^+
 NOT Na^+ and OH^- combine



Q# 12/ iGCSE Chemistry/2008/s/Paper 31/

- 3 (a) impure copper [1]
 (pure) copper [1]
ACCEPT any (soluble) copper salt or Cu^{2+} [1]
 if both name and formulae given, both have to be correct
- (b) $\text{Cu} - 2\text{e}^- \rightarrow \text{Cu}^{2+}$ or $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$ [2]
 for having $\text{Cu} \rightarrow \text{Cu}^{2+}$ [1] **ONLY**

Q# 13/ iGCSE Chemistry/2007/w/Paper 3/ Q4

- (c) (i) $\text{Zn}^{2+} + 2\text{e}^- = \text{Zn}$ [1]
- (ii) $4\text{OH}^- - 4\text{e}^- = \text{O}_2 + 2\text{H}_2\text{O}$ [2]
 or $4\text{OH}^- = \text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^-$
 or $2\text{H}_2\text{O} = 4\text{H}^+ + \text{O}_2 + 4\text{e}^-$
 or $2\text{H}_2\text{O} - 4\text{e}^- = 4\text{H}^+ + \text{O}_2$
 oxygen as product [1]
- (iii) sulphuric acid [1]
NOTE there are no alternative answers to the above

Q# 14/ iGCSE Chemistry/2007/w/Paper 3/

- 6 (a) (i) heat (energy) [1]
- (ii) exothermic [1]
- (iii) $\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 = 2\text{CO}_2 + 3\text{H}_2\text{O}$ [2]
 For $\text{CO}_2 + \text{H}_2\text{O}$ **ONLY** [1]
- (iv) plotting points correctly [1]
 straight line [1]
 between -2640 and -2700kJ/mol [1]
NOTE minus sign needed

Q# 15/ iGCSE Chemistry/2006/w/Paper 3/ Q6

- (b) (i) impure copper/blister copper/boulder copper etc [1]
 (pure) copper [1]
 copper sulphate or nitrate or chloride or contains Cu^{2+}aq [1]
- (ii) $\text{Cu}^{2+} + 2\text{e}^- = \text{Cu}$ [1]

Q# 16/ iGCSE Chemistry/2006/s/Paper 3/ Q6

- (c) (i) reductant zinc [1]
 oxidant hydrogen (ions) [1]
- (ii) magnesium instead of zinc or increase concentration of acid [1]
 or copper instead of iron
- (iii) sacrificial protection or stop iron/steel rusting [1]
 or galvanising
- (d) (i) pink or purple [1]
 to colourless or decolourised [1]
NOT red **NOT** clear
- (ii) $2\text{I}^- - 2\text{e}^- = \text{I}_2$ [2]
 unbalanced **ONLY** [1]



Q# 17/ iGCSE Chemistry/2005/w/Paper 3/ Q5(c)

- (ii) $\text{Sr}^{2+} + 2\text{e} = \text{Sr}$ [1]
 $2\text{Cl}^- - 2\text{e} = \text{Cl}_2$ [1]
 or $2\text{Cl}^- = \text{Cl}_2 + 2\text{e}$
- (iii) hydrogen [1] and strontium hydroxide [1] [2]

Q# 18/ iGCSE Chemistry/2004/s/Paper 3/ Q5

- (b) (i) $\text{Cu}^{2+} + 2\text{e} = \text{Cu}$ [1]
- (ii) gas is oxygen [1]
 (copper(II) sulphate) changes to sulphuric acid [1]
 or copper ions removed from solution
- (c) (i) copper atoms - electrons = copper ions [1]
 accept correct symbol equation
- (ii) concentration of copper ions does not change or [1]
 amount or number of copper ions does not change
 copper ions are removed and then replaced [1]
 or copper is transferred from anode to cathode
- (iii) refining copper or plating (core) [1]
 or extraction of boulder copper

Q# 19/ iGCSE Chemistry/2003/s/Paper 3/ Q5

- (b) (i) $\text{La}^{3+} + 3\text{e}^- = \text{La}$ [1]
 (ii) hydrogen [1]
 bromine NOT Bromide [1]
 caesium hydroxide [1]
 ignore any comments about electrodes

Q# 20/ iGCSE Chemistry/2003/s/Paper 3/ Q5 iGCSE Chemistry/201

- (e) anode tin NOT impure time [1]
 cathode iron or steel [1]
 tin salt or tin ions as electrolyte [1]
 NOT oxide or hydroxide or carbonate

Q# 21/ iGCSE Chemistry/2002/w/Paper 3/ Q4

- (b) (i) copper deposited or mass increases [1]
- (ii) copper goes into solution or mass decreases [1]
- (iii) $\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$ [1]
- (iv) oxygen [1]
 sulphuric acid accept hydrogen sulphate [1]
- (c) (ii) cells produce electricity or exothermic or change [1]
 chemical energy into electrical energy
 electrolysis uses it or endothermic or change [1]
 electrical energy into chemical energy



- (c) (steam) and alkane [1]
 heat or catalyst or details of chemistry – forms carbon monoxide/dioxide
 and (hydrogen) [1]
- OR electrolysis [1]
 brine or acidified water
 or hydrogen forms at cathode [1]
- OR carbon/coke [1]
 heat or details of chemistry – forms carbon monoxide/dioxide and
 (hydrogen) [1]

- (ii) electrolysis [1]

- (e) (i) $\text{Zn} - 2\text{e} \Rightarrow \text{Zn}^{2+}$ [1]
- (ii) Higher reactivity metal instead of Zn
 or lower instead of iron or bigger difference in reactivity or increase concentration of
 acid [1]
- (f) (i) hydroxide [1]
- (ii) $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e} \Rightarrow 4\text{OH}^-$ [2]
 unbalanced only [1]
 $\text{O}_2 + 2\text{H}_2\text{O} + 2\text{Fe} \rightarrow 2\text{Fe}(\text{OH})_2$ [2]

11.10 FUNDAMENTAL Assessed Activity 1 Keyword Test

English	Meaning
anion	
anode	
brine	
cathode	
cation	
electrochemical cell	
electrode	
electrolysis	
electrolyte	



electrolytic cell	
electroplating	

11.11 ESSENTIAL Assessed Activity 2 Multiple Choice T5 16marks

Q# 1

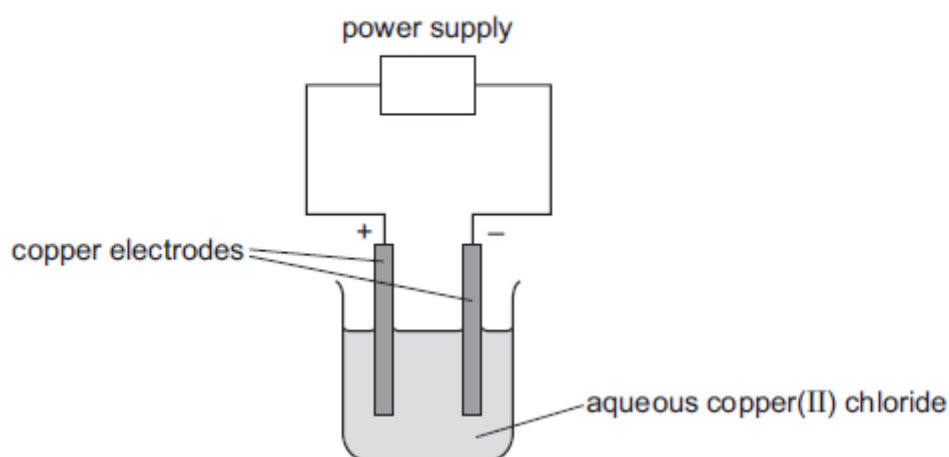
10 Electrolysis of copper(II) sulfate can be done using either carbon electrodes or copper electrodes.

Which statement describes what happens at the positive electrode?

- A Copper is deposited if the electrode is made from carbon.
- B Copper is deposited if the electrode is made from copper.
- C Oxygen gas is produced if the electrode is made from carbon.
- D Oxygen gas is produced if the electrode is made from copper.

Q# 2/

10 Concentrated aqueous copper(II) chloride is electrolysed using copper electrodes as shown.



What happens to the mass of each electrode during this process?

	positive electrode	negative electrode
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases



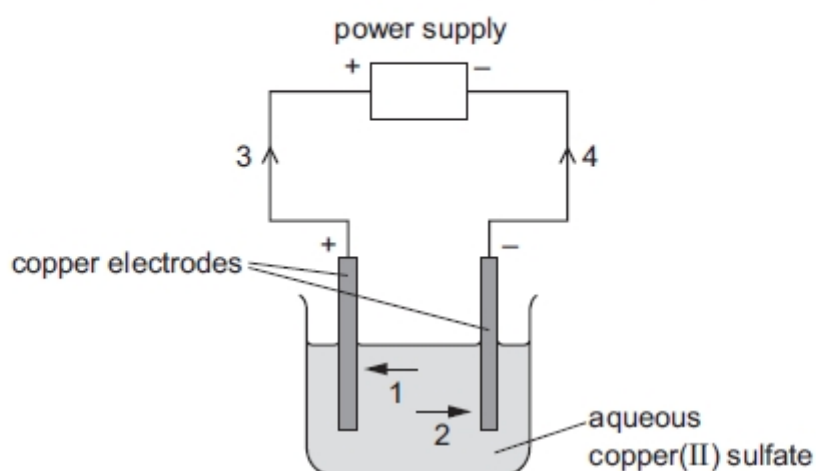
Q# 3/

10 Aqueous copper(II) sulfate is electrolysed using carbon electrodes.

What is the product at each electrode?

	product at the positive electrode	product at the negative electrode
A	copper	oxygen
B	hydrogen	oxygen
C	oxygen	copper
D	oxygen	hydrogen

11 The diagram shows a circuit used to electrolyse aqueous copper(II) sulfate.



Which arrows indicate the movement of the copper ions in the electrolyte and of the electrons in the external circuit?

	copper ions	electrons
A	1	3
B	1	4
C	2	3
D	2	4

Q# 4/

10 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

Which statement is correct?

- A Oxygen gas is produced at the positive electrode.
- B The blue colour of the solution gradually fades.
- C The concentration of copper ions in the solution stays the same.
- D The mass of the negative electrode decreases.



Q# 5/

10 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

Which statement about the electrolysis is **not** correct?

- A An oxidation reaction occurs at the positive electrode.
- B The current is carried through the electrolyte by ions.
- C The negative electrode gains mass.
- D The number of copper(II) ions in the electrolyte decreases.

Q# 6/

10 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

Which statement is correct?

- A A reduction reaction occurs at the positive electrode.
- B The blue colour of the solution becomes darker.
- C The concentration of copper ions in the solution decreases.
- D The mass of the negative electrode increases.

11 Dilute sulfuric acid is electrolysed using inert electrodes.

What are the ionic half-equations for the reactions that take place at each electrode?

	positive electrode	negative electrode
A	$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$	$4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$
B	$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$	$4\text{OH}^- + 4\text{H}^+ \rightarrow 4\text{H}_2\text{O}$
C	$4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$	$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$
D	$4\text{OH}^- + 4\text{H}^+ \rightarrow 4\text{H}_2\text{O}$	$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$

Q# 7/

10 Which substance is **not** produced during the electrolysis of concentrated aqueous sodium chloride?

- A chlorine
- B hydrogen
- C sodium
- D sodium hydroxide

11 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

What are the ionic half-equations for the reactions that occur at each electrode?

	anode	cathode
A	$\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$	$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$
B	$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$	$\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$
C	$4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$	$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$
D	$4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$	$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$



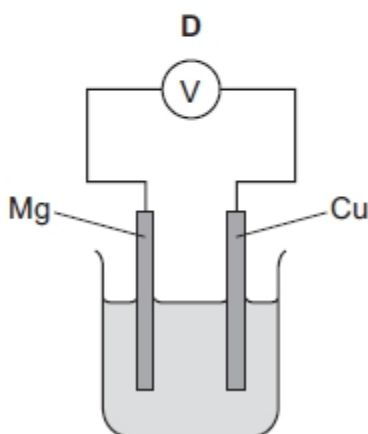
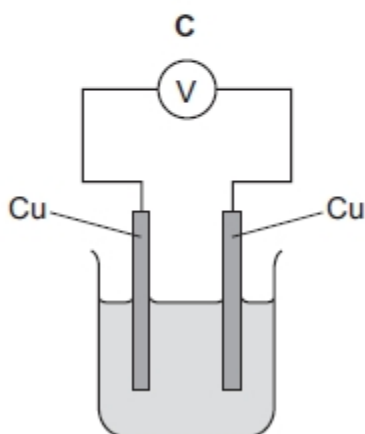
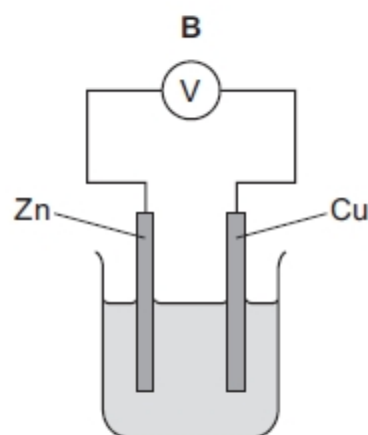
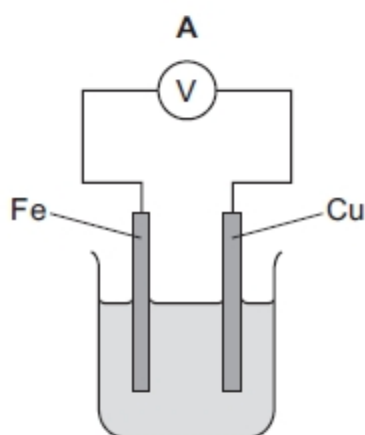
Q# 8/

9 Which statements about the electrolysis of concentrated copper(II) chloride are correct?

- 1 Electrons are transferred from the cathode to the copper(II) ions.
- 2 Electrons move round the external circuit from the cathode to the anode.
- 3 Chloride ions are attracted to the anode.
- 4 Hydroxide ions transfer electrons to the cathode.

A 1 and 3 B 1 and 4 C 2 and 3 D 2 and 4

10 Which metal combination produces the highest voltage reading in the cells shown?



Q# 9/

9 Which statement about electrolysis is correct?

- A Electrons move through the electrolyte from the cathode to the anode.
- B Electrons move towards the cathode in the external circuit.
- C Negative ions move towards the anode in the external circuit.
- D Positive ions move through the electrolyte towards the anode during electrolysis.

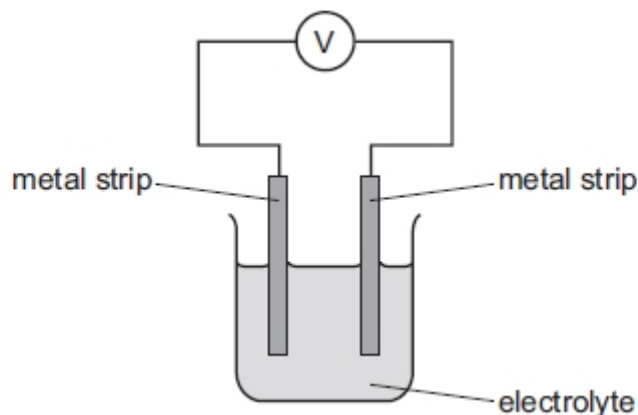


Q# 10/

10 The reactivity series for a number of different metals is shown.

most reactive			least reactive		
magnesium	zinc	iron	copper	silver	platinum

The diagram shows different metal strips dipped into an electrolyte.

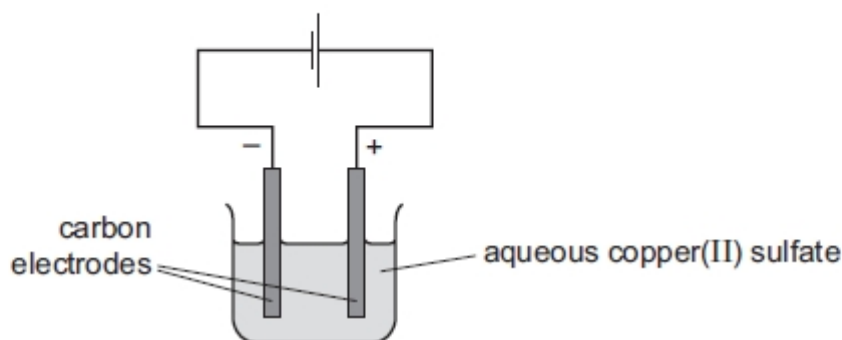


Which pair of metals produces the highest voltage?

- A copper and magnesium
- B magnesium and platinum
- C magnesium and zinc
- D silver and platinum

Q# 11/

10 The diagram shows the electrolysis of aqueous copper(II) sulfate.



Which statement is correct?

- A Copper metal is deposited at the positive electrode.
- B In the external circuit the electrons move from positive to negative.
- C In the solution the electrons move from negative to positive.
- D Oxygen gas is produced at the positive electrode.



11 Four solutions are separately electrolysed.

experiment	solution	electrodes
1	dilute aqueous sodium chloride	carbon
2	aqueous copper(II) sulfate	copper
3	concentrated hydrochloric acid	carbon
4	dilute sulfuric acid	carbon

In which two experiments is a colourless gas evolved at the anode?

- A 1 and 2 B 1 and 4 C 2 and 3 D 3 and 4

11.12 EXTENTION Assessed Activity 3 T5 Longer answer questions 21marks
Q# 1/

(b) The ions present in aqueous sodium chloride are $\text{Na}^+(\text{aq})$, $\text{Cl}^-(\text{aq})$, $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$.

The electrolysis of concentrated aqueous sodium chloride forms three products. They are hydrogen, chlorine and sodium hydroxide.

(i) Explain how these **three** products are formed. Give ionic equations for the reactions at the electrodes.

.....

.....

.....

.....

..... [4]

(ii) If the solution of the electrolyte is stirred, chlorine reacts with sodium hydroxide to form sodium chlorate(I), sodium chloride and water.
Write an equation for this reaction.



[2]



Q# 2/

7 Aluminium is obtained from purified alumina, Al_2O_3 , by electrolysis.

(b) Describe the extraction of aluminium from alumina. Include the electrolyte, the electrodes and the reactions at the electrodes.

.....

.....

.....

.....

.....

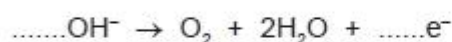
.....

.....

..... [6]

(c) Aluminium is resistant to corrosion. It is protected by an oxide layer on its surface. The thickness of this oxide layer can be increased by anodising.

(ii) Anodising is an electrolytic process. Dilute sulfuric acid is electrolysed with an aluminium object as the anode. The thickness of the oxide layer is increased. Complete the equations for the reactions at the aluminium anode.



Q# 3/

(b) Chlorine is made by the electrolysis of concentrated aqueous sodium chloride. Describe this electrolysis. Write ionic equations for the reactions at the electrodes and name the sodium compound formed.

.....

.....

.....

.....

.....

..... [5]



11.13 Extension Mind Map for Topic 5 Electrochemistry



11.14 Essential End of Topic 5 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?



11.15 Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus

Michael Faraday, for a long while he was on the back of the UK 20 pound note (who was recently replaced by the artist J. M. W. Turner, [click here to find out more about the artist](#)). Einstein famously said that Faraday was the greatest experimental scientist in history and kept a picture of him in his study (Gleeson-White, Jane (10 November 2003). *"Einstein's Heroes (book review)"*. *The Sydney Morning Herald*. Retrieved 24 October 2017.). It's been suggested that it was Faraday's work on invisible magnetic fields allowed Einstein to create his ideas on how gravity is able to curve space-time which he explores in his theories on special and general relativity.



Who was Michael Faraday and what did he discover?

To find out more about electricity you can go here:

<https://www.chemguide.co.uk/inorganic/electrolysismenu.html#top>

And read this Wikipedia article which can be found here:

<https://www.smashingsciencecn.org/igcse-chem-additional-resources>



12 Topic 6 Chemical Energetics

12.1 End of Topic 6 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTENSION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTENSION
	Scored over 95%		SMASHING!!!



Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book <u>you enjoy</u> (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book <u>you enjoy</u> in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book <u>you enjoy</u> in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

12.2 Topic 6 Syllabus

6 Chemical energetics

6.1 Energetics of a reaction

Core

- Describe the meaning of *exothermic* and *endothermic* reactions
- Interpret energy level diagrams showing exothermic and endothermic reactions

Supplement

- Describe bond breaking as an endothermic process and bond forming as an exothermic process
- Draw and label energy level diagrams for exothermic and endothermic reactions using data provided
- Calculate the energy of a reaction using bond energies

6.2 Energy transfer

Core

- Describe the release of heat energy by burning fuels
- State the use of hydrogen as a fuel
- Describe radioactive isotopes, such as ^{235}U , as a source of energy

Supplement

- Describe the use of hydrogen as a fuel reacting with oxygen to generate electricity in a fuel cell. (Details of the construction and operation of a fuel cell are **not** required.)



12.3 ESSENTIAL Glossary for Keywords for Topic 6

Topic #	English	Chinese
6	activation energy (EA) the energy required to start a chemical reaction – for a reaction to take place the colliding particles must possess at least this amount of energy	活化能 (EA), 用于启动化学反应所需的能量 -为了发生反应, 碰撞的粒子必须至少具有此能量
6	bond energy the energy required to break a particular type of covalent bond	键能打破特定类型的共价键所需的能量
6	burning is a combustion reaction which produces a flame	燃烧是产生火焰的燃烧反应
6	catalyst a substance which increases the rate of a chemical reaction but itself remains unchanged at the end of the reaction	催化剂一种增加化学反应速率但在反应结束时本身保持不变的物质
6	collision theory a theory which states that a chemical reaction takes place when particles for the reactants collide with sufficient energy to initiate the reaction	碰撞理论一种理论, 该理论指出, 当反应物的颗粒与足够的能量碰撞以引发反应时, 就会发生化学反应
6	combustion a chemical reaction in which a substance reacts with oxygen – the reaction is exothermic;	燃烧一种化学反应, 其中一种物质与氧气反应 -该反应是放热的;
6	endothermic change a process or chemical reaction which takes in heat from the surroundings; ΔH has a positive value	吸热改变从周围吸收热量的过程或化学反应; ΔH 为正值
6	exothermic change a process or chemical reaction in which heat energy is produced and released to the surroundings; ΔH has a negative value	放热的变化过程或化学反应, 在其中产生热能并释放到周围; ΔH 为负值
6	fuel a substance that can be used as a source of energy, usually by burning (combustion)	燃料通常可以通过燃烧 (燃烧) 用作能源的物质
6	fuel cell a device for continuously converting chemical energy into electrical energy using a combustion reaction; a hydrogen fuel cell uses the reaction between hydrogen and oxygen	燃料电池: 一种通过燃烧反应将化学能连续转换为电能的装置。氢燃料电池利用氢和氧之间的反应
6	fuel cells are electrolytic cells capable of providing a continuous supply of electricity without recharging	燃料电池是能够连续供电而无需充电的电解电池
6	heat of combustion the heat change which takes place when one mole of a substance is completely burnt in oxygen	燃烧热当一摩尔物质在氧气中完全燃烧时发生的热变化
6	heat of reaction the heat change during the course of a reaction; can be either exothermic or endothermic	反应热反应过程中的热变化; 可以是放热的或吸热的
6	kinetic (particle) theory a theory which accounts for the bulk properties of the different states of matter in terms of the movement of particles (atoms or molecules) – the theory explains what happens during changes in physical state	动力学 (粒子) 理论, 根据粒子 (原子或分子) 的运动解释物质不同状态的整体性质的理论 -该理论解释了物理状态变化时发生的情况

12.4 ESSENTIAL Classroom Active Learning Tasks 1 Drawing AND Interpreting Graphs for Paper 6

Q# 4/ iGCSE Chemistry/2017/w/Paper 63/Q2



- 2 A student investigated what happened to the temperature when two different solids, **W** and **X**, dissolved in water.

Two experiments were carried out.

Experiment 1

- Using a measuring cylinder, 30 cm³ of distilled water were poured into a polystyrene cup. The initial temperature of the water was measured at time = 0 seconds.
- Solid **W** was added to the water, a timer was started and the solution was stirred with a thermometer.
- The temperature of the solution was measured every 10 seconds for 90 seconds.

(a) Use the thermometer diagrams to record the temperatures in the table.

time / s	0	10	20	30	40	50	60	70	80	90
thermometer diagram										
temperature of the solution / °C										

[2]

Experiment 2

- The polystyrene cup was emptied and rinsed with water.
- Experiment 1 was repeated using solid **X**.
- The temperature of the solution was measured every 10 seconds for 90 seconds.

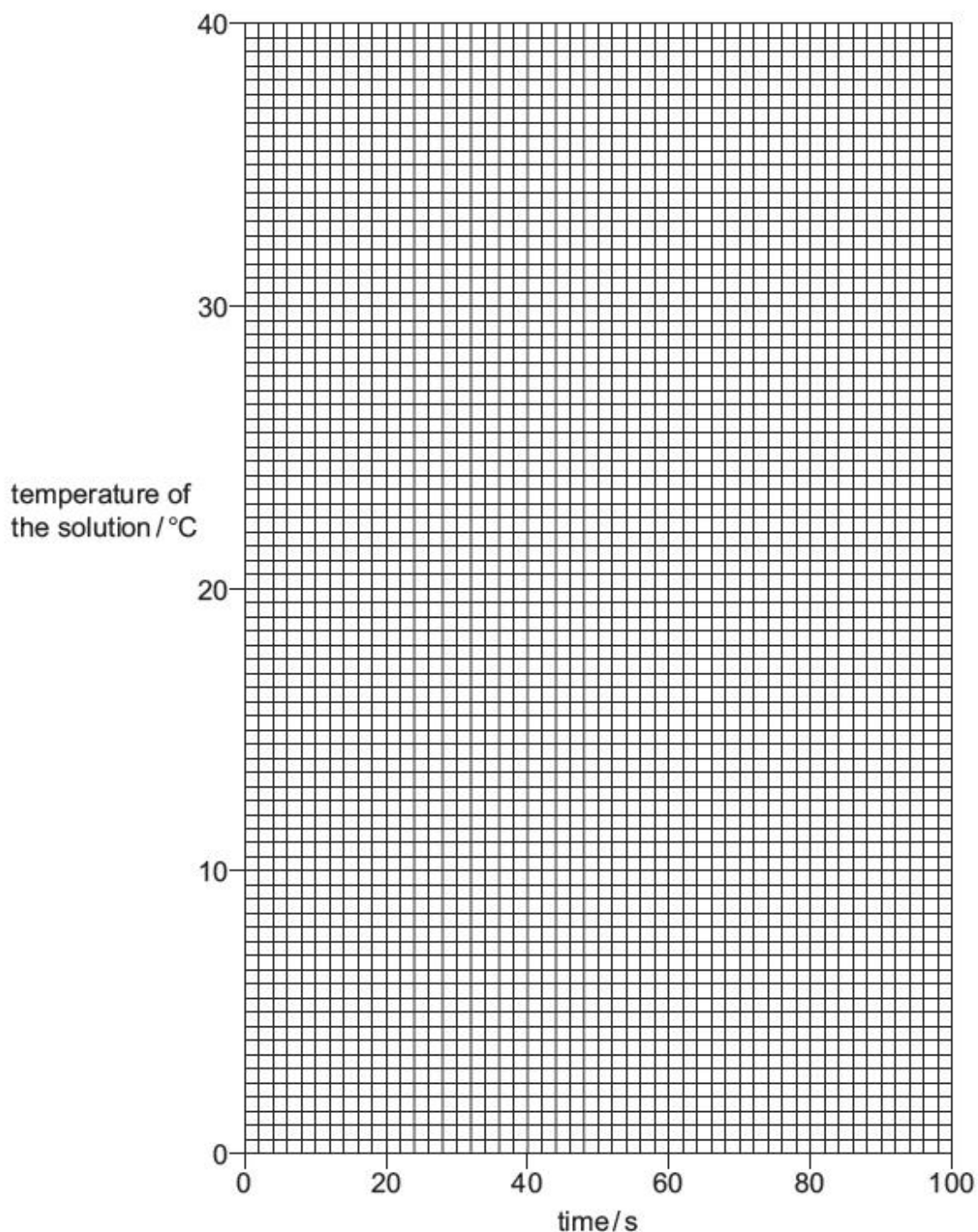
(b) Use the thermometer diagrams to record the temperatures in the table.

time / s	0	10	20	30	40	50	60	70	80	90
thermometer diagram										
temperature of the solution / °C										

[2]



- (c) Plot the results for Experiments 1 and 2 on the grid. Draw **two** smooth line graphs. Clearly label your lines.



[4]

- (d) (i) **From your graph**, deduce the temperature of the solution in Experiment 1 after 15 seconds. Show clearly **on the grid** how you worked out your answer.

..... °C [2]

- (ii) **From your graph**, deduce the time taken for the temperature of the solution in Experiment 2 to change by 6 °C from the initial temperature. Show clearly **on the grid** how you worked out your answer.

..... s [2]

- (e) Use the results to identify the type of energy change that occurs when solid **X** dissolves in water.

..... [1]

- (f) Predict the temperature of the solution in Experiment 2 after 1 hour. Explain your answer.

.....
..... [1]

- (g) State **two** sources of error in these experiments. Give **one** improvement to reduce each of these sources of error.

source of error 1

improvement 1

source of error 2

improvement 2

[4]

- (h) When carrying out the experiments, what would be a disadvantage of taking the temperature readings only every 30 seconds?

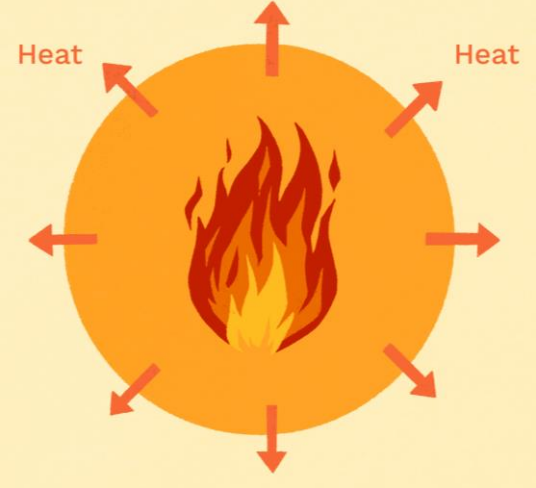
.....
..... [1]



12.5 ESSNETIAL Classroom Active Learning Tasks 2 Endothermic or Exothermic?

Circle or highlight if these processes are either exothermic or endothermic. The first has already been done for you

Q# 1/



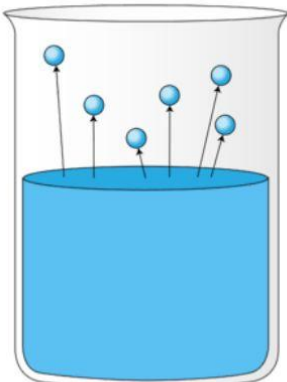
Exothermic or Endothermic?

Q# 2/ Boiling water



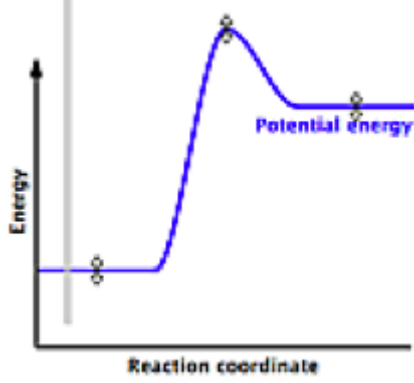
Exothermic or Endothermic?

Q# 3/ **Evaporation**



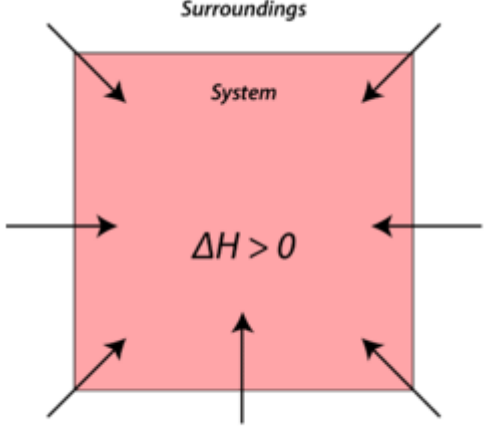
Vapor Pressure < Atmospheric Pressure
Bubbles cannot form

Q# 4/



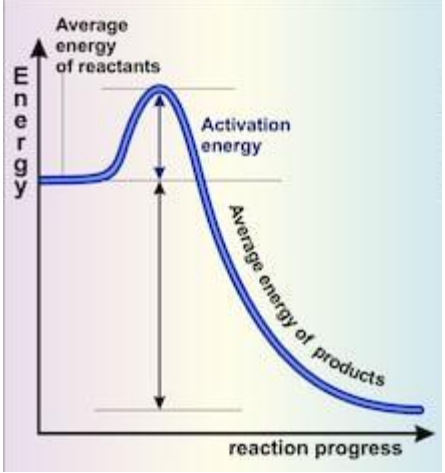
Exothermic or Endothermic?

Q# 5/



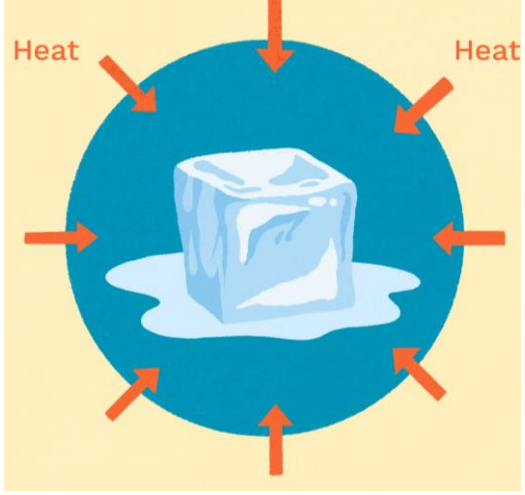
A Surroundings get cooler
Exothermic or Endothermic?

Q# 6/



Exothermic or Endothermic?

Q# 7/

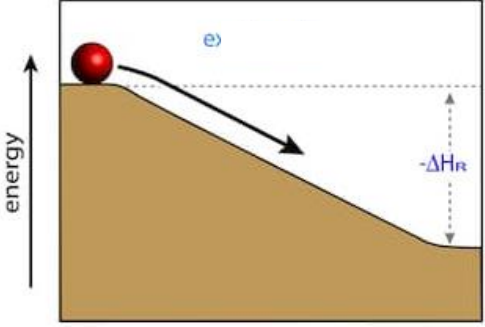
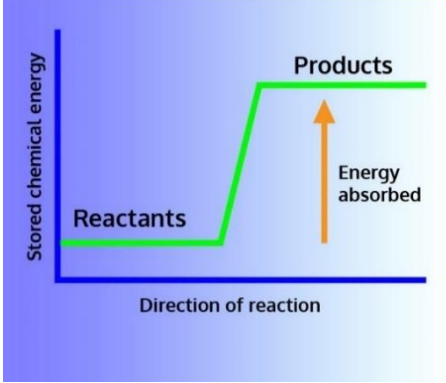
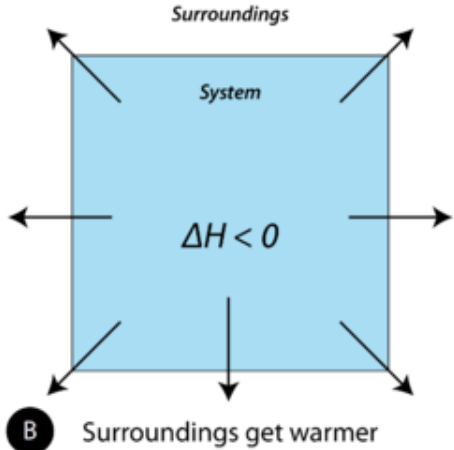
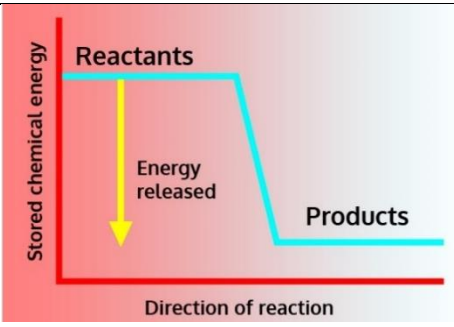


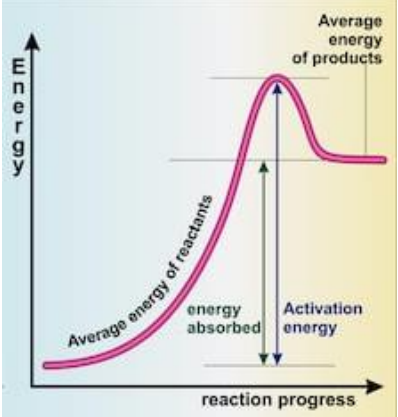
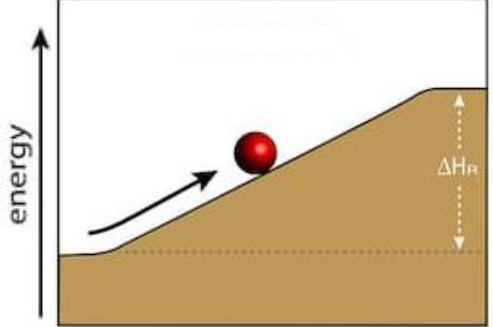
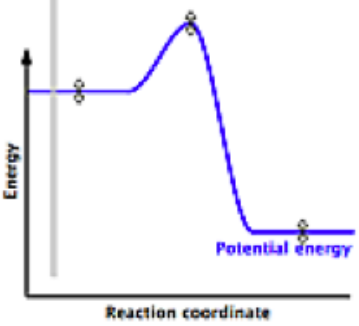
Exothermic or Endothermic?

Q# 8/

$$\text{H}_3\text{C}-\text{CH}_2-\text{OH} + 3\text{O}=\text{O} \longrightarrow \text{O}=\text{C}=\text{O} + \text{O}=\text{C}=\text{O} + \text{H}_2\text{O}$$

Exothermic or Endothermic?

Q# 9/	 Exothermic or Endothermic
Q# 10/	 Exothermic or Endothermic?
Q# 11/	 Exothermic or Endothermic?
Q# 12/	 Exothermic or Endothermic?
Q# 13/	 Exothermic or Endothermic?

Q# 14/	 Exothermic or Endothermic?
Q# 15/	 Exothermic or Endothermic?
Q# 16/	 Exothermic or Endothermic?
Q# 17/	$\text{CaCO}_3(\text{s}) \xrightarrow{\text{Heat}} \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$ Calcium carbonate (Limestone) Calciumoxide (Lime) Carbondioxide Exothermic or Endothermic?
Q# 18/	Acid + Alkali → Salt + Water Exothermic or Endothermic?
Q# 19/	$\text{Br}_2(\text{l}) \rightarrow \text{Br}_2(\text{s})$ Exothermic or Endothermic?
Q# 20/	Sulfuric acid → Sodium sulfate + Sodium hydroxide + Water Exothermic or Endothermic?
Q# 21/	$\text{N}_2(\text{g}) \rightarrow 2\text{N}(\text{g})$ Exothermic or Endothermic?
Q# 22/	$\text{Hg}(\text{l}) \rightarrow \text{Hg}(\text{g})$ Exothermic or Endothermic?
Q# 23/	$\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{g})$ Exothermic or Endothermic?
Q# 24/	Photosynthesis Exothermic or Endothermic?



Extension Activity: Name the reaction that is being shown, if it could be more than one reaction, name a reaction it could be and try to include the chemical formula

Q#	Q# 1/	Q# 2/	Q# 3/	Q# 4/	Q# 5/	Q# 6/	Q# 7/	Q# 8/	Q# 9/	Q# 10/	Q# 11/	Q# 12/	Q# 13/	Q# 14/	Q# 15/	Q# 16/	Q# 17/	Q# 18/	Q# 19/	Q# 20/	Q# 21/	Q# 22/	Q# 23/	Q# 24/	Q# 25/
Endo/Exo?	Exo	Endo	Endo	Endo	Endo	Exo	Endo	Exo	Exo	Exo	Endo	Exo	Exo	Endo	Endo	Exo	Endo	Exo	Exo	Exo	Endo	Endo	Endo	Endo	Exo

12.6 ESSENTIAL EXAM QUESTIONS Topic 6 Paper 2 31marks Mark Scheme

Q# 1/ iGCSE Chemistry/2018/m/Paper 22/

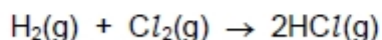
12 10g of ammonium nitrate is added to water at 25 °C and the mixture stirred.

The ammonium nitrate dissolves and, after one minute, the temperature of the solution is 10 °C.

Which word describes this change?

- A endothermic
- B exothermic
- C neutralisation
- D reduction

13 Hydrogen reacts with chlorine according to the following equation.



The reaction is exothermic.

Which statement about this reaction is correct?

- A Energy absorbed for bond breaking is greater than the energy released in bond making.
- B Energy absorbed for bond breaking is less than the energy released in bond making.
- C Energy released in bond breaking is greater than the energy absorbed in bond making.
- D Energy released in bond breaking is less than the energy absorbed in bond making.

14 Hydrogen-oxygen fuel cells can be used to power cars. Platinum is used as a catalyst.

The amount of energy produced per gram is shown for three fuels.

fuel	energy produced per g of fuel/kJ
hydrogen	143
methane	55
petrol	44



Which statement is correct and is an advantage of a hydrogen-oxygen fuel cell?

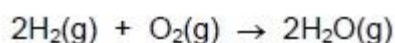
- A Hydrogen is difficult to store.
- B Hydrogen produces less energy per gram than methane or petrol.
- C Platinum is rare and expensive.
- D The only product is water.

Q# 2/ iGCSE Chemistry/2017/w/Paper 23/

11 Some bond energies are shown in the table.

bond	bond energy in kJ/mol
H-H	+436
O=O	+496
H-O	+460

Hydrogen reacts with oxygen. The reaction is exothermic.

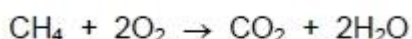


What is the energy change for the reaction?

- A -3208 kJ/mol
- B -908 kJ/mol
- C -472 kJ/mol
- D -448 kJ/mol

Q# 3/ iGCSE Chemistry/2017/w/Paper 22/

11 The equation for the combustion of methane is shown.



The energy change for the combustion of methane is -890 kJ/mol.

The bond energies are shown in the table.

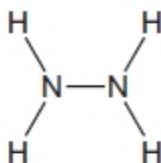
bond	bond energy in kJ/mol
C-H	+410
O=O	+496
H-O	+460

What is the bond energy of the C=O bond?

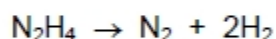
- A +49 kJ/mol B +841 kJ/mol C +1301 kJ/mol D +1335 kJ/mol



11 The compound hydrazine is used as a rocket fuel. It has the structural formula shown.



One of the reactions of hydrazine is shown. This reaction is exothermic.



The bond energies are shown in the table.

	bond energy in kJ/mol
H–H	+436
N–H	+390
N–N	+160
N≡N	+945

What is the energy change for this reaction?

- A –339 kJ/mol B –97 kJ/mol C +97 kJ/mol D +339 kJ/mol

12 Which statement describes an exothermic reaction?

- A The energy absorbed for bond breaking is greater than the energy released by bond formation.
 B The energy absorbed for bond breaking is less than the energy released by bond formation.
 C The energy released by bond breaking is greater than the energy absorbed for bond formation.
 D The energy released by bond breaking is less than the energy absorbed for bond formation.

11 Heat energy is produced when hydrocarbons burn in air.

Which equations represent this statement?

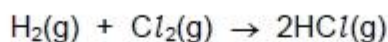
- 1 $\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O}$
 2 $\text{C}_2\text{H}_4 + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 2\text{H}_2\text{O}$
 3 $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$

- A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 and 3 only



13 Hydrogen and chlorine react to form hydrogen chloride.

The reaction is exothermic.



The overall energy change for this reaction is -184 kJ/mol .

The table gives some of the bond energies involved.

bond	bond energy in kJ/mol
H-Cl	+430
H-H	+436

What is the energy of the Cl-Cl bond?

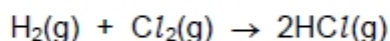
- A -240 kJ/mol
- B -190 kJ/mol
- C $+190 \text{ kJ/mol}$
- D $+240 \text{ kJ/mol}$

Q# 6/ iGCSE Chemistry/2017/s/Paper 22/

11 Which statement about fuels is correct?

- A Heat energy can only be produced by burning fuels.
- B Hydrogen is used as a fuel although it is difficult to store.
- C Methane is a good fuel because it produces only water when burned.
- D Uranium is burned in air to produce energy.

13 The equation for the reaction between hydrogen and chlorine is shown.



The reaction is exothermic.

The bond energies are shown in the table.

bond	bond energy in kJ/mol
Cl-Cl	+240
H-Cl	+430
H-H	+436



What is the energy change for the reaction?

- A -1536 kJ/mol
- B -184 kJ/mol
- C +184 kJ/mol
- D +246 kJ/mol

Q# 7/ iGCSE Chemistry/2017/s/Paper 21/

11 Some properties of four fuels are shown in the table.

Which fuel is a gas at room temperature and makes two products when it burns in a plentiful supply of air?

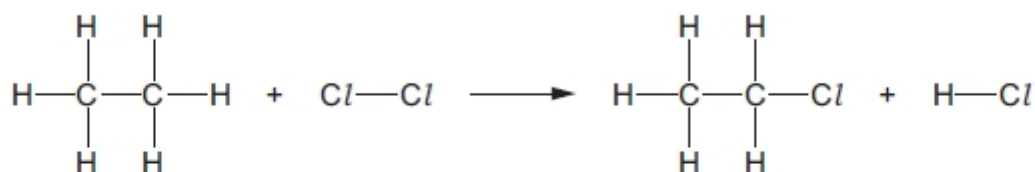
	fuel	formula	melting point /°C	boiling point /°C
A	hydrogen	H ₂	-259	-253
B	methane	CH ₄	-182	-164
C	octane	C ₈ H ₁₈	-57	126
D	wax	C ₃₁ H ₆₄	60	400

12 Which statements about exothermic and endothermic reactions are correct?

- 1 During an exothermic reaction, heat is given out.
- 2 The temperature of an endothermic reaction goes up because heat is taken in.
- 3 Burning methane in the air is an exothermic reaction.

- A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 and 3 only

13 Chlorine reacts with ethane to produce chloroethane and hydrogen chloride.



The reaction is exothermic.

The bond energies are shown in the table.

bond	bond energy in kJ/mol
C-Cl	+340
C-C	+350
C-H	+410
Cl-Cl	+240
H-Cl	+430

What is the energy change for the reaction?

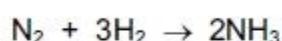
- A -1420 kJ/mol
- B -120 kJ/mol
- C +120 kJ/mol
- D +1420 kJ/mol

Q# 8/ iGCSE Chemistry/2017/m/Paper 22/

12 Ammonia is made by reacting nitrogen with hydrogen in the presence of an iron catalyst.

The reaction is exothermic.

The equation for the reaction is shown.



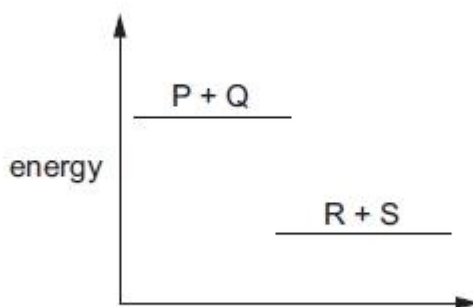
The bond energies are shown in the table.

bond	bond energy in kJ/mol
H-H	436
N-H	390
N≡N	945

What is the energy given out during this reaction?

- A -4593 kJ/mol B -1083 kJ/mol C -959 kJ/mol D -87 kJ/mol

13 The energy level diagram for the reaction between P and Q to form R and S is shown.



Which row describes the energy changes involved and the type of reaction?

	energy changes involved	type of reaction
A	more energy is given out when the bonds in the products are formed than is needed to break the bonds in the reactants	endothermic
B	more energy is given out when the bonds in the products are formed than is needed to break the bonds in the reactants	exothermic
C	more energy is needed to break the bonds in the reactants than is given out when the bonds in the products are formed	endothermic
D	more energy is needed to break the bonds in the reactants than is given out when the bonds in the products are formed	exothermic

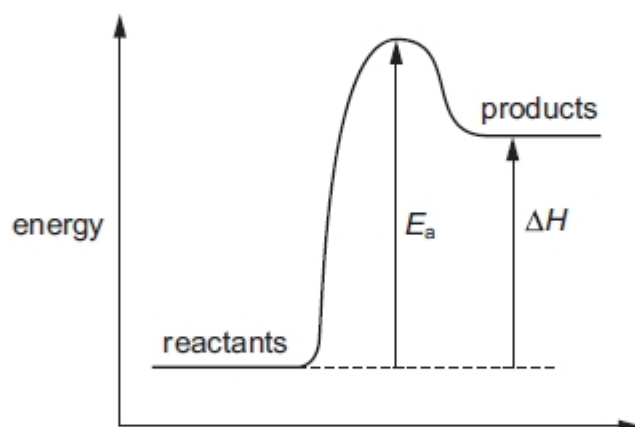


- 12 10g of ammonium nitrate are added to water at 25°C and the mixture stirred. The ammonium nitrate dissolves and, after one minute, the temperature of the solution is 10°C.

Which word describes this change?

- A endothermic
- B exothermic
- C neutralisation
- D reduction

- 13 The energy level diagram for a reaction is shown.



Which row is correct?

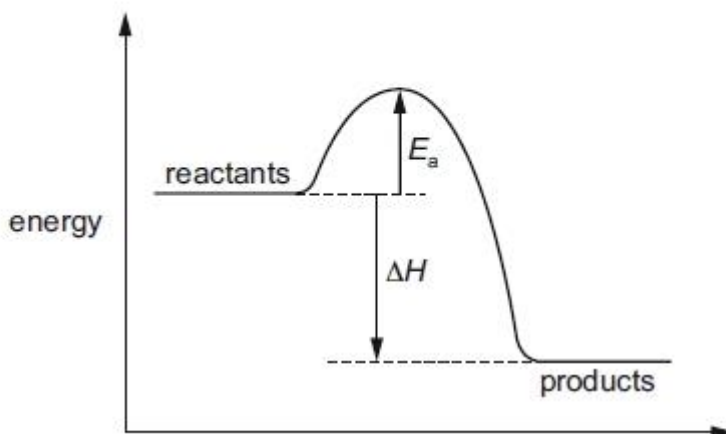
	sign of ΔH	overall energy change	sign of E_a
A	–	exothermic	–
B	+	endothermic	+
C	+	endothermic	–
D	+	exothermic	+

- 12 Which experiment is the most exothermic?

	initial temperature / °C	final temperature / °C
A	20	5
B	20	32
C	25	12
D	25	34



13 The energy level diagram for a reaction is shown.

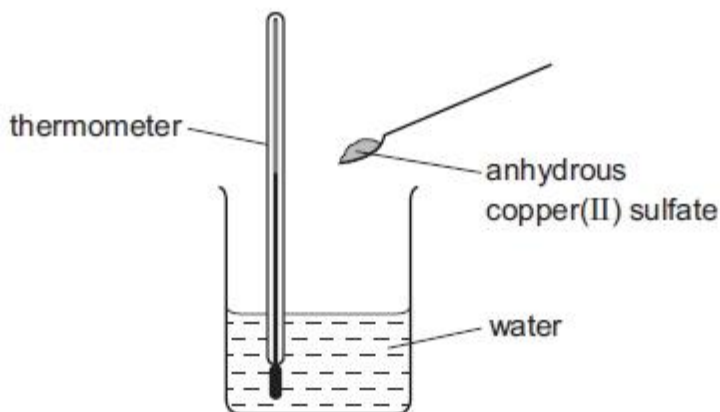


Which row is correct?

	sign of ΔH	overall energy change	sign of E_a
A	–	exothermic	–
B	+	endothermic	+
C	+	endothermic	–
D	–	exothermic	+

Q# 11/ iGCSE Chemistry/2016/w/Paper 21/

12 When anhydrous copper(II) sulfate is added to water a solution is formed and heat is given out.

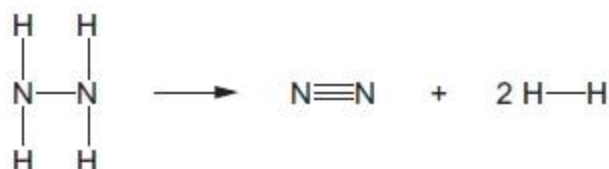


Which row shows the temperature change and the type of reaction taking place?

	temperature change	type of reaction
A	decrease	endothermic
B	decrease	exothermic
C	increase	endothermic
D	increase	exothermic



13 Hydrazine, N_2H_4 , decomposes as shown.



The energy change for this reaction is -95 kJ/mol .

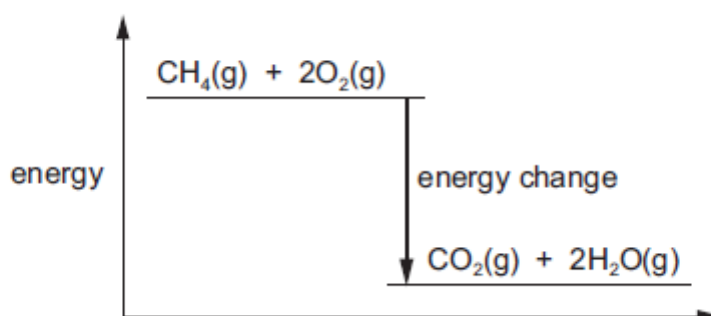
The table shows some bond energies involved.

bond	bond energy in kJ/mol
$\text{N} \equiv \text{N}$	945
$\text{N}-\text{H}$	391
$\text{H}-\text{H}$	436

What is the bond energy of the $\text{N}-\text{N}$ bond?

- A** 158 kJ/mol **B** 315 kJ/mol **C** 348 kJ/mol **D** 895 kJ/mol

13 The energy level diagram for the combustion of methane is shown.



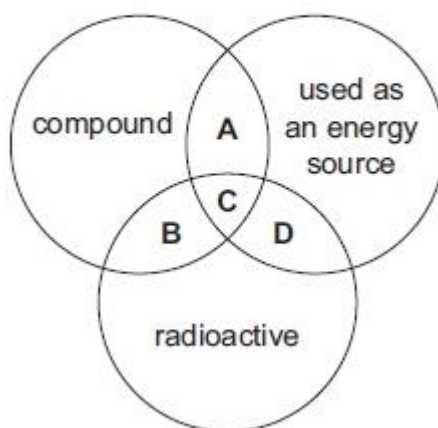
Which row gives the equation and energy change for this reaction?

	equation	energy change in kJ/mol
A	$\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$	+891
B	$\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$	-891
C	$\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$	+891
D	$\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$	-891



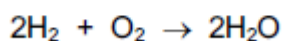
11 The diagram shows some properties that substances may have.

To which labelled part of the diagram does ^{235}U belong?



13 Hydrogen burns exothermically in oxygen.

The equation for the reaction is:



The table shows the bond energies involved.

bond	bond energy in kJ/mol
H–H	436
O=O	498
O–H	464

What is the energy given out during the reaction?

- A –3226 kJ/mol
- B –884 kJ/mol
- C –486 kJ/mol
- D –442 kJ/mol

12 Which substance could **not** be used as a fuel to heat water in a boiler?

- A ethanol
- B hydrogen
- C methane
- D oxygen



13 Which row describes an endothermic reaction?

	energy needed to break bonds /kJ	energy released by forming bonds/kJ	temperature
A	400	200	decreases
B	400	800	decreases
C	600	200	increases
D	600	800	increases

12.6.1 ESSENTIAL EXAM QUESTIONS Topic 6 Paper 2 31marks Mark Scheme

Q# 1/ iGCSE Chemistry/2018/m/Paper 22/

12	A
13	B
14	D

Q# 2/ iGCSE Chemistry/2017/w/Paper 23/

11	C
12	B

Q# 3/ iGCSE Chemistry/2017/w/Paper 22/

11	B
12	B

Q# 4/ iGCSE Chemistry/2017/w/Paper 21/

11	B
12	B

Q# 5/ iGCSE Chemistry/2017/s/Paper 23/

11	D
13	D

Q# 6/ iGCSE Chemistry/2017/s/Paper 22/

11	B
12	C
13	B

Q# 7/ iGCSE Chemistry/2017/s/Paper 21/

11	B
12	C
13	B

Q# 8/ iGCSE Chemistry/2017/m/Paper 22/

12	D
13	B

Q# 9/ iGCSE Chemistry/2016/w/Paper 23/

12	A
13	B

Q# 10/ iGCSE Chemistry/2016/w/Paper 22/

12	B
13	D

Q# 11/ iGCSE Chemistry/2016/w/Paper 21/

12	D
----	---

Q# 12/ iGCSE Chemistry/2016/s/Paper 23/

13	A
----	---

Q# 13/ iGCSE Chemistry/2016/s/Paper 22/

13	B
----	---

Q# 14/ iGCSE Chemistry/2016/s/Paper 21/

11	D
13	C

Q# 15/ iGCSE Chemistry/2016/m/Paper 22/

12	D
13	A



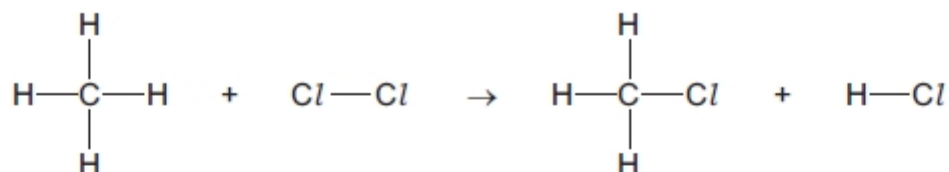
12.7 ESSENTIAL EXAM QUESTIONS T6 Paper 3/4 29marks

Q# 1/ iGCSE Chemistry/2013/w/Paper 31/ Q7

(b) Bond forming is exothermic, bond breaking is endothermic. Explain the difference between an exothermic reaction and an endothermic reaction.

.....
 [2]

(c) Use the bond energies to show that the following reaction is exothermic.
 Bond energy is the amount of energy (kJ/mol) which must be supplied to break one mole of the bond.



Bond energies in kJ/mol

Cl-Cl +242

C-Cl +338

C-H +412

H-Cl +431

bonds broken energy in kJ/mol

.....

.....

total energy =

bonds formed energy in kJ/mol

.....

.....

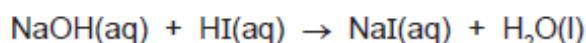
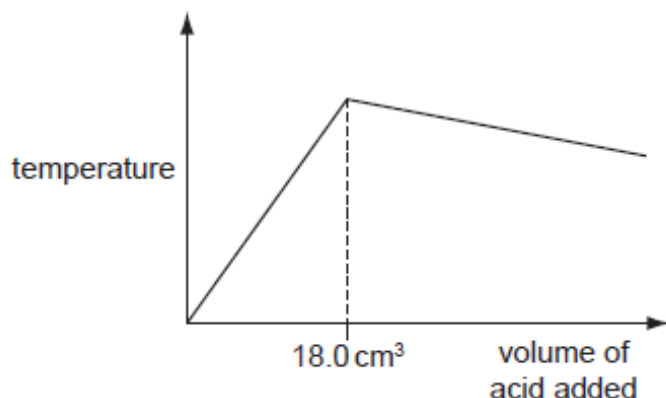
total energy =

.....

..... [4]



- (d) 20.0 cm³ of aqueous sodium hydroxide, 2.00 mol / dm³, was placed in a beaker. The temperature of the alkali was measured and 1.0 cm³ portions of hydriodic acid were added. After each addition, the temperature of the mixture was measured. Typical results are shown on the graph.



- (i) Explain why the temperature increases rapidly at first then stops increasing.

.....
 [2]

- (ii) Suggest why the temperature drops after the addition of 18.0 cm³ of acid.

..... [1]

7 Hydrogen reacts with the halogens to form hydrogen halides.

- (a) Bond energy is the amount of energy, in kJ, that must be supplied (endothermic) to break one mole of a bond.

bond	bond energy in kJ/mol
H—H	+436
Cl—Cl	+242
H—Cl	+431

Use the above data to show that the following reaction is exothermic.



.....

 [3]



6 (a) Exothermic reactions produce heat energy.

An important fuel is methane, natural gas. The equation for its combustion is as follows.



- (i) In chemical reactions bonds are broken and new bonds are formed.
Using this reaction give an example of

a bond that is broken,

a bond that is formed. [2]

- (ii) Explain, using the idea of bonds forming and breaking, why this reaction is exothermic, that is it produces heat energy.

.....
..... [2]

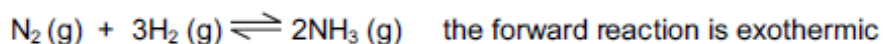
(b) Some radioactive isotopes are used as nuclear fuels.

- (i) Give the symbol and the nucleon number of an isotope that is used as a nuclear fuel.

..... [2]

Q# 5/ iGCSE Chemistry/2005/w/Paper 3/ Q7

- 7 In 1909, Haber discovered that nitrogen and hydrogen would react to form ammonia. The yield of ammonia was 8%.



catalyst platinum
temperature 600 °C
pressure 200 atm

- (c) (i) Complete the following table that describes the bond breaking and forming in the reaction between nitrogen and hydrogen to form ammonia.

bonds	energy change /kJ	exothermic or endothermic
1 mole of $\text{N} \equiv \text{N}$ broken	+945	.....
3 moles of broken	+1308	.....
6 moles of $\text{N} - \text{H}$ formed	-2328	.....

[3]



(ii) Explain, using the above data, why the forward reaction is exothermic.

[2]

Q# 6/ iGCSE Chemistry/2004/s/Paper 3/

1 It was reported from America that a turbine engine, the size of a button, might replace batteries. The engine would be built from silicon which has suitable properties for this purpose.

(a) (i) Why are batteries a convenient source of energy?

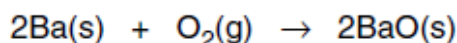
[1]

(ii) The engine will run on a small pack of jet fuel. What other chemical is needed to burn this fuel?

[1]

Q# 7/ iGCSE Chemistry/2003/s/Paper 3/Q5

(f) The reactions of these metals with oxygen are exothermic.



(i) Give an example of bond forming in this reaction.

(ii) Explain using the idea of bond breaking and forming why this reaction is exothermic.

[3]

12.7.1 ESSENTIAL EXAM QUESTIONS Paper 2 29marks Mark Scheme

Q# 1/ iGCSE Chemistry/2013/w/Paper 31/ Q7

(b) exothermic reaction gives out energy [1]
endothermic reaction absorbs [1]
takes in energy

(c) bonds broken	energy	
C-H	+412	
C-I-CI	+242	
total energy	+654	[1]
bonds formed	energy	
C-CI	-338	
H-CI	-431	
total energy	-769	[1]
energy change	-115	[1]
negative sign indicates exothermic		[1]

Q# 2/ iGCSE Chemistry/2011/s/Paper 31/ Q5



- (d) (i) the reaction is exothermic / reaction produces heat/energy [1]
all the sodium hydroxide used up/neutralised / reaction has stopped [1]
- (ii) adding colder acid / no more heat produced [1]
if not given in (d)(i) any comments such as "reaction has stopped" can gain mark

Q# 3/ iGCSE Chemistry/2009/s/Paper 31/

- 7 (a) (total endothermic change = $436 + 242 = +678$ kJ [1]
(total exothermic change = $2 \times 431 = -862$ kJ [1]
accept correct sign/supplied/absorbed for endo etc.
accept correct sign/evolved/produced for exo etc.
change for reaction = -184 kJ [1]
- not necessary to calculate -184 , just show that exo change > than endo
ecf allowed provided negative
 -184 kJ scores all 3 marks

Q# 4/ iGCSE Chemistry/2006/s/Paper 3/

- 6 (a) (i) Any bond that is broken C-H or O=O [1]
Bond that is formed C=O or O-H [1]
Do not insist on double bonds
- (ii) More energy is released forming bonds [1]
than is used breaking bonds [1]
For just - more energy released than used [1]
For - energy is released forming bonds and it is used
breaking bonds [1]
- (b) (i) U [1]
235 [1]

Q# 5/ iGCSE Chemistry/2005/w/Paper 3/ Q7

- (c)(i) H—H [1]
endothermic [1]
endothermic [1]
exothermic
- (ii) More heat given out than taken in [1]
 $-2328 + 945 + 1308 = -75$ (kJ) [1]
- OR** More heat given out bond forming than taken in bond breaking [2]
Must mention bond breaking and forming [2]

Q# 6/ iGCSE Chemistry/2004/s/Paper 3/

1. (a) (i) portable [1]
(ii) oxygen or air [1]

Q# 7/ iGCSE Chemistry/2003/s/Paper 3/Q5

- (f) (i) barium - oxygen or ionic [1]
(ii) bond forming energy released/exothermic [1]
bond breaking energy taken in/endothermic [1]
more energy released [1]



12.8 ESSENTIAL EXAM QUESTIONS Topic 6 Paper 6 75marks

Most of the exam questions on this topic will be found in Paper 6 and relate to drawing graphs using them to get data from the trend line and explaining what they are showing.

Q# 2/ iGCSE Chemistry/2018/s/Paper 63/Q2

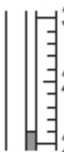
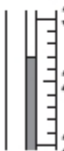
- 2** A student investigated how the temperature changed when aqueous sodium hydroxide reacted with solutions of two different acids, acid **R** and acid **S**.

Two experiments were done.

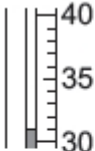
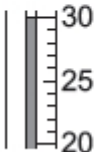
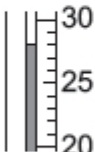
Experiment 1

- A measuring cylinder was used to pour 50 cm³ of aqueous sodium hydroxide into a polystyrene cup. The temperature of the solution was measured.
- A burette was filled up to the 0.0 cm³ mark with acid **R**.
- 5.0 cm³ of acid **R** was added to the aqueous sodium hydroxide in the polystyrene cup and the solution stirred.
- The highest temperature of the solution was measured.
- A further 5.0 cm³ of acid **R** was added to the polystyrene cup and the solution was stirred.
- The highest temperature of the solution was measured.
- Further 5.0 cm³ portions of acid **R** were added to the polystyrene cup until a total volume of 40.0 cm³ of acid **R** had been added. The highest temperature of the solution was measured after each addition.

(a) Use the thermometer diagrams to record the results in the table.

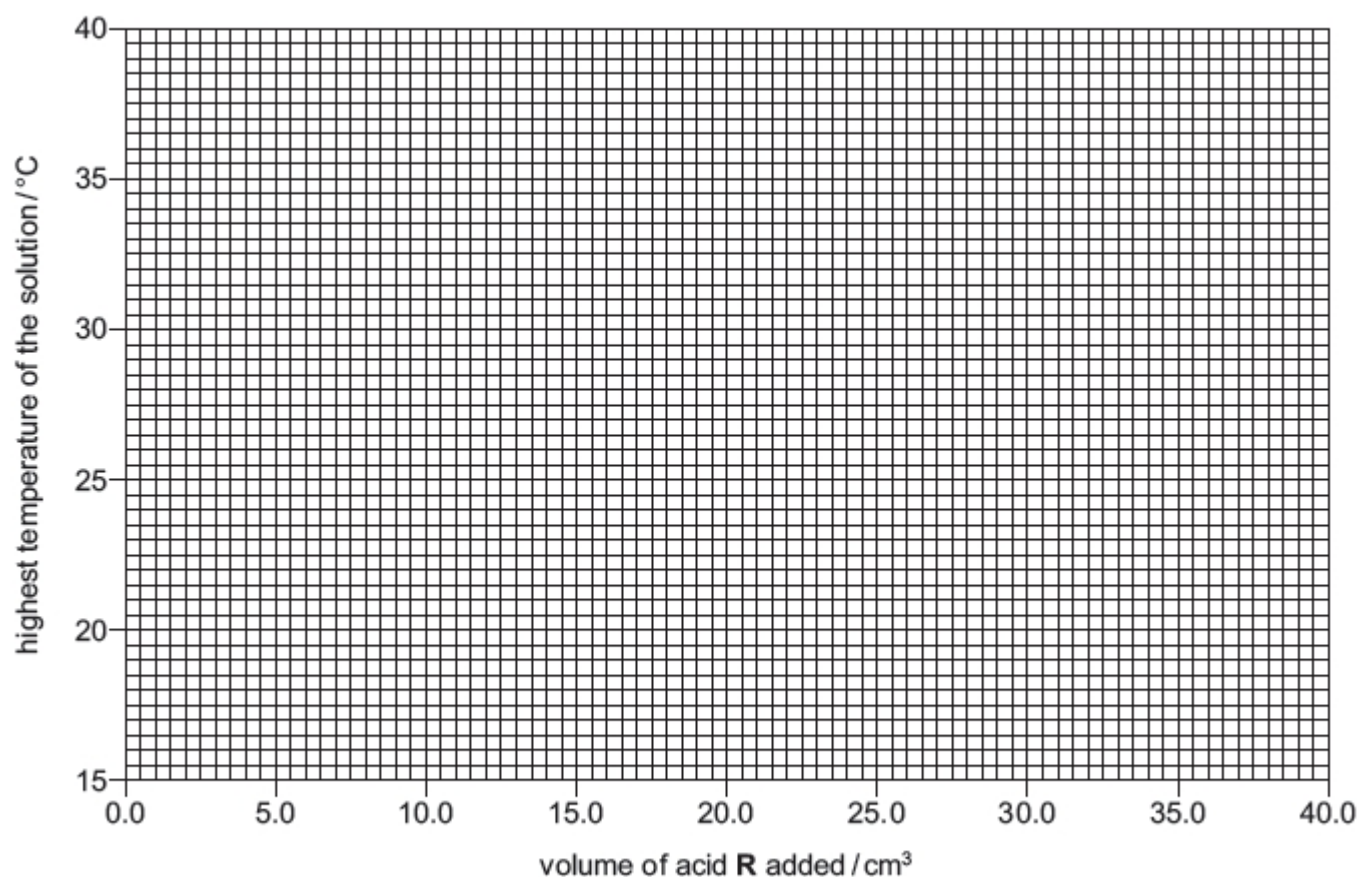
volume of acid R added / cm ³	thermometer diagram	highest temperature of the solution / °C
0.0		
5.0		
10.0		
15.0		
20.0		



25.0		
30.0		
35.0		
40.0		

[2]

(b) Plot the results for Experiment 1 on the grid and draw **two** intersecting straight line graphs.



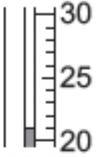
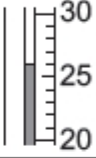
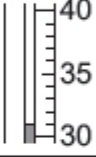
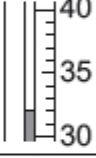
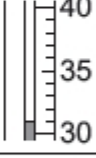
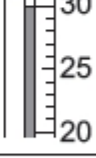
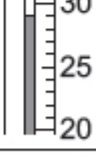
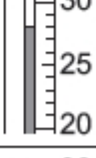
[2]



Experiment 2

- The burette was rinsed with distilled water and then with acid **S**.
- Experiment 1 was repeated but using acid **S** instead of acid **R**.

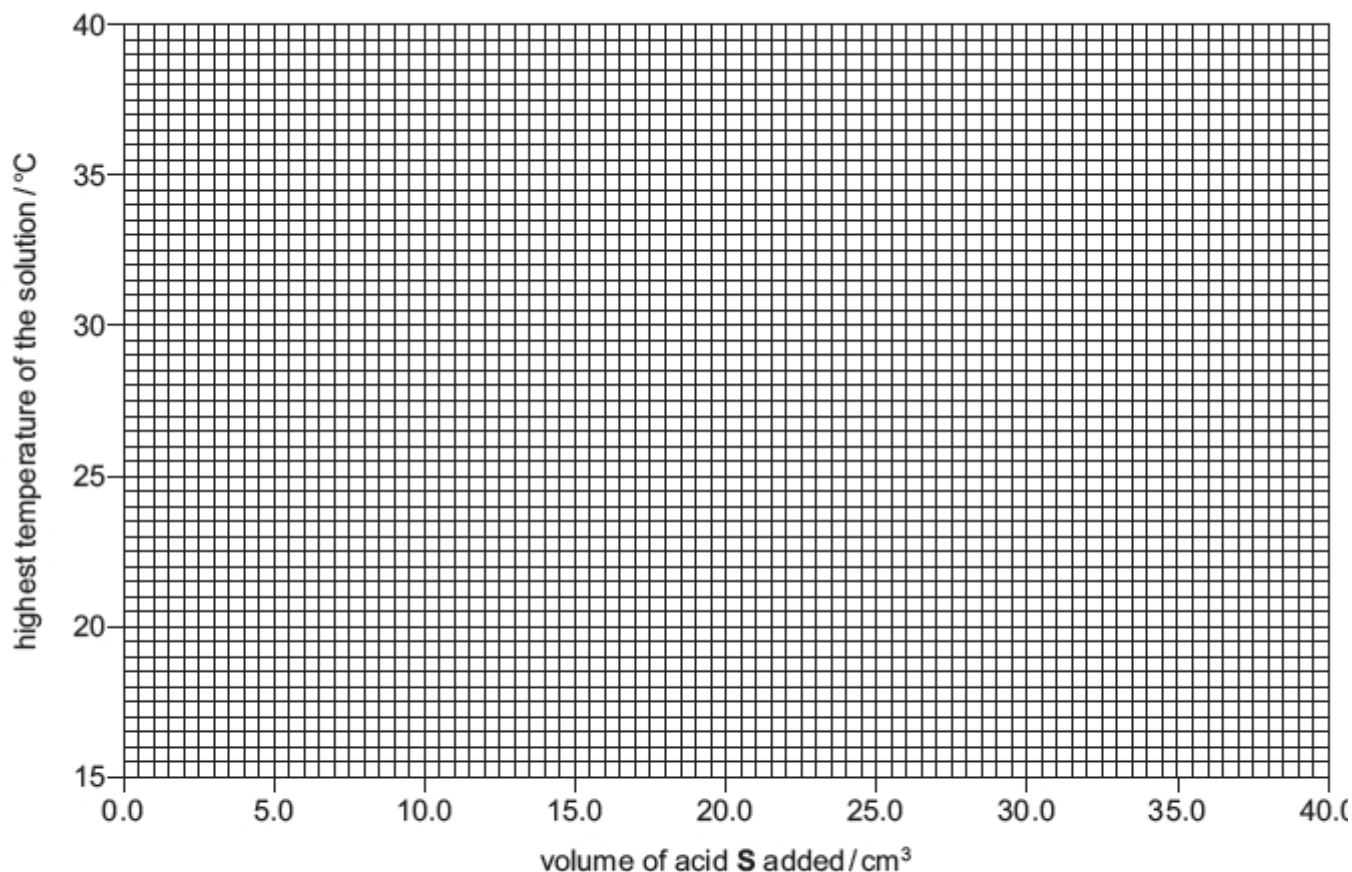
(c) Use the thermometer diagrams to record the results in the table.

volume of acid S added / cm ³	thermometer diagram	highest temperature of the solution / °C
0.0		
5.0		
10.0		
15.0		
20.0		
25.0		
30.0		
35.0		
40.0		

[2]



(d) Plot the results for Experiment 2 on the grid and draw **two** intersecting straight line graphs.



[2]

(e) (i) Use your graph to estimate the volume of acid **S** which must be added to neutralise 50 cm³ of aqueous sodium hydroxide.

Show clearly **on the grid** how you worked out your answer.

..... cm³ [2]

(ii) Suggest how the volume in (e)(i) would differ if the experiment were repeated using 25 cm³ instead of 50 cm³ of aqueous sodium hydroxide. Explain your answer.

.....

..... [2]

(f) What type of energy change occurs when acid **S** reacts with aqueous sodium hydroxide?

..... [1]



(g) (i) In Experiment 2, why was the burette rinsed with distilled water?

..... [1]

(ii) Why was the burette then rinsed with acid **S**?

..... [1]

(h) Describe **one** source of error in Experiment 2. Suggest an improvement to reduce this source of error.

source of error

improvement

[2]

[Total: 17]

Q# 3/ iGCSE Chemistry/2018/s/Paper 62/Q2

2 A student investigated the temperature changes when two different solids, solid **C** and solid **D**, dissolved in water.

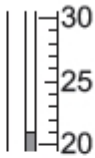
Two experiments were done.

Experiment 1

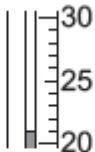
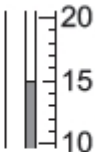
- Using a measuring cylinder, 40 cm³ of distilled water was poured into a polystyrene cup. The initial temperature of the distilled water was measured.
- 3 g of solid **C** was added to the polystyrene cup and the mixture was stirred with a thermometer. The temperature of the solution was measured after 1 minute.
- The procedure was repeated using 4 g of solid **C**.
- The procedure was repeated using 6 g of solid **C**.

(a) Use the thermometer diagrams to record the results in the table.

Calculate and record the temperature change in each case, including whether the temperature increased (+) or decreased (–).

mass of solid C / g	thermometer diagram	initial temperature of the distilled water / °C	thermometer diagram	temperature of the solution after 1 min / °C	temperature change / °C
3					
4					



6					
---	---	--	---	--	--

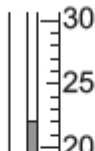
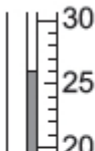
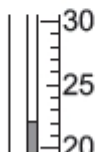
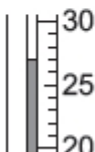
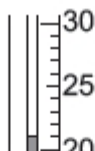
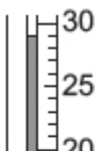
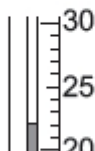
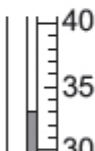
[2]

Experiment 2

- Experiment 1 was repeated but using 3 g, 4 g, 6 g and 8 g of solid **D**.

(b) Use the thermometer diagrams to record the results in the table.

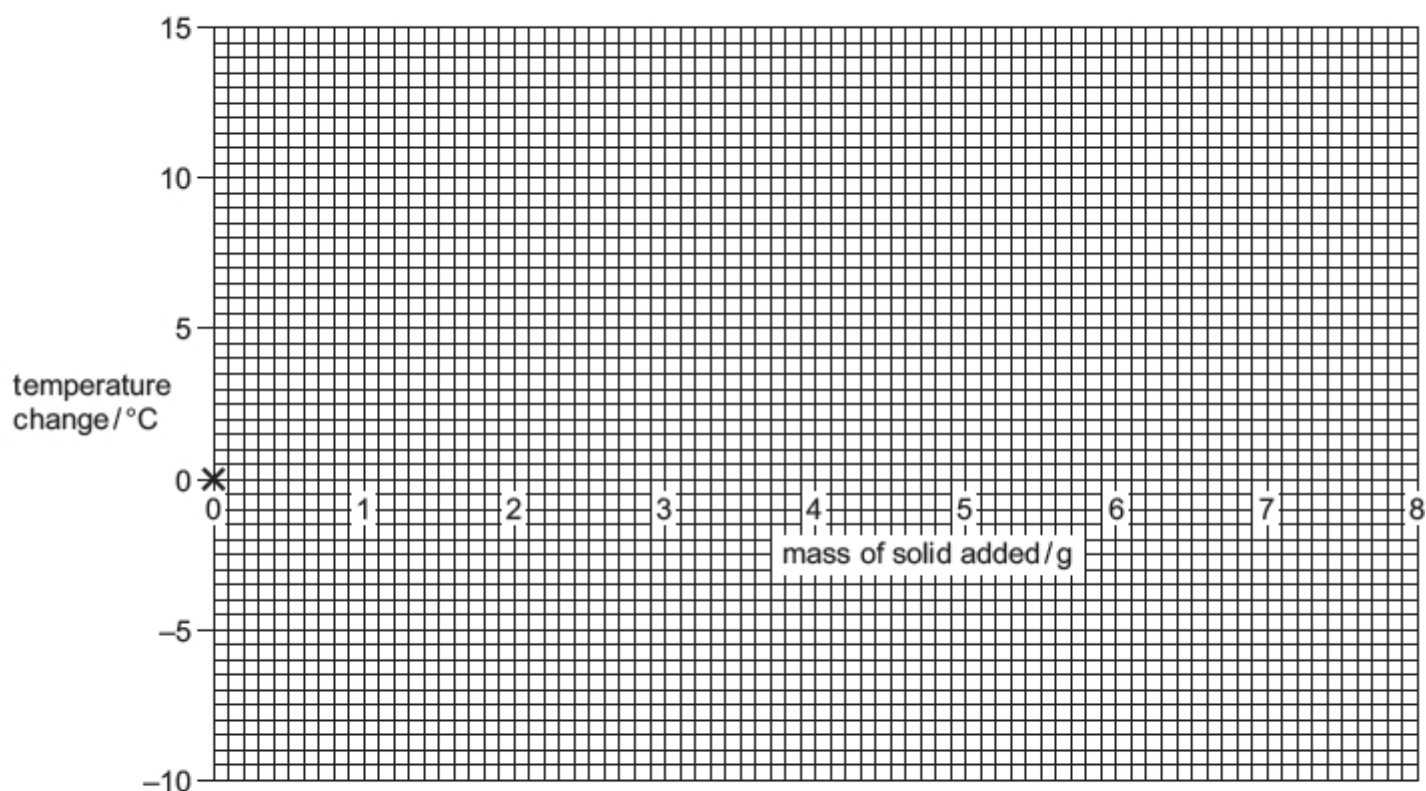
Calculate and record the temperature change in each case, including whether the temperature increased (+) or decreased (–).

mass of solid D /g	thermometer diagram	initial temperature of the distilled water/°C	thermometer diagram	temperature of the solution after 1 min/°C	temperature change/°C
3					
4					
6					
8					

[2]



- (c) Plot the results for Experiments 1 and 2 on the grid. The (0,0) point has been plotted for you. Draw **two** straight lines of best fit. Clearly label your graphs.



[4]

- (d) Use **your graph** to estimate the temperature change after 1 minute if 8 g of solid **C** were added to 40 cm³ of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... °C [2]

- (e) What type of energy change occurs when solid **D** dissolves in water?

..... [1]

- (f) Suggest the temperature of the solution containing 8 g of solid **D**, if the solution were left for 2 hours.
Explain your answer.

.....
..... [2]



- (g) How would the temperature changes measured after 1 minute differ if the experiments were repeated using 80 cm³ instead of 40 cm³ of distilled water in each case?

[2]

- (h) Suggest **one** change you could make to the experiments to obtain more accurate results. Explain how this change would make the results more accurate.

change

explanation

[2]

- (i) Suggest how the reliability of the results could be checked.

[2]

[Total: 19]

12.8.1 ESSENTIAL EXAM QUESTIONS Topic 6 Paper 6 75marks Mark Scheme

Q# 2/ iGCSE Chemistry/2018/s/Paper 63/Q2

2(a)	all temperature boxes completed correctly: 21, 23, 25, 27, 29, 31, 30, 29, 28	2
2(b)	all points plotted correctly (□ half a small square)	1
	best-fit intersecting straight-line graphs	1
2(c)	temperature boxes completed correctly: 21, 26, 31, 32, 31, 30, 29, 28, 27	2
2(d)	all points plotted correctly	1
	best-fit intersecting straight-line graphs	1
2(e)(i)	value from graph where lines cross: 12 cm ³	1
	shown clearly at intersection	1
2(e)(ii)	half volume of acid	1
	less / half as many moles of sodium hydroxide present	1
2(f)	exothermic / heat given out	1
2(g)(i)	to remove traces of acid / clean / remove impurities	1
2(g)(ii)	to remove traces of water	1
2(h)	sources of error using a measuring cylinder or heat losses	1
	improvement use a pipette / use a burette / lag / insulation / lid	1



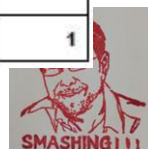
Q# 3/ iGCSE Chemistry/2018/s/Paper 62/Q2

2(a)	initial temperatures all 21 AND final temperatures 18, 17, 15	1
	temperature changes -3, -4, -6	1
2(b)	initial temperatures 22, 22, 21, 22 AND final temperatures 26, 27, 29, 33	1
	temperature changes +4, +5, +8, +11	1
2(c)	all points plotted correctly (□ half a small square)	2
	best-fit straight-line graphs	1
	labels D (upper) and C (lower) or (expt.) 2 and 1	1
2(d)	value from graph, -8 °C	1
	extrapolation	1
2(e)	exothermic	1
2(f)	room temperature / 21 °C / 22 °C	1
	heat lost to surroundings	1
2(g)	half as much	2
2(h)	change in apparatus or method e.g. use a pipette / burette or use insulation / lid	1
	explanation e.g. as more accurate / precise, than a <u>measuring cylinder</u> / reduce heat losses	1
2(i)	repeat experiments	1
	compare / average	1

Q# 4/ iGCSE Chemistry/2017/w/Paper 63/

Q14/18352 chemistry/2017/W/Paper 05/

2(a)	temperature boxes completed: 23, 16, 14, 13, 12, 11, 11, 11, 11, 11 all readings correct = [2] 8 or 9 readings correct = [1]	2														
2(b)	temperature boxes completed correctly: 22, 26, 29, 31, 32, 33, 34, 35, 35, 35 all readings correct = [2] 8 or 9 readings correct = [1]	2														
2(c)	all points plotted	1														
	two smooth line graphs (one line graph correct = [1])	2														
	both graphs appropriately labelled	1														
2(d)(i)	value from graph	1														
	shown clearly	1														
2(d)(ii)	value from graph	1														
	shown clearly	1														
2(e)	exothermic	1														
2(f)	room temperature / 22 °C AND reaction has finished / all the solid has dissolved	1														
2(g)	<table><tr><th>source of error</th><th>improvement</th></tr><tr><td>heat losses</td><td>use a lid / lag the apparatus</td></tr><tr><td>use of a measuring cylinder</td><td>use a pipette/burette</td></tr><tr><td>wet cup in the second experiment</td><td>use new/another cup OR dry the cup</td></tr><tr><td>the solid absorbs water from the air</td><td>store in a sealed container / airtight container / desiccator</td></tr><tr><td>only done once</td><td>repeat and average</td></tr><tr><td>different masses of solids used / masses of solids not measured</td><td>use same mass of solid / weigh the solids</td></tr></table>	source of error	improvement	heat losses	use a lid / lag the apparatus	use of a measuring cylinder	use a pipette/burette	wet cup in the second experiment	use new/another cup OR dry the cup	the solid absorbs water from the air	store in a sealed container / airtight container / desiccator	only done once	repeat and average	different masses of solids used / masses of solids not measured	use same mass of solid / weigh the solids	4
source of error	improvement															
heat losses	use a lid / lag the apparatus															
use of a measuring cylinder	use a pipette/burette															
wet cup in the second experiment	use new/another cup OR dry the cup															
the solid absorbs water from the air	store in a sealed container / airtight container / desiccator															
only done once	repeat and average															
different masses of solids used / masses of solids not measured	use same mass of solid / weigh the solids															
2(h)	fewer data / less detail / fewer readings / graph not as good / not enough readings whilst the solid is reacting	1														



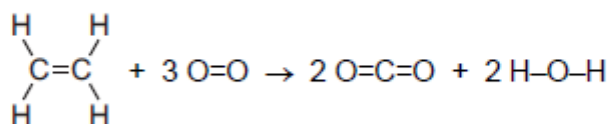
12.9 FUNDAMENTAL Assessed Activity 1 Keyword Test

Topic #	English	Meaning
998 5	exothermic change	
842 9	activation energy (EA)	
776 3	burning	
700 8	combustion	
664 9	fuel cells	
642 1	kinetic (particle) theory	
621 3	fuel cell	
592 8	collision theory	
530 7	endothermic change	
434 7	fuel	
307 1	bond energy	
183 6	catalyst	
724	heat of combustion	
133	heat of reaction	



Q# 1/

12 Ethene burns in oxygen to form carbon dioxide and water vapour.



The bond energies are shown in the table.

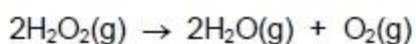
bond	bond energy in kJ/mol
C=C	+610
C-H	+410
O=O	+497
C=O	+805
O-H	+460

What is the energy change for the reaction?

- A -2959 kJ/mol
 B -2313 kJ/mol
 C -1319 kJ/mol
 D -399 kJ/mol

Q# 2/

12 Hydrogen peroxide, H-O-O-H, decomposes to form water and oxygen.



The bond energies are shown in the table. The reaction is exothermic.

bond	bond energy in kJ/mol
O-H	+460
O-O	+150
O=O	+496

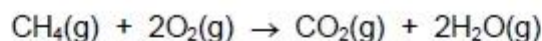
What is the energy change for the reaction?

- A -346 kJ/mol B -196 kJ/mol C +196 kJ/mol D +346 kJ/mol



Q# 3/

12 Methane burns in an excess of oxygen. The equation is shown.



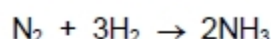
The bond energies are shown in the table.

bond	bond energy in kJ/mol
C-H	+410
C=O	+805
O-H	+460
O=O	+496

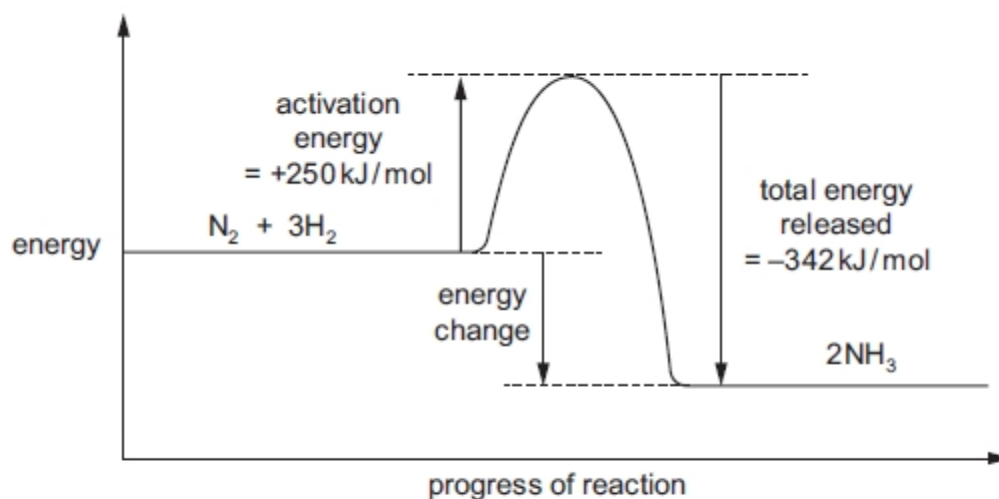
What is the energy change for the reaction?

- A +818 kJ/mol
- B +102 kJ/mol
- C -359 kJ/mol
- D -818 kJ/mol

13 The equation for the formation of ammonia is shown.



The energy level diagram for the reaction is shown.



What is the energy change for the reaction?

- A -592 kJ/mol
- B -92 kJ/mol
- C +92 kJ/mol
- D +592 kJ/mol



Q# 4/

17 Part of the Periodic Table is shown.

Which element forms an oxide that reacts with dilute acid to form a salt and water?

I II		III IV V VI VII VIII					
				A		B	
	C		D				

18 Aqueous sodium hydroxide is added to solid Q in a test-tube.

A gas is produced which turns damp red litmus blue.

What is Q?

- A aluminium
- B ammonia
- C ammonium chloride
- D sodium nitrate

19 Potassium hydroxide is a base.

Which statement describes a reaction of potassium hydroxide?

- A Chlorine is formed when it is heated with ammonium chloride.
- B It turns Universal Indicator green.
- C It reacts with an acid to produce a salt and water.
- D It turns methyl orange red.

20 Some general rules for the solubility of salts in water are listed.

- Carbonates are insoluble (except ammonium carbonate, potassium carbonate and sodium carbonate).
- Chlorides are soluble (except lead(II) chloride and silver chloride).
- Nitrates are soluble.
- Sulfates are soluble (except barium sulfate, calcium sulfate and lead(II) sulfate).

Which substances produce an insoluble salt when aqueous solutions of them are mixed?

- A barium chloride and magnesium nitrate
- B calcium chloride and ammonium nitrate
- C silver nitrate and zinc chloride
- D sodium carbonate and potassium sulfate



Q# 5/

12 Information about two reactions is given.

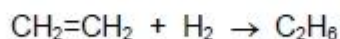
- The neutralisation reaction between citric acid and sodium hydrogencarbonate is endothermic.
- The displacement reaction between magnesium and carbon dioxide is exothermic.

Which statements about the two reactions are correct?

- 1 The energy of the products formed in the neutralisation reaction is greater than the energy of the reactants.
- 2 The energy of magnesium and carbon dioxide is greater than the energy of magnesium oxide and carbon.
- 3 In an exothermic reaction, the energy required to break the bonds is greater than the energy released when the new bonds are formed.

A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 and 3 only

13 Ethene reacts with hydrogen. The equation is shown.



The bond energies are shown in the table. The reaction is exothermic.

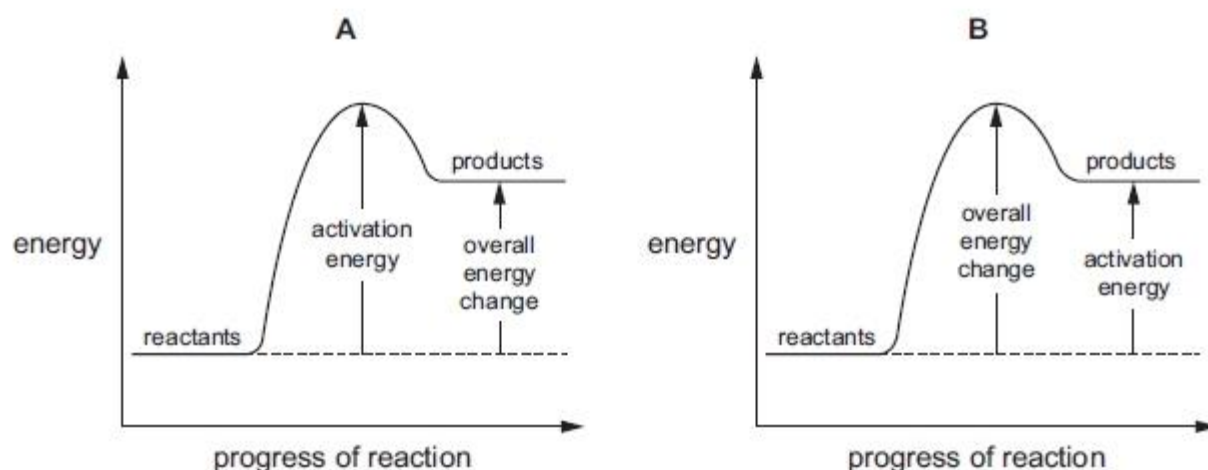
bond	bond energy in kJ/mol
C–C	+350
C=C	+610
C–H	+410
H–H	+436

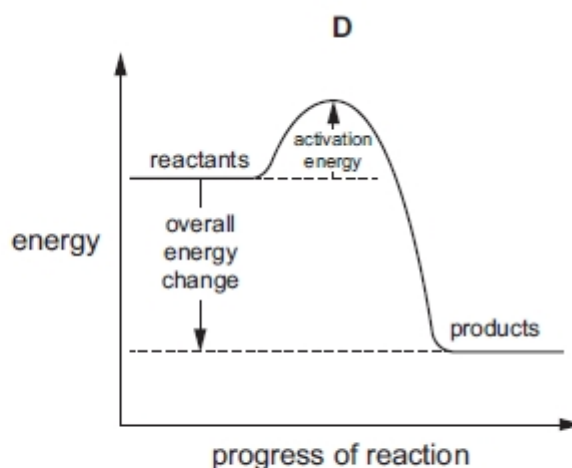
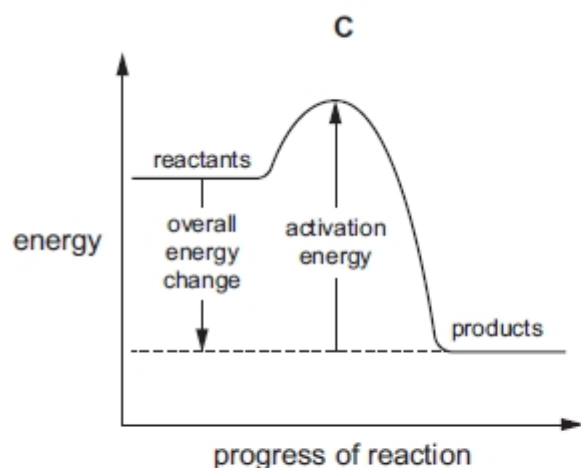
What is the energy change for the reaction?

A –560 kJ/mol B –124 kJ/mol C +486 kJ/mol D +5496 kJ/mol

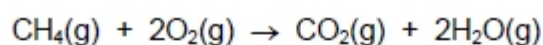
Q# 6/

12 Which diagram is a correctly labelled energy level diagram for an endothermic reaction?





13 The equation for the complete combustion of methane is shown.



The bond energies are shown in the table.

bond	bond energy in kJ/mol
C–H	+410
C=O	+805
O–H	+460
O=O	+496

What is the energy change for the reaction?

A –818 kJ/mol **B** –359 kJ/mol **C** –323 kJ/mol **D** +102 kJ/mol

Q# 7/

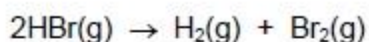
12 Plant cells use energy from sunlight for photosynthesis.

Which row describes and explains the energy change that occurs?

	type of energy change	explanation
A	endothermic	less energy is released making bonds than is absorbed to break bonds
B	endothermic	more energy is released making bonds than is absorbed to break bonds
C	exothermic	less energy is released making bonds than is absorbed to break bonds
D	exothermic	more energy is released making bonds than is absorbed to break bonds



13 Hydrogen bromide decomposes to form hydrogen and bromine. The equation is shown.



The bond energies are shown in the table. The reaction is endothermic.

bond	bond energy in kJ/mol
Br–Br	+193
H–Br	+366
H–H	+436

What is the energy change for the reaction?

- A +263 kJ/mol B +103 kJ/mol C –103 kJ/mol D –263 kJ/mol

12.11 Essential Assessed Activity 3 Topic 6 Paper 6 19marks

Q# 1/

- 2 A student investigated the temperature changes when two different metals, zinc and magnesium, reacted with aqueous copper(II) sulfate.

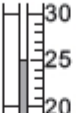
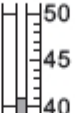
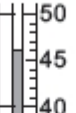
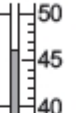
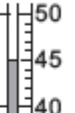
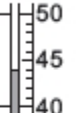
Three experiments were done.

Experiment 1

- A measuring cylinder was used to pour 25 cm³ aqueous copper(II) sulfate into a polystyrene cup.
- The initial temperature of the solution was measured and the timer was started.
- The temperature of the solution was measured at 30 seconds and at 60 seconds.
- At 60 seconds, 5 g of zinc powder was added to the aqueous copper(II) sulfate. The mixture was stirred with a thermometer.
- The temperature of the mixture was measured every 30 seconds for 210 seconds. The mixture was stirred continuously.



(a) Use the thermometer diagrams to record the temperatures in the table.

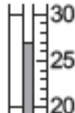
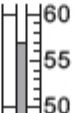
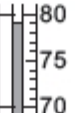
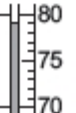
time / s	0	30	60	90	120	150	180	210
thermometer diagram								
temperature of mixture / °C								

[2]

Experiment 2

- Experiment 1 was repeated using 5 g of magnesium powder instead of zinc powder.

(b) Use the thermometer diagrams to record the temperatures in the table.

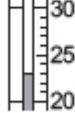
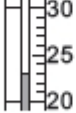
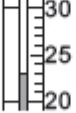
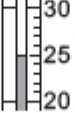
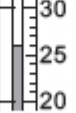
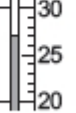
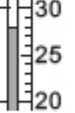
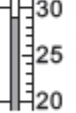
time / s	0	30	60	90	120	150	180	210
thermometer diagram								
temperature of mixture / °C								

[1]

Experiment 3

- Experiment 1 was repeated using 5 g of zinc granules instead of zinc powder.

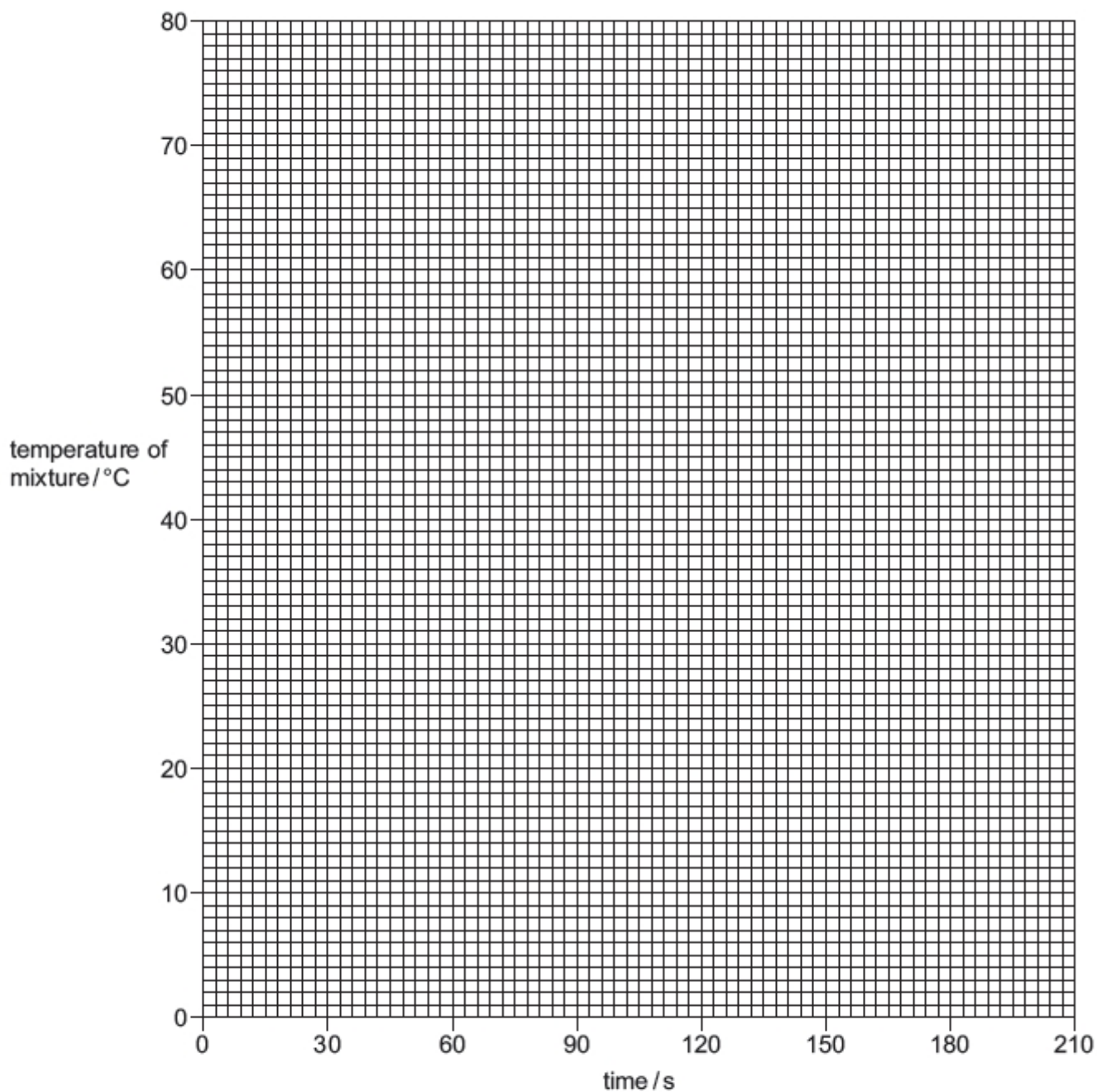
(c) Use the thermometer diagrams to record the temperatures in the table.

time / s	0	30	60	90	120	150	180	210
thermometer diagram								
temperature of mixture / °C								

[1]



- (d) Plot the results for Experiments 1–3 on the grid and draw **three** smooth line graphs. Clearly label your lines.



[3]

- (e) From your graph, deduce the temperature of the mixture in Experiment 2 after 75 seconds.

Show clearly **on the grid** how you worked out your answer.

..... °C [2]



(f) (i) From the results, which Experiment was the most exothermic? Explain your answer.

.....
..... [2]

(ii) Compare the rates of reaction in Experiments 1 and 3. Explain why the rates of reaction are different.

.....
.....
..... [2]

(g) Predict the temperature of the mixture in Experiment 2 after 2 hours. Explain your answer.

.....
..... [2]

(h) When doing the experiments, what would be the advantage of taking the temperature readings every 15 seconds?

.....
..... [2]

(i) Explain why a copper can should **not** be used in place of the polystyrene cup in these experiments.

.....
.....
..... [2]

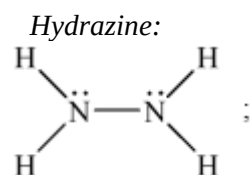
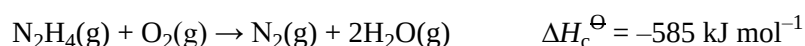
[Total: 19]



10. Bond enthalpies and average bond enthalpies at 298 K

Bond	$\Delta H / \text{kJ mol}^{-1}$	Bond	$\Delta H / \text{kJ mol}^{-1}$
H-H	436	C-H	413
C-C	347	Si-H	318
C=C	612	N-H	391
C $\equiv$ C	838	P-H	321
C $\equiv$ C (benzene)	505	O-H	464
Si-Si	226	S-H	364
N-N	158	F-H	568
N=N	410	Cl-H	432
N $\equiv$ N	945	Br-H	366
P-P	198	I-H	298
O-O	144	C-O	358
O=O	498	C=O	746
S-S	266	C-N	286
F-F	158		

11. One important property of a rocket fuel mixture is the large volume of gaseous products formed which provide thrust. Hydrazine, N_2H_4 , is often used as a rocket fuel. The combustion of hydrazine is represented by the equation below.



- (a) Hydrazine reacts with fluorine to produce nitrogen and hydrogen fluoride only, all in the gaseous state. State an equation for the reaction.

.....

(2)

- (c) Use the average bond enthalpies given in Table 10 of the Data Booklet to determine the enthalpy change for the reaction in part (a) above.

.....

.....

.....

(3)

- (d) Based on your answers to parts (a) and (c), suggest whether a mixture of hydrazine and fluorine is a better rocket fuel than a mixture of hydrazine and oxygen.

.....

.....



13. Which equation best represents the bond enthalpy of HCl?

- A. $\text{HCl(g)} \rightarrow \text{H}^+(\text{g}) + \text{Cl}^-(\text{g})$
- B. $\text{HCl(g)} \rightarrow \text{H(g)} + \text{Cl(g)}$
- C. $\text{HCl(g)} \rightarrow \frac{1}{2} \text{H}_2(\text{g}) + \frac{1}{2} \text{Cl}_2(\text{g})$
- D. $2\text{HCl(g)} \rightarrow \text{H}_2(\text{g}) + \text{Cl}_2(\text{g})$

(Total 1 mark)

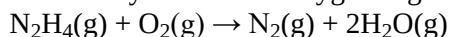
14. Which process represents the C–Cl bond enthalpy in tetrachloromethane?

- A. $\text{CCl}_4(\text{g}) \rightarrow \text{C(g)} + 4\text{Cl(g)}$
- B. $\text{CCl}_4(\text{g}) \rightarrow \text{CCl}_3(\text{g}) + \text{Cl(g)}$
- C. $\text{CCl}_4(\text{l}) \rightarrow \text{C(g)} + 4\text{Cl(g)}$
- D. $\text{CCl}_4(\text{l}) \rightarrow \text{C(s)} + 2\text{Cl}_2(\text{g})$

(Total 1 mark)

15. Hydrazine is a valuable rocket fuel.

The equation for the reaction between hydrazine and oxygen is given below.



Use the bond enthalpy values from Table 10 to determine the enthalpy change for this reaction.

.....
.....
.....

(Total 3 marks)

16. When some solid barium hydroxide and solid ammonium thiosulfate were reacted together, the temperature of the surroundings was observed to decrease from 15 °C to – 4 °C. What can be deduced from this observation?

- A. The reaction is exothermic and ΔH is negative.
- B. The reaction is exothermic and ΔH is positive.
- C. The reaction is endothermic and ΔH is negative.
- D. The reaction is endothermic and ΔH is positive.



12.13 ESSENTIAL End of Topic 6 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

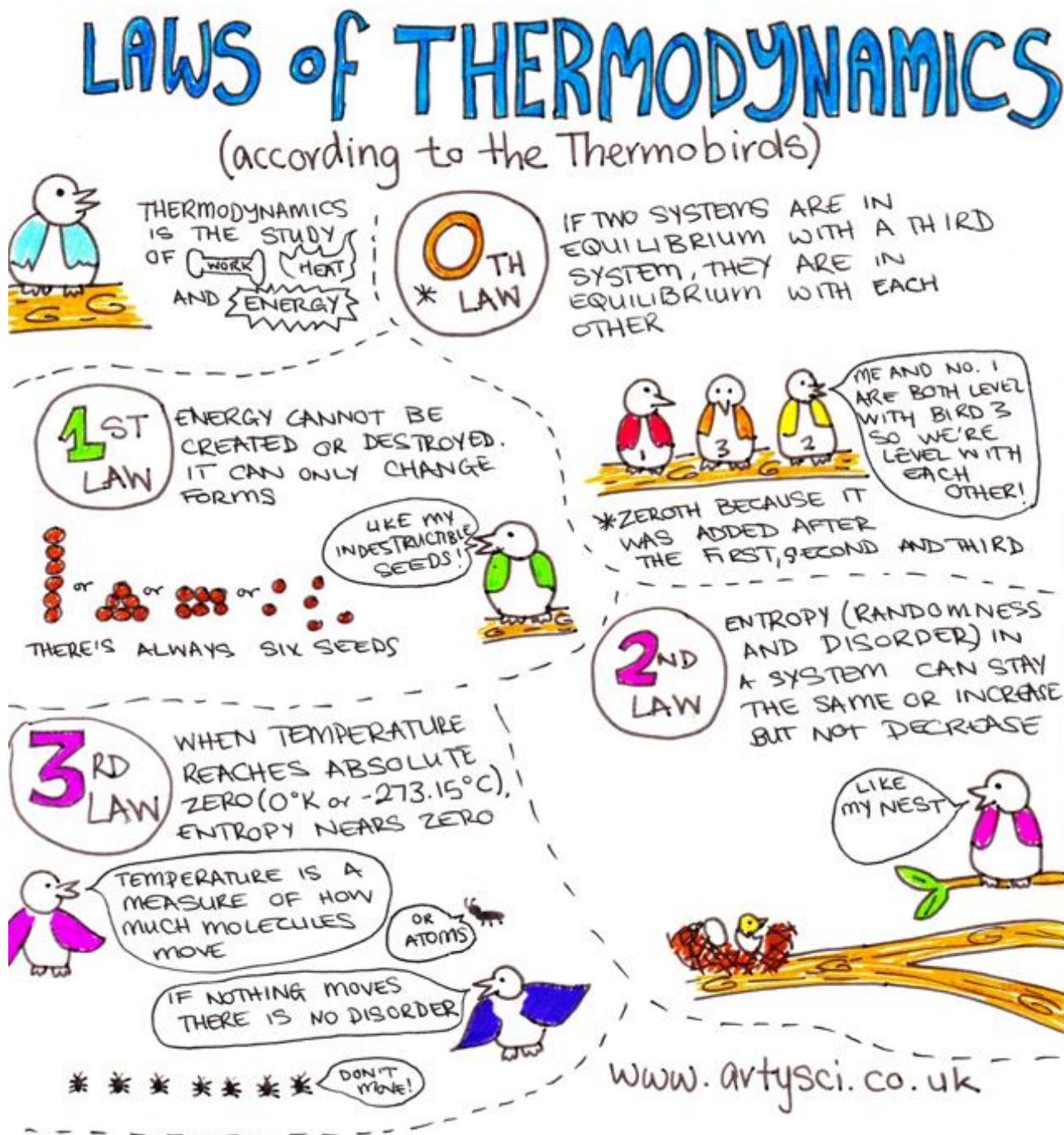
1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?



Most reactions that happen on Earth give out heat energy, but not all of them. The first law of thermodynamics suggests that energy can neither be created nor destroyed. But it is not the only law, nor is it the most important law. Pick one law and create a short presentation about it



You could investigate Entropy. What is it, and what isn't it?

EXCEPTIONALLY SMASHING Ideas: Why has Entropy created problems for the existence of Black Holes? Have these problems been solved? If so how?

12.16 EXCEPTIONAL EXAM QUESTIONS T6 From IB SL 31marks

These questions are taken from an AS Level style syllabus called IB Standard Level. In theory a top level an iGCSE student has covered everything needed answer these questions, but most A* level students probably wouldn't be able to answer them all.

10. Bond enthalpies and average bond enthalpies at 298 K

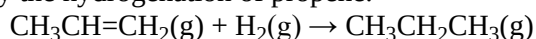
Bond	$\Delta H / \text{kJ mol}^{-1}$	Bond	$\Delta H / \text{kJ mol}^{-1}$
H-H	436	C-H	413
C-C	347	Si-H	318
C=C	612	N-H	391
C $\equiv$ C	838	P-H	321
C=C (benzene)	505	O-H	464
Si-Si	226	S-H	364
N-N	158	F-H	568
N=N	410	Cl-H	432
N $\equiv$ N	945	Br-H	366
P-P	198	I-H	298
O-O	144		
O=O	498	C-O	358
S-S	266	C=O	746
F-F	158	C-N	286
Cl-Cl	243	C=N	615
Br-Br	193	C $\equiv$ N	887
I-I	151	C-F	467
		C-Cl	346
		C-Br	290
		C-I	228
		Si-O	466

1. Which statement about bonding is correct?

- A. Bond breaking is endothermic and requires energy.
- B. Bond breaking is endothermic and releases energy.
- C. Bond making is exothermic and requires energy.
- D. Bond making is endothermic and releases energy.

(Total 1 mark)

2. Propane can be formed by the hydrogenation of propene.



(ii) Enthalpy changes can be determined using average bond enthalpies. Define the term *average bond enthalpy*.

.....

(2)

(iii) Determine a value for the hydrogenation of propene using information from Table 10 above.

.....

(2)

(iv) Explain why the enthalpy of hydrogenation of propene is an exothermic process.



3. Which types of reaction are always exothermic?

- I. Neutralization
- II. Decomposition
- III. Combustion

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

(Total 1 mark)

4. Which equation represents the bond enthalpy for the H–Br bond in hydrogen bromide?

- A. $\text{HBr(g)} \rightarrow \text{H(g)} + \text{Br(g)}$
- B. $\text{HBr(g)} \rightarrow \text{H(g)} + \text{Br(l)}$
- C. $\text{HBr(g)} \rightarrow \text{H(g)} + \frac{1}{2} \text{Br}_2(\text{l})$
- D. $\text{HBr(g)} \rightarrow \text{H(g)} + \frac{1}{2} \text{Br}_2(\text{g})$

(Total 1 mark)

5. Which is correct about energy changes during bond breaking and bond formation?

	Bond breaking	Bond formation
A.	exothermic and ΔH positive	endothermic and ΔH negative
B.	exothermic and ΔH negative	endothermic and ΔH positive
C.	endothermic and ΔH positive	exothermic and ΔH negative
D.	endothermic and ΔH negative	exothermic and ΔH positive

(Total 1 mark)

6. Which processes are exothermic?

- I. Ice melting
- II. Neutralization
- III. Combustion

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

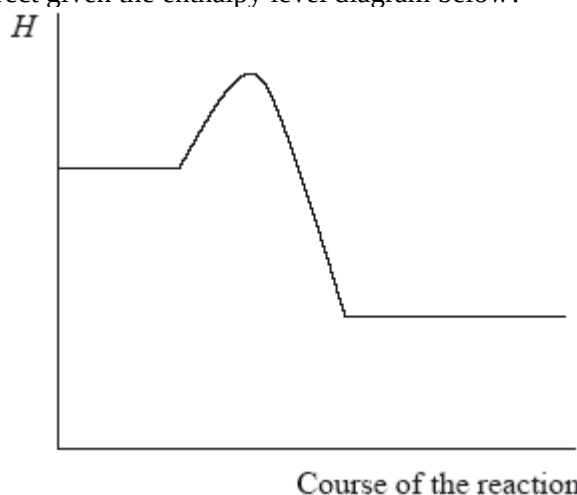
(Total 1 mark)

7. Which is true for a chemical reaction in which the products have a higher enthalpy than the reactants?

	Reaction	ΔH
A.	endothermic	positive
B.	endothermic	negative
C.	exothermic	positive
D.	exothermic	negative

(Total 1 mark)

8. Which statement is correct given the enthalpy level diagram below?



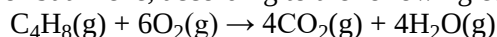
- A. The reaction is endothermic and the products are more thermodynamically stable than the reactants.



- B. The reaction is exothermic and the products are more thermodynamically stable than the reactants.
- C. The reaction is endothermic and the reactants are more thermodynamically stable than the products.
- D. The reaction is exothermic and the reactants are more thermodynamically stable than the products.

(Total 1 mark)

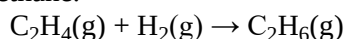
9. (b) Use the information from Table 10 above to calculate the enthalpy change for the complete combustion of but-1-ene, according to the following equation.



.....

(3)

10. Two students were asked to use information from the Data Booklet to calculate a value for the enthalpy of hydrogenation of ethene to form ethane.



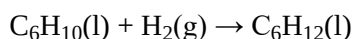
John used the average bond enthalpies from Table 10. Marit used the values of enthalpies of combustion from Table 12.

- (a) Calculate the value for the enthalpy of hydrogenation of ethene obtained using the average bond enthalpies given in Table 10.

.....

(2)

- (d) John then decided to determine the enthalpy of hydrogenation of cyclohexene to produce cyclohexane.



- (i) Use the average bond enthalpies to deduce a value for the enthalpy of hydrogenation of cyclohexene.

.....

(1)

(Total 1 mark)



1. A [1]
2. (ii) the enthalpy change when (one mole of) the gaseous bond is broken (or formed) / $X-Y(g) \rightarrow X(g) + Y(g)$ / $X(g) + Y(g) \rightarrow X-Y(g)$; averaged for the same bond in a number of similar compounds / *OWTTE*; 2
- (iii) energy in: $C=C + H-H$ **and** energy out: $C-C + 2C-H$; *Accept energy in $C-C + 6C-H + C=C + H-H$ and energy out $2C-C + 8C-H$.* 2
- $\Delta H = (612 + 436) - (347 + 826) = 1048 - 1173 / -125 \text{ (kJ mol}^{-1}\text{)}$; *Award [2] for correct final answer.*
- Award [1] for +125.*
- If old Data Booklet values then allow: $\Delta H = 1048 - 1172 = -124 \text{ (kJ mol}^{-1}\text{)}$*
- (iv) due to the relative strength of the $C-C$ and $2C-H$ bonds compared to the $C=C$ and $H-H$ bonds / bonds in products stronger than bonds in reactants; 1
3. B [7]
4. A [1]
5. C [1]
6. C [1]
7. A [1]
8. B [1]
9. (b) Bonds broken $(612) + (2 \times 348) + (8 \times 412) + (6 \times 496) / 7580 \text{ (kJ mol}^{-1}\text{)}$; Bonds made $(8 \times 743) + (8 \times 463) / 9648 \text{ (kJ mol}^{-1}\text{)}$; $\Delta H = -2068 \text{ (kJ mol}^{-1}\text{)}$; 3
- Award [3] for the correct answer.*
- Allow full ECF.*
- Allow kJ but no other incorrect units.*
- Even if the first two marks are lost, the candidate can score [1] for a clear correct subtraction for ΔH .*
10. (a) energy required = $C=C + H-H / 612 + 436$ and energy released = $C-C + 2(C-H) / 347 + 2(413)$ / energy required = $C=C + H-H + 4(C-H) / 612 + 436 + 4(413)$ and energy released = $C-C + 6(C-H) / 347 + 6(413)$; $\Delta H = (1048 - 1173) / (2700 - 2825) = -125 \text{ kJ mol}^{-1}$ 2
- (d) (i) -125 kJ mol^{-1} ; 1



13 Topic 7.1 & 7.2 Chemical and Physical Reactions and Rate of Reactions

13.1 End of Topic 7.1 & 7.2 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTENSION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTENSION
	Scored over 95%		SMASHING!!!



Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book <u>you enjoy</u> (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book <u>you enjoy</u> in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book <u>you enjoy</u> in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

13.2 Topic 7.1 and 7.2 Syllabus

7 Chemical reactions

7.1 Physical and chemical changes

Core

- Identify physical and chemical changes, and understand the differences between them

7.2 Rate (speed) of reaction

Core

- Describe and explain the effect of concentration, particle size, catalysts (including enzymes) and temperature on the rate of reactions
- Describe the application of the above factors to the danger of explosive combustion with fine powders (e.g. flour mills) and gases (e.g. methane in mines)
- Demonstrate knowledge and understanding of a practical method for investigating the rate of a reaction involving gas evolution
- Interpret data obtained from experiments concerned with rate of reaction

Note: Candidates should be encouraged to use the term *rate* rather than *speed*.

Supplement

- Devise and evaluate a suitable method for investigating the effect of a given variable on the rate of a reaction
- Describe and explain the effects of temperature and concentration in terms of collisions between reacting particles. (An increase in temperature causes an increase in collision rate **and** more of the colliding molecules have sufficient energy (activation energy) to react whereas an increase in concentration only causes an increase in collision rate.)
- Describe and explain the role of light in photochemical reactions and the effect of light on the rate of these reactions. (This should be linked to section 14.4.)
- Describe the use of silver salts in photography as a process of reduction of silver ions to silver; and photosynthesis as the reaction between carbon dioxide and water in the presence of chlorophyll and sunlight (energy) to produce glucose and oxygen



13.3 ESSENTIAL Glossary for Keywords for Topic 7.1 & 7.2

Topic #	English	Chinese
7	enzymes protein molecules that act as biological catalysts	酶充当生物催化剂的蛋白质分子
7	photochemical reaction a chemical reaction that occurs when light, usually of a particular wavelength, falls on the reactants	光化学反应当通常是特定波长的光照射到反应物上时发生的化学反应
7	photosynthesis the chemical process by which plants synthesise glucose from atmospheric carbon dioxide and water: the energy required for the process is captured from sunlight by chlorophyll molecules in the green leaves of the plants	光合作用是植物从大气中的二氧化碳和水合成葡萄糖的化学过程：该过程所需的能量是由植物的绿叶中的叶绿素分子从阳光中捕获的
	Denature If an enzyme is placed in an extreme environment, e.g. too acidic or alkali, too hot or is physically damaged by motion I (like shaking) will no longer be able to function. Usually this change is permanent.	变性如果将酶置于极端环境中，例如 太酸或太碱，太热或被运动I物理损坏（如摇晃）将不再起作用。通常，此更改是永久性的。
7	reaction rate a measure of how fast a reaction takes place	反应速率衡量反应发生的速度
7	speed of reaction a less accurate name for reaction rate	反应速度反应速度的名称不太准确

13.4 EXTENSION Keywords

You do not need to understand these words to score a good A, or even a low A* but if you are aiming for a good or high A* then understanding words like these here will be helpful.

13.5 ESSENTIAL Classroom Active Learning Tasks Drawing Graphs

Based on the Rate of a Reaction from Paper 6 36marks

Q# 1/ iGCSE Chemistry/2018/w/Paper 63/Q2

- 2 A student investigated the rate of reaction between solution **S** and solution **T** at different temperatures. When these chemicals react they form iodine. Sodium thiosulfate solution and starch solution were used to show how fast the reaction proceeded.

Four experiments were done.

Experiment 1

- A measuring cylinder was used to add 10 cm³ of solution **S** and 10 cm³ of sodium thiosulfate solution to a conical flask.
- A teat pipette was then used to add 1 cm³ of starch solution to the mixture.
- The temperature of the mixture was measured and recorded in the table.
- The reaction was started by using a measuring cylinder to add 10 cm³ of solution **T** to the conical flask. A timer was started immediately and the mixture was swirled.
- The time taken for the mixture to turn blue-black was measured.
- The final temperature of the mixture was measured and recorded.
- The conical flask was emptied and rinsed with distilled water.



Experiment 2

- A measuring cylinder was used to add 10 cm³ of solution **S** and 10 cm³ of sodium thiosulfate solution to the conical flask.
- A teat pipette was then used to add 1 cm³ of starch solution to the mixture.
- The mixture was then heated to about 30 °C.
- The temperature of the mixture was measured and recorded in the table.
- The reaction was started by using a measuring cylinder to add 10 cm³ of solution **T** to the conical flask. The timer was started immediately and the mixture was swirled.
- The time taken for the mixture to turn blue-black was measured.
- The final temperature of the mixture was measured and recorded.
- The conical flask was emptied and rinsed with distilled water.

Experiment 3

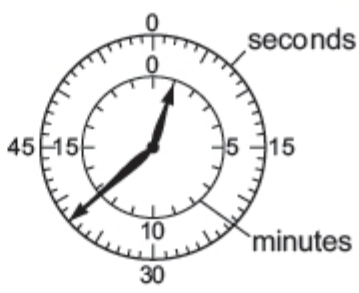
- Experiment 2 was repeated but the mixture of solution **S**, sodium thiosulfate solution and starch solution in the conical flask was heated to about 40 °C before adding solution **T**.

Experiment 4

- Experiment 2 was repeated but the mixture of solution **S**, sodium thiosulfate solution and starch solution in the conical flask was heated to about 50 °C before adding solution **T**.



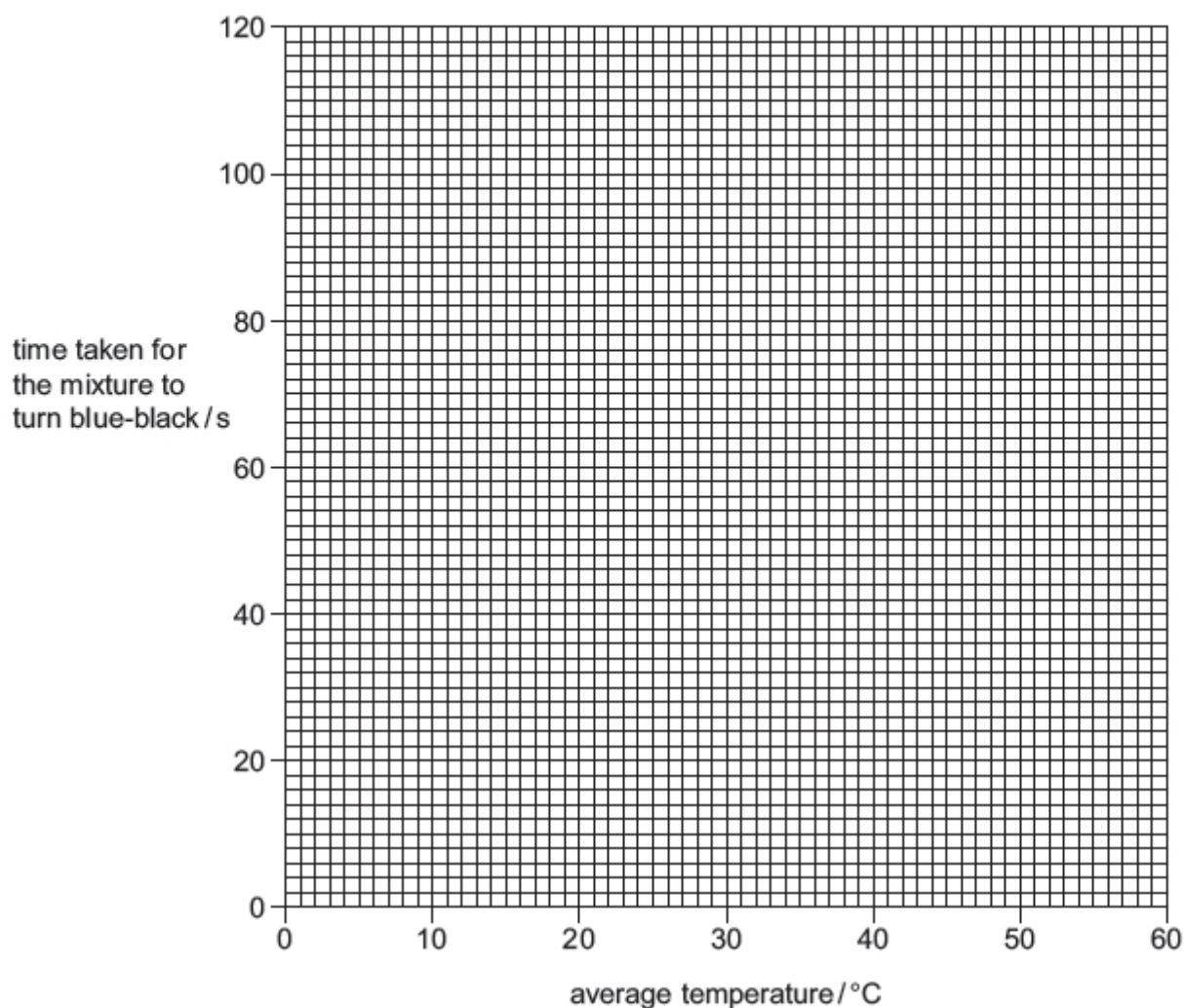
- (a) Calculate the average temperatures in the table.
Use the stop-clock diagrams to record the time taken for each experiment in the table.

experiment number	initial temperature /°C	final temperature /°C	average temperature /°C	stop-clock diagram	time taken for the mixture to turn blue-black/s
1	22	22			
2	31	29			
3	41	37			
4	51	45			

[4]



(b) Plot the results for Experiments 1–4 on the grid. Draw a smooth line graph.



[4]

(c) From your graph, deduce the average temperature needed for the mixture to turn blue-black in 60 s.

Show clearly on the grid how you worked out your answer.

..... [3]

(d) (i) In which experiment, 1, 2, 3 or 4, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....
.....
..... [2]



- (e) Pipettes or burettes could be used to measure the volumes of solution **S** and the sodium thiosulfate solution more accurately.

State and explain **one other** way to improve the accuracy of the results of these experiments.

way to improve the accuracy

explanation

[2]

- (f) A student predicted that using a burette to add solution **T** would improve the accuracy of the results of these experiments.

Suggest why the student's prediction would **not** improve the accuracy of the results of these experiments.

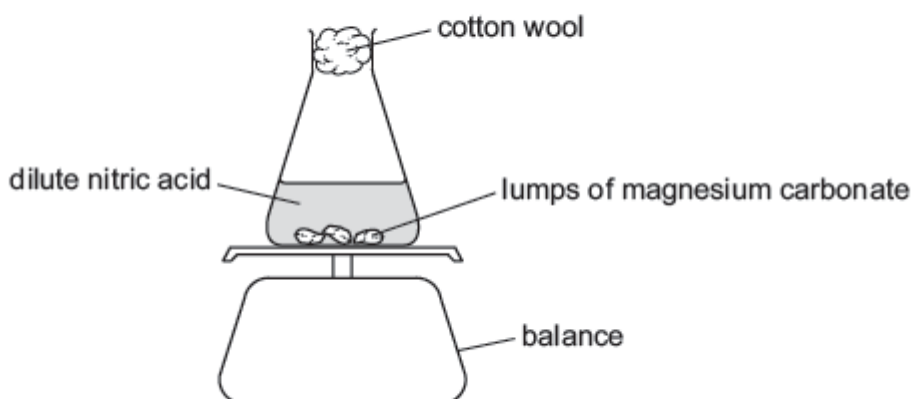
.....

..... [2]

[Total: 18]

Q#2/ iGCSE Chemistry/2018/w/Paper 61/Q2

- 2** A student investigated the rate of reaction between dilute nitric acid and lumps of magnesium carbonate. The apparatus shown was used.



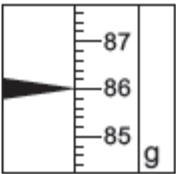
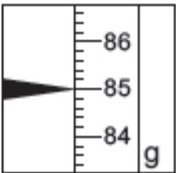
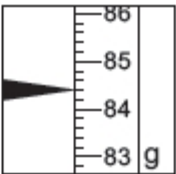
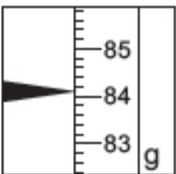
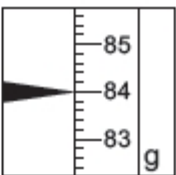
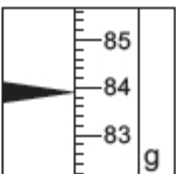
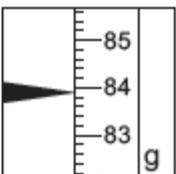
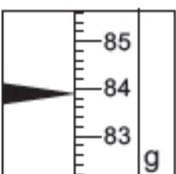
Lumps of magnesium carbonate were added to a conical flask. 40 cm³ of dilute nitric acid was then poured into the conical flask using a measuring cylinder. The magnesium carbonate was in **excess**.

The conical flask was placed on a balance. Cotton wool was placed in the top of the conical flask.

The mass of the conical flask and its contents was measured and a timer was started. The mass of the conical flask and its contents was measured every minute for 7 minutes.



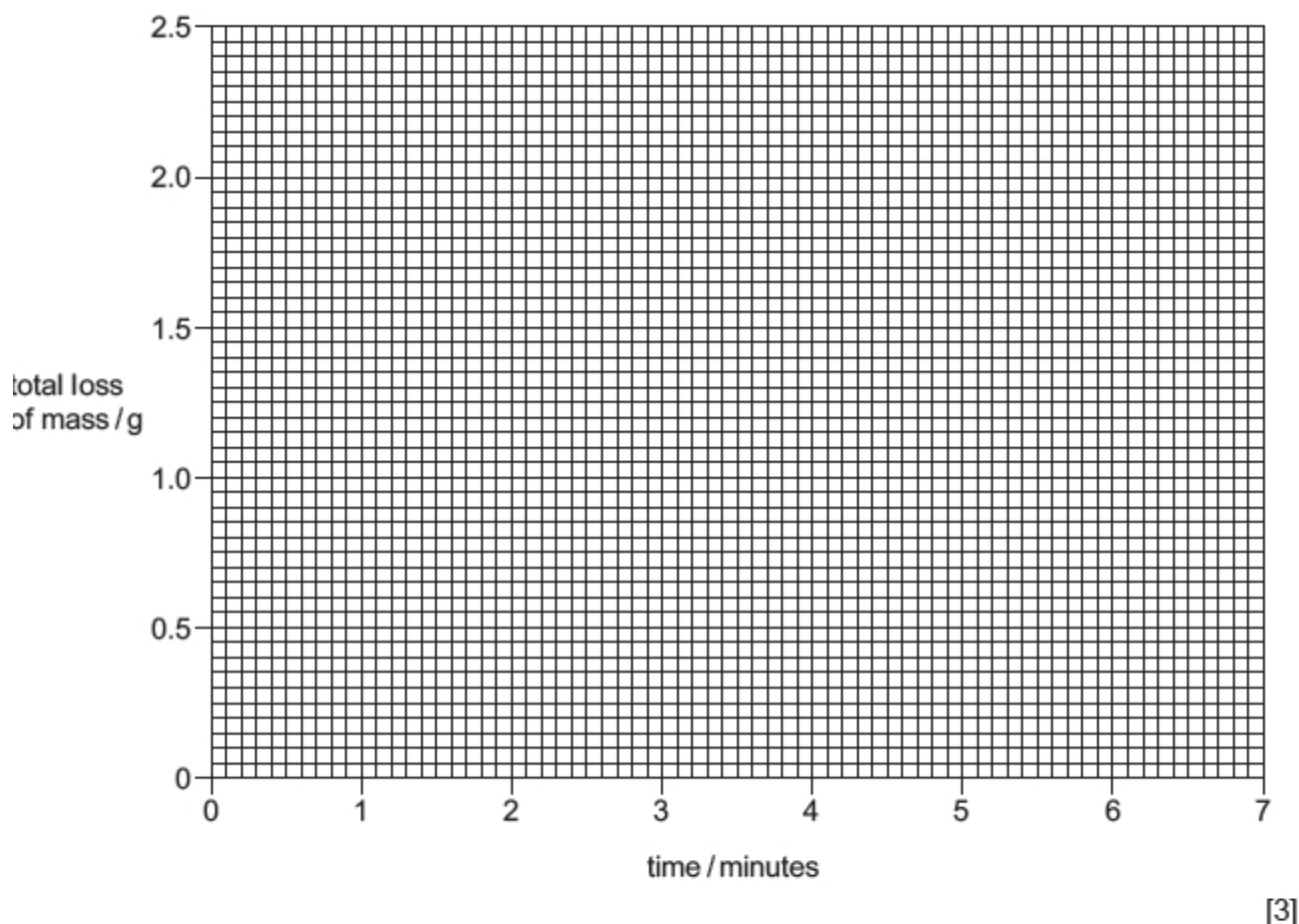
- (a) Use the balance diagrams to record the mass of the conical flask and its contents in the table. Complete the table to work out the total loss of mass of the conical flask and its contents since the start of the experiment.

time / minutes	balance diagram	mass of conical flask and its contents / g	total loss of mass / g
0			
1			
2			
3			
4			
5			
6			
7			

[3]



(b) Plot the results on the grid. Draw a smooth line graph.



(c) The average rate of reaction can be calculated using the equation shown.

$$\text{average rate of reaction} = \frac{\text{total loss of mass/g}}{\text{time taken/s}}$$

Calculate the average rate of reaction for the first 30 **seconds** of the reaction.
Deduce the unit.

rate =

unit =

[3]

(d) The experiment is repeated using an excess of powdered magnesium carbonate. All other conditions are kept the same.

Sketch on the grid the graph you would expect.

[2]



(e) (i) Why does the mass of the conical flask and its contents decrease?

.....
 [1]

(ii) Suggest the purpose of the cotton wool.

.....

 [2]

(iii) Why does the graph level off? Explain your answer.

.....
 [2]

(f) Give **one** advantage and **one** disadvantage of using a burette instead of a measuring cylinder to add the dilute nitric acid to the conical flask.

advantage

disadvantage [2]

[Total: 18]

Makr Scheme For Drawing Graphs Active Learning Exercise

Q# 1/ iGCSE Chemistry/2018/w/Paper 63/Q2

2(a)	Table of results for experiments 1–4	1
	average temperature boxes completed correctly 22, 30, 39, 48	
	Time boxes completed correctly 98, 42, 26, 22	2
	Times completed in seconds	1
2(b)	All points plotted correctly	3
	Smooth line graph (curve)	1
2(c)	indication on graph	1
	Value from graph	1
	°C	1
2(d)(i)	Experiment 4	1
2(d)(ii)	M1 particles (of solution L) have more / most (kinetic) energy / move faster	1
	M2 more frequent collisions / particles collide more often	1
2(e)	M1 Insulation / use a lid	1
	M2 To reduce heat losses	1
2(f)	M1 Too slow / slower addition of solution	1
	M2 Measuring time-taken / results less accurate	1

Q#2/ iGCSE Chemistry/2018/w/Paper 61/Q2



2(a)	mass boxes correctly completed to 1 dp 86.0, 85.0, 84.4, 84.1, 84.0, 83.9, 83.9, 83.9	2
	Loss in mass boxes correctly completed 0.0, 1.0, 1.6, 1.9, 2.0, 2.1, 2.1, 2.1	1
2(b)	points correctly plotted:	2
	smooth line graph;	1
2(c)	M1 mass loss from graph at 30 seconds (0.5)	1
	M2 mass in M1 / 30 calculated (= 0.017)	1
	M3 g / s;	1
2(d)	Sketch steeper than original graph	1
	To same level	1
2(e)(i)	gas / carbon dioxide given off	1
2(e)(ii)	Allow gas to escape	1
	Prevent loss of acid;	1
2(e)(iii)	Reaction finished	1
	All nitric acid has reacted	1
2(f)	Advantage: more accurate;	1
	Disadvantage: slow	1

13.6 Extension Classroom Active Learning Tasks Dealing with Multi-mark Questions

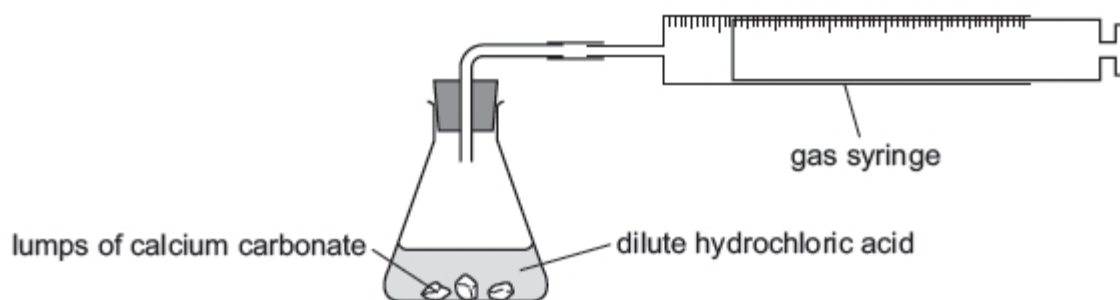
Based on Rate of reaction 43 Marks

Q# 1/ IGCSE Chemistry/2018/w/Paper 43/Q5

- 5** A student investigates the rate of reaction between lumps of calcium carbonate and dilute hydrochloric acid using the apparatus shown.



The calcium carbonate was in excess.



- (a)** Which measurements should the student make during the reaction to determine the rate of reaction?

.....
 [2]



(b) What happens to the rate of reaction as the reaction proceeds? Explain your answer.

.....

.....

.....

..... [3]

(c) The student repeated the experiment at a higher temperature. All other conditions were kept the same. The student found that the rate of reaction increased.

Explain, in terms of collisions, why the rate of reaction increased.

.....

.....

.....

..... [4]

Q# 2/ IGCSE Chemistry/2018/w/Paper 42/Q4

(c) The original experiment was repeated at a higher temperature. All other conditions were kept the same.

Describe and explain, in terms of collisions between particles, the effect of using a higher temperature on the time taken for the reaction to finish.

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

Q# 3/ IGCSE Chemistry/2018/s/Paper 43/Q3

(d) Cobalt reacts with dilute hydrochloric acid to make the salt cobalt(II) chloride. Bubbles of hydrogen gas are produced.



- (iii) Use collision theory to explain how heating the dilute hydrochloric acid makes the rate of reaction faster.

.....

.....

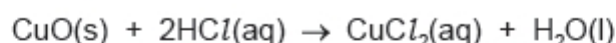
.....

.....

..... [3]

Q# 4/ IGCSE Chemistry/2017/w/Paper 41/

7 Copper(II) oxide reacts with dilute hydrochloric acid.



6.00 g of copper(II) oxide were added to 50.0 cm³ of 1.00 mol/dm³ hydrochloric acid. This was an excess of copper(II) oxide.

- (a) The rate of the reaction can be increased by increasing the concentration of the hydrochloric acid or by heating it.

- (i) In terms of collisions, explain why increasing the concentration of the hydrochloric acid increases the rate of the reaction.

.....

.....

.....

..... [2]

- (ii) In terms of collisions, explain why heating the hydrochloric acid increases the rate of the reaction.

.....

.....

.....

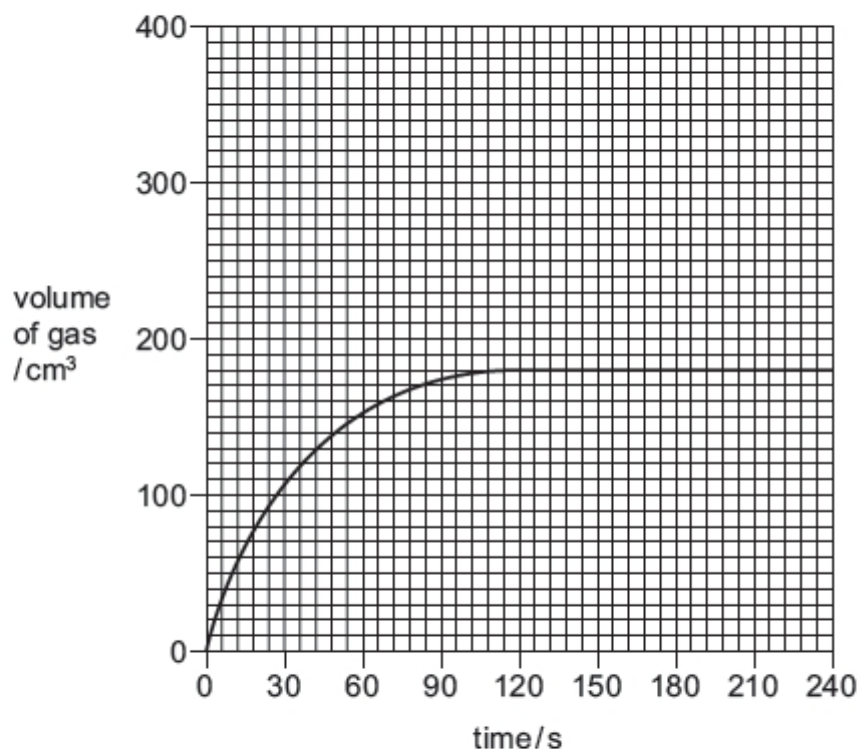
..... [2]



(e) The original graph has been drawn again.

On the grid, draw the graph expected if the concentration of dilute hydrochloric acid is changed from 0.1 mol/dm^3 to 0.2 mol/dm^3 . All other conditions are the same as in the original experiment.

Explain, in terms of particles, why your graph is different from the original graph.

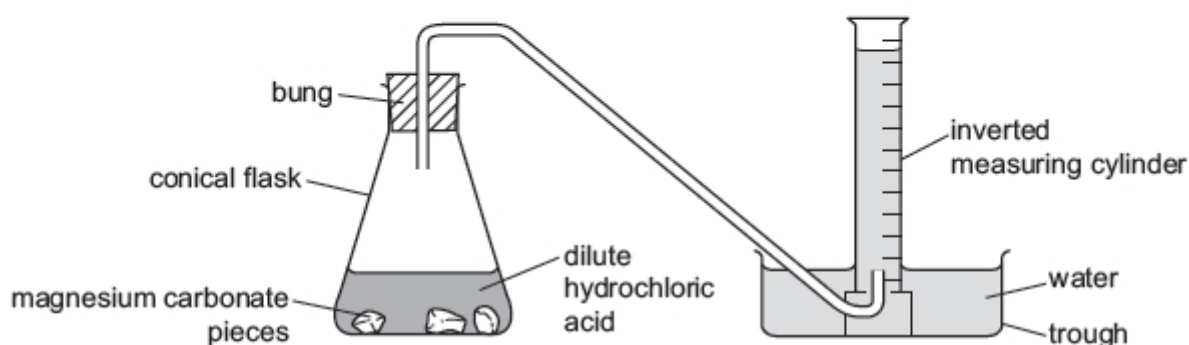


[4]

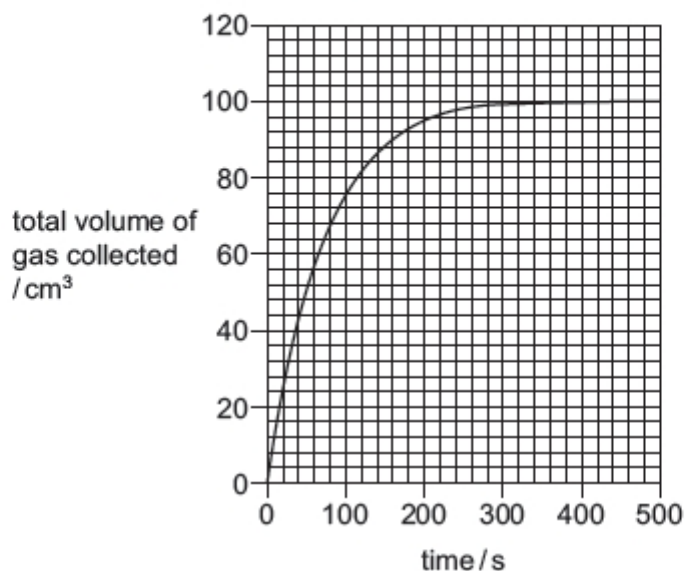
8 Magnesium carbonate reacts with dilute hydrochloric acid.



An excess of magnesium carbonate pieces was added to dilute hydrochloric acid. The apparatus in the diagram was used to measure the volume of gas produced. The total volume of gas collected was recorded every 20 seconds.



(a) The results obtained are shown on the graph.



(i) Describe how the rate of this reaction changed during the reaction. Explain why the rate changed in this way.

.....

.....

.....

.....

..... [4]

(ii) The experiment was repeated using the same mass of **powdered** magnesium carbonate with the same volume and concentration of dilute hydrochloric acid.

Explain how the initial rate of reaction and total volume of gas collected would compare to the first experiment.

initial rate of reaction

.....

.....

total volume of gas

.....

..... [4]



- (b) A piece of magnesium ribbon was cleaned. The experiment was repeated using this clean magnesium ribbon instead of magnesium carbonate.



This reaction is exothermic.

The rate of the reaction gradually increased over the first 2 minutes.

Explain why the rate of the reaction increased.

.....

.....

.....

.....

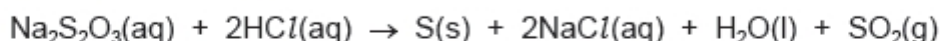
.....

.....

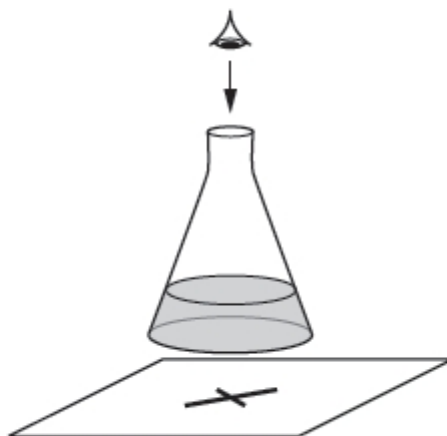
..... [5]

Q# 7/ IGCSE Chemistry/2016/s/Paper 41/

- 3 When aqueous sodium thiosulfate and dilute hydrochloric acid are mixed, a precipitate of insoluble sulfur is produced. This makes the mixture difficult to see through.



The time taken for the cross to disappear from view is measured.



A student adds the following volumes of aqueous sodium thiosulfate, dilute hydrochloric acid and distilled water to the conical flask.

The time taken for the formation of the precipitate of sulfur to make the cross disappear from view is recorded.

experiment number	volume of sodium thiosulfate / cm ³	volume of hydrochloric acid / cm ³	volume of distilled water / cm ³	time taken for cross to disappear from view/s
1	10	10	40	56
2	20	10	30	28
3				

- (ii) Use collision theory to explain why increasing the concentration of sodium thiosulfate would change the rate of reaction.

.....

.....

.....

..... [2]

- (c) The student repeated experiment 1 at a higher temperature.

Use collision theory to explain why the rate of reaction would increase.

.....

.....

.....

..... [3]

Mark Scheme Extension Classroom Active Learning Tasks Dealing With Multi-mark Questions Based on Rate of reaction 43 Marks

Q# 1/ IGCSE Chemistry/2018/w/Paper 43/

5(a)	M1 volume of gas M2 time	2
5(b)	M1 rate decreases / reaction gets slower M2 concentration of acid decreases M3 fewer collisions per unit time	3



5(c)	M1 particles have more kinetic energy M2 particles move faster M3 more collisions per unit time M4 more of the particles have energy greater than or equal to activation energy / more of the collisions have energy greater than or equal to activation energy OR more of the particles have sufficient energy to react / more of the collisions have sufficient energy to react OR A greater percentage or greater proportion or greater fraction of collisions are successful	4
------	---	----------

Q# 2/ IGCSE Chemistry/2018/w/Paper 42/

4(c)	M1 Time taken is less M2 (particles) have more energy M3 (particles) move faster M4 More collisions (of particles) occur per second / per unit time M5 More (of the) particles / collisions have energy greater than activation energy or More (of the) particles / collisions have sufficient energy to react or A greater percentage / proportion / fraction of collisions (of particles) are successful	5
------	---	----------

Q# 3/ IGCSE Chemistry/2018/s/Paper 43/

3(d)(iii)	(particles) have more energy / (particles) move faster	1
	more collisions per second / greater collision rate	1
	more of the colliding molecules have sufficient energy (activation energy) to react	1

Q# 4/ IGCSE Chemistry/2017/w/Paper 41/

7(a)(i)	more particles (of acid) in a given volume / dm^3 / cm^3	1
	more collisions per second / unit time OR greater collision rate	1
7(a)(ii)	particles have more energy / particles move faster / more collisions per second / more collisions per unit time / greater collision rate	1
	more (of the) particles / collisions have energy greater than the activation energy / more particles have sufficient energy to react / more collisions have sufficient energy to react / a greater percentage of collisions are successful	1

Q# 5/ IGCSE Chemistry/2017/s/Paper 41/

5(d)	curve starts from (0,0) and has a lower gradient than the original curve	1
	because lumps have a lower surface area	1
5(d)	curve starts from (0,0) and has a lower gradient than the original curve	1
	because lumps have a lower surface area	1



Q# 6/ IGCSE Chemistry/2016/w/Paper 41/

8(a)(i)	any 4 from: slowed down acid became less concentrated OR fewer particles per unit volume fewer collisions per second OR lower collision rate (then the reaction) stopped all the hydrochloric acid reacted	4
8(a)(ii)	any 4 from: faster (reaction) (powder has) larger surface area more collisions per second OR higher collision rate same volume of gas amount/moles hydrochloric acid is not changed	4
8(b)	any 5 from: temperature increased particles have more energy (particles) move faster more collisions per second OR higher collision rate more particles have sufficient energy to react/activation energy more of the collisions are successful	5

Q# 7/ IGCSE Chemistry/2016/s/Paper 41/

3(b)(ii)	M1 more particles per unit volume/particles are closer together; M2 increases the rate of collisions/there are more collisions per unit time;	1 1	2
3(c)	M1 particles gain more energy and move faster; M2 increasing rate of collisions/more collisions per unit time; M3 higher proportion of particles have sufficient energy to react/collisions have sufficient energy to react/are above the activation energy;	1 1 1	3

13.7 ESSENTIAL EXAM QUESTIONS Paper 2 Topic 7.1 & 7.2 12marks

Q# 1/ iGCSE Chemistry/2018/w/Paper 23/

14 Dilute hydrochloric acid reacts with 1 g of limestone.

Which conditions produce the fastest rate of reaction?

- A 2 mol/dm³ hydrochloric acid and a single lump of limestone
- B 4 mol/dm³ hydrochloric acid and a single lump of limestone
- C 4 mol/dm³ hydrochloric acid and small pieces of limestone
- D 4 mol/dm³ hydrochloric acid and powdered limestone

Q# 2/ iGCSE Chemistry/2018/w/Paper 22/

14 The rate of reaction between magnesium ribbon and 2 mol/dm³ hydrochloric acid at 25°C to produce hydrogen gas is measured.

In another experiment, either the concentration of the hydrochloric acid or the temperature is changed. All other conditions are kept the same.

Which conditions increase the rate of reaction?

- A 1 mol/dm³ hydrochloric acid at 25°C
- B 2 mol/dm³ hydrochloric acid at 10°C
- C 2 mol/dm³ hydrochloric acid at 20°C
- D 3 mol/dm³ hydrochloric acid at 25°C



14 The effects of a change in conditions on a chemical reaction are listed.

- 1 The total number of collisions per minute increased.
- 2 The number of effective collisions per minute increased.
- 3 The average energy of the particles increased.

Which change in conditions caused all of these effects?

- A addition of a catalyst
- B increasing the concentration of a solution of a reactant
- C increasing the surface area of a solid reactant
- D increasing the temperature

14 Which row describes the effects of increasing both concentration and temperature on the collisions between reacting particles?

	increasing concentration	increasing temperature
A	more collisions per second only	more collisions per second only
B	more collisions per second and more collisions with sufficient energy to react	more collisions per second only
C	more collisions per second only	more collisions per second and more collisions with sufficient energy to react
D	more collisions per second and more collisions with sufficient energy to react	more collisions per second and more collisions with sufficient energy to react

15 A student adds dilute hydrochloric acid at two different temperatures to two different lumps of limestone. The lumps of limestone have the same mass.

The carbon dioxide gas produced is collected in a gas syringe.

The volume of carbon dioxide collected in 1 minute at each temperature is shown.

temperature / °C	volume of carbon dioxide produced in 1 minute / cm ³
25	10
50	40

Which row describes and explains the results obtained at 50 °C compared with 25 °C?

	reaction rate	energy of collisions
A	higher	lower
B	higher	higher
C	lower	lower
D	lower	higher



Q# 6/ iGCSE Chemistry/2017/w/Paper 23/

15 Which statement about the effect of concentration and temperature on the rate of a reaction is **not** correct?

- A If the concentration of a reactant is increased, the rate of reaction increases because more particles have sufficient energy to react.
- B If the concentration of a reactant is increased, the rate of reaction increases because there are more collisions between particles per second.
- C If the temperature is increased, the rate of reaction increases because there are more collisions between particles per second.
- D If the temperature is increased, the rate of reaction increases because more particles have sufficient energy to react.

Q# 7/ iGCSE Chemistry/2017/w/Paper 22/

15 Four statements about the effect of increasing temperature on a reaction are shown.

- 1 The activation energy becomes lower.
- 2 The particles move faster.
- 3 There are more collisions between reacting particles.
- 4 There are more collisions which have energy greater than the activation energy.

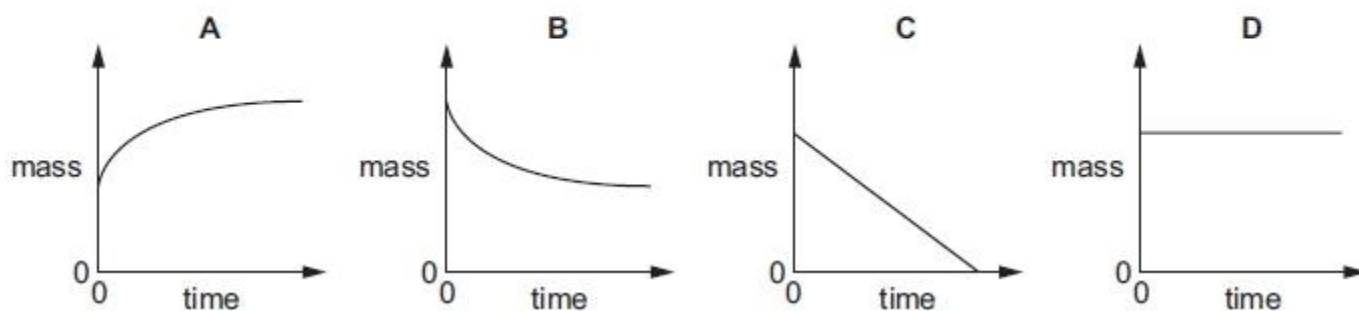
Which statements are correct?

- A 1, 2 and 3 B 1, 3 and 4 C 2, 3 and 4 D 2 and 3 only

Q# 8/ iGCSE Chemistry/2017/w/Paper 21/

13 The mass of a beaker and its contents is plotted against time.

Which graph represents what happens when sodium carbonate reacts with an excess of dilute hydrochloric acid in an open beaker?



Q# 9/ iGCSE Chemistry/2017/s/Paper 23/

14 Which changes are physical changes?

- 1 melting ice to form water
- 2 burning hydrogen to form water
- 3 adding sodium to water
- 4 boiling water to form steam

- A 1 and 2 B 1 and 4 C 2 and 3 D 3 and 4



14 A gas is produced when calcium carbonate is heated.

Which type of change is this?

- A chemical
- B exothermic
- C physical
- D separation

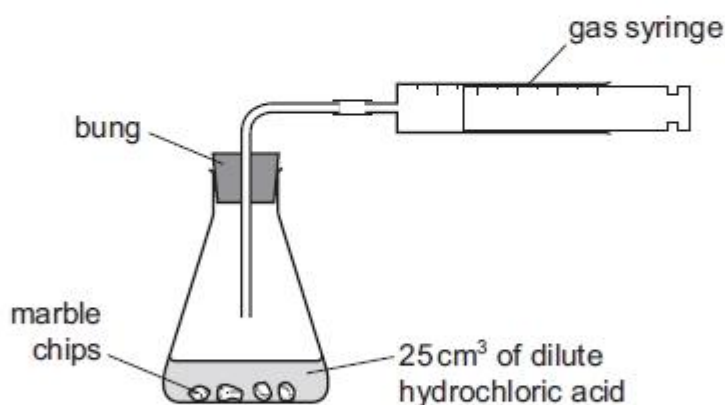
14 When sulfur is heated it undergoes a1..... change as it melts.

Further heating causes the sulfur to undergo a2..... change and form sulfur dioxide.

Which words complete gaps 1 and 2?

	1	2
A	chemical	chemical
B	chemical	physical
C	physical	chemical
D	physical	physical

15 A student was investigating the reaction between marble chips and dilute hydrochloric acid.



Which changes slow down the rate of reaction?

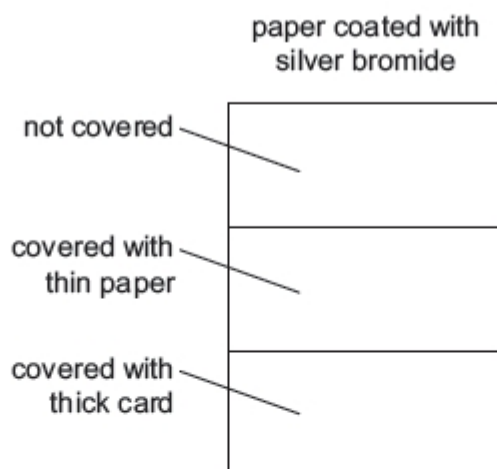
	temperature of acid	concentration of acid	surface area of marble chips
A	decrease	decrease	decrease
B	decrease	decrease	increase
C	increase	decrease	decrease
D	increase	increase	increase



Q# 1/ iGCSE Chemistry/2015/w/Paper 31/Q7

7 The rate of a photochemical reaction is affected by light.

(b) A piece of white paper was coated with silver bromide and exposed to the light. Sections of the paper were covered as shown in the diagram.



Predict the appearance of the different sections of the paper after exposure to the light and the removal of the card. Explain your predictions.

.....

.....

.....

.....

.....

.....

..... [4]

(c) Photosynthesis is another example of a photochemical reaction. Green plants can make simple carbohydrates, such as glucose. These can polymerise to make more complex carbohydrates, such as starch.

(i) Write a word equation for photosynthesis.

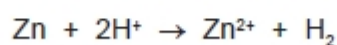
..... [2]

(ii) Name the substance which is responsible for the colour in green plants and is essential for photosynthesis.

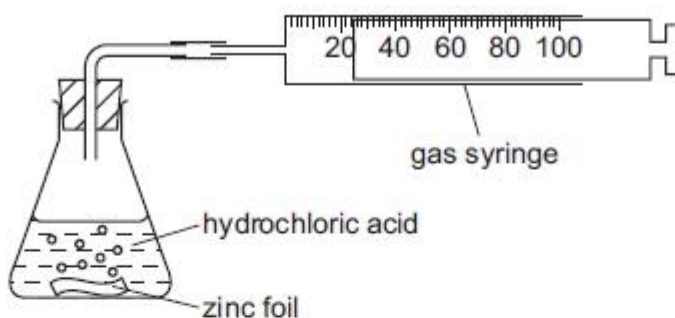
..... [1]

Q# 2/ iGCSE Chemistry/2015/s/Paper 31/

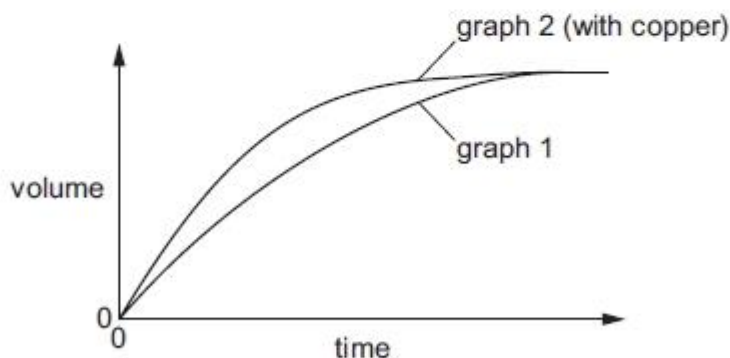
3 (a) The reactions between metals and acids are redox reactions.



- (b) The rate of reaction between a metal and an acid can be investigated using the apparatus shown below.



A piece of zinc foil was added to 50 cm³ of hydrochloric acid, of concentration 2.0 mol / dm³. The acid was in excess. The hydrogen evolved was collected in the gas syringe and its volume measured every minute. The results were plotted and labelled as graph 1.



The experiment was repeated to show that the reaction between zinc metal and hydrochloric acid is catalysed by copper. A small volume of aqueous copper(II) chloride was added to the acid before the zinc was added. The results of this experiment were plotted on the same grid and labelled as graph 2.

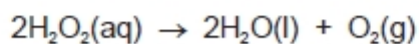
- (i) Explain why the reaction mixture in the second experiment contains copper metal. Include an equation in your explanation.

.....
..... [2]

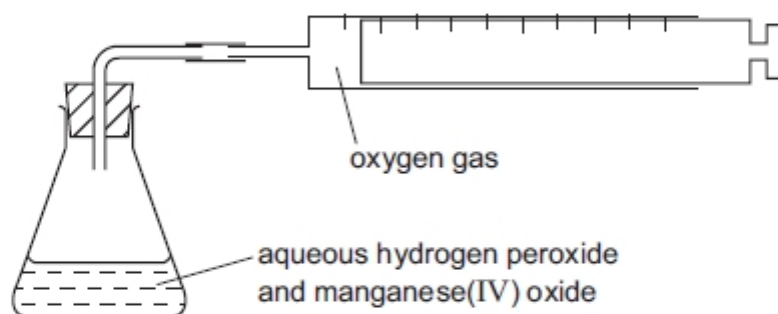
- (ii) Explain how graph 2 shows that copper catalyses the reaction.

.....
.....
..... [3]

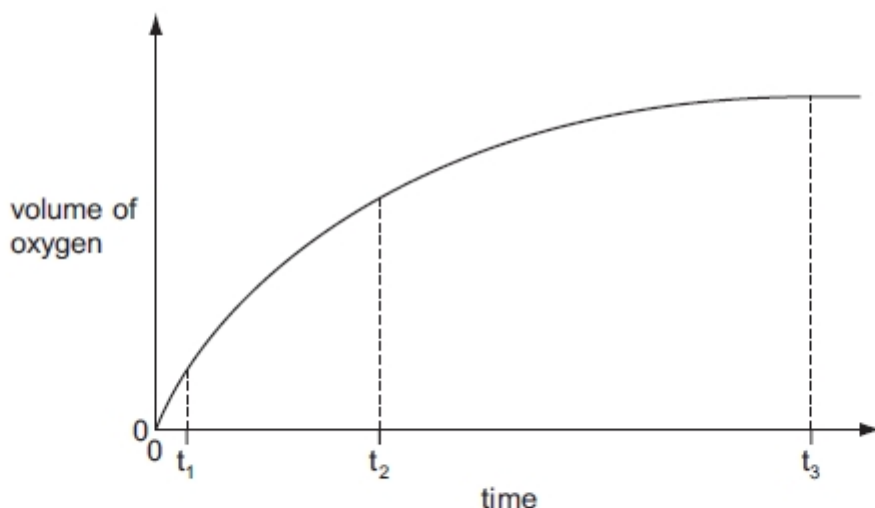
- 6 Hydrogen peroxide decomposes to form water and oxygen. This reaction is catalysed by manganese(IV) oxide.



The rate of this reaction can be investigated using the following apparatus.



40 cm³ of aqueous hydrogen peroxide was put in the flask and 0.1 g of small lumps of manganese(IV) oxide was added. The volume of oxygen collected was measured every 30 seconds. The results were plotted to give the graph shown below.



- (a) (i) How do the rates at times t_1 , t_2 and t_3 differ?

.....
 [2]

- (ii) Explain the trend in reaction rate that you described in (a)(i).

.....

 [2]



(b) The experiment was repeated using 0.1 g of finely powdered manganese(IV) oxide. All the other variables were kept the same.

(i) On the axes opposite, sketch the graph that would be expected. [2]

(ii) Explain the shape of this graph.

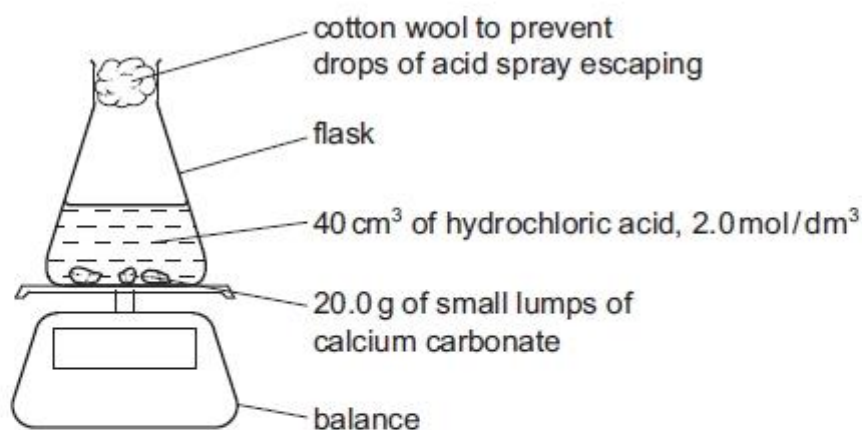
.....
.....
..... [2]

(c) Describe how you could show that the catalyst, manganese(IV) oxide, was not used up in the reaction. Manganese(IV) oxide is insoluble in water.

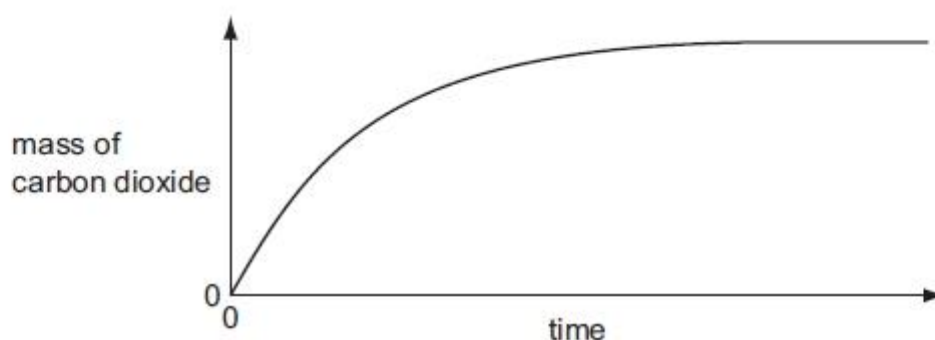
.....
.....
.....
..... [4]

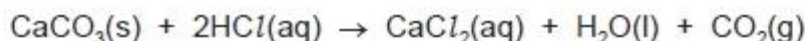
Q# 4/ iGCSE Chemistry/2013/w/Paper 31/

- 4 20.0 g of small lumps of calcium carbonate and 40 cm³ of hydrochloric acid, concentration 2.0 mol / dm³, were placed in a flask on a top pan balance. The mass of the flask and contents was recorded every minute.



The mass of carbon dioxide given off was plotted against time.





In all the experiments mentioned in this question, the calcium carbonate was in excess.

- (a) (i) Explain how you could determine the mass of carbon dioxide given off in the first five minutes.

..... [1]

- (ii) Label the graph **F** where the reaction rate is the fastest, **S** where it is slowing down and **0** where the rate is zero. [2]

- (iii) Explain how the shape of the graph shows where the rate is fastest, where it is slowing down and where the rate is zero.

.....

 [2]

- (b) Sketch on the same graph, the line which would have been obtained if 20.0 g of small lumps of calcium carbonate and 80 cm³ of hydrochloric acid, concentration 1.0 mol/dm³, had been used. [2]

- (c) Explain in terms of collisions between reacting particles each of the following.

- (i) The reaction rate would be slower if 20.0 g of larger lumps of calcium carbonate and 40 cm³ of hydrochloric acid, concentration 2.0 mol/dm³, were used.

.....

 [2]

- (ii) The reaction rate would be faster if the experiment was carried out at a higher temperature.

.....

 [2]



- 3 A small piece of marble, CaCO_3 , was added to 5.0 cm^3 of hydrochloric acid, concentration 1.0 mol/dm^3 , at 25°C . The time taken for the reaction to stop was measured. The experiment was repeated using 5.0 cm^3 of different solutions of acids. The acid was in excess in all of the experiments.

Typical results are given in the table.

experiment	temperature / $^\circ\text{C}$	acid solution	time / min
1	25	hydrochloric acid 1.0 mol/dm^3	3
2	25	hydrochloric acid 0.5 mol/dm^3	7
3	25	ethanoic acid 1.0 mol/dm^3	10
4	15	hydrochloric acid 1.0 mol/dm^3	8

- (a) (i) Explain why it is important that the pieces of marble are the same size and the same shape.

.....

 [2]

- (ii) How would you know when the reaction had stopped?

..... [1]

- (c) (i) Explain why the reaction in experiment 1 is faster than the reaction in experiment 2.

..... [1]

- (iii) Explain in terms of collisions between reacting particles why experiment 4 is slower than experiment 1.

.....

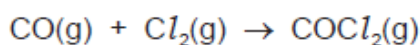
 [3]



Q# 6/ iGCSE Chemistry/2012/w/Paper 31/

5 Carbonyl chloride, COCl_2 , is widely used in industry to make polymers, dyes and pharmaceuticals.

(a) Carbonyl chloride was first made in 1812 by exposing a mixture of carbon monoxide and chlorine to bright sunlight. This is a photochemical reaction.



(i) Explain the phrase *photochemical reaction*.

.....
..... [2]

(ii) Give another example of a photochemical reaction and explain why it is important either to the environment or in industry.

.....
.....
..... [3]

Q# 7/ iGCSE Chemistry/2012/w/Paper 31/

5 Carbonyl chloride, COCl_2 , is widely used in industry to make polymers, dyes and pharmaceuticals.

(iii) Explain why a catalyst is used.

..... [1]

Q# 8/ iGCSE Chemistry/2012/w/Paper 31/

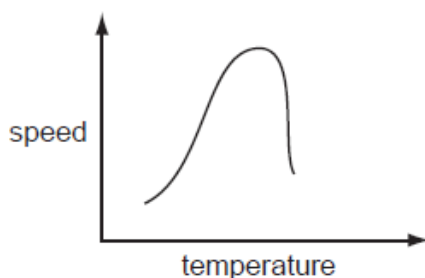
3 The speed (rate) of a chemical reaction depends on a number of factors which include temperature and the presence of a catalyst.

(a) Reaction speed increases as the temperature increases.

(i) Explain why reaction speed increases with temperature.

.....
.....
..... [3]

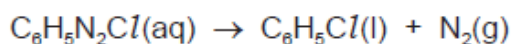
(ii) Reactions involving enzymes do not follow the above pattern.
The following graph shows how the speed of such a reaction varies with temperature.



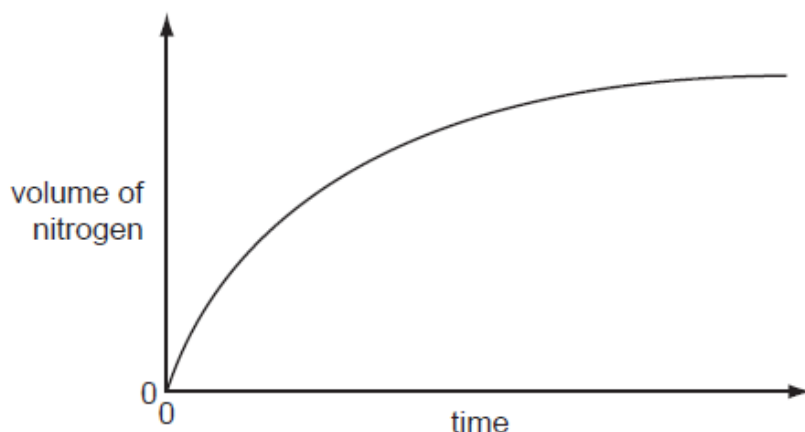
Suggest an explanation why initially the reaction speed increases then above a certain temperature the speed decreases.

.....
..... [2]

(b) An organic compound decomposes to give off nitrogen.



The speed of this reaction can be determined by measuring the volume of nitrogen formed at regular intervals. Typical results are shown in the graph below.



(i) The reaction is catalysed by copper.

Sketch the graph for the catalysed reaction on the diagram above. [2]

(ii) How does the speed of this reaction vary with time?

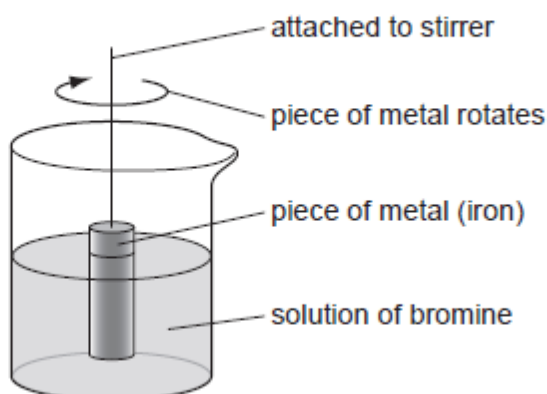
..... [1]

(iii) Why does the speed of reaction vary with time?

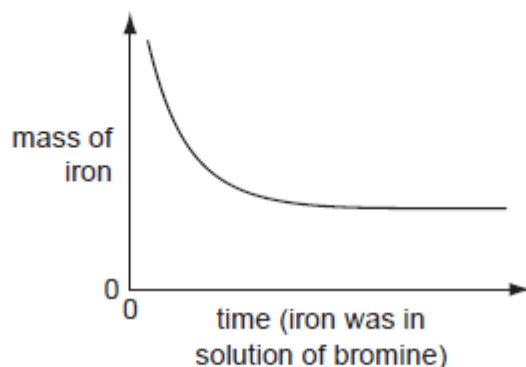
.....
..... [2]

Q# 9/ iGCSE Chemistry/2011/w/Paper 31/

5 The rate of the reaction between iron and aqueous bromine can be investigated using the apparatus shown below.



- (a) A piece of iron was weighed and placed in the apparatus. It was removed at regular intervals and the clock was paused. The piece of iron was washed, dried, weighed and replaced. The clock was restarted. This was continued until the solution was colourless. The mass of iron was plotted against time. The graph shows the results obtained.



- (i) Suggest an explanation for the shape of the graph.

.....

 [3]

- (ii) Predict the shape of the graph if a similar piece of iron with a much rougher surface had been used. Explain your answer.

.....
 [2]

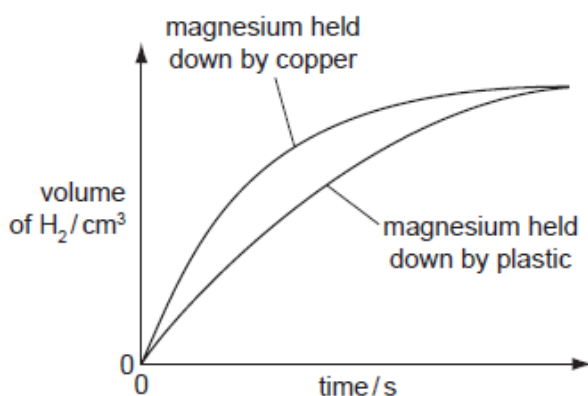
- (iii) Describe how you could find out if the rate of this reaction depended on the speed of stirring.

.....

 [2]

Q# 10/ iGCSE Chemistry/2010/s/Paper 31/ Q4

- (b) The only difference in the two experiments was the method used to hold down the magnesium. The results are shown below.



(i) In which experiment did the magnesium react faster?

..... [1]

(ii) Suggest a reason why the experiment chosen in (i) had the faster rate.

..... [1]

(d) Give **two** factors which would alter the rate of this reaction.
For each factor explain why it alters the rate.

factor

explanation

.....

factor

explanation

..... [4]

Q# 11/ iGCSE Chemistry/2008/s/Paper 31/

6 Three of the factors that can influence the rate of a chemical reaction are:

- physical state of the reactants
- light
- the presence of a catalyst

(a) The first recorded dust explosion was in a flour mill in Italy in 1785. Flour contains carbohydrates. Explosions are very fast exothermic reactions.

(i) Use the collision theory to explain why the reaction between the particles of flour and the oxygen in the air is very fast.

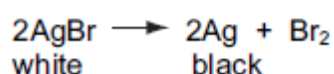
.....

..... [2]

(ii) Write a word equation for this exothermic reaction.

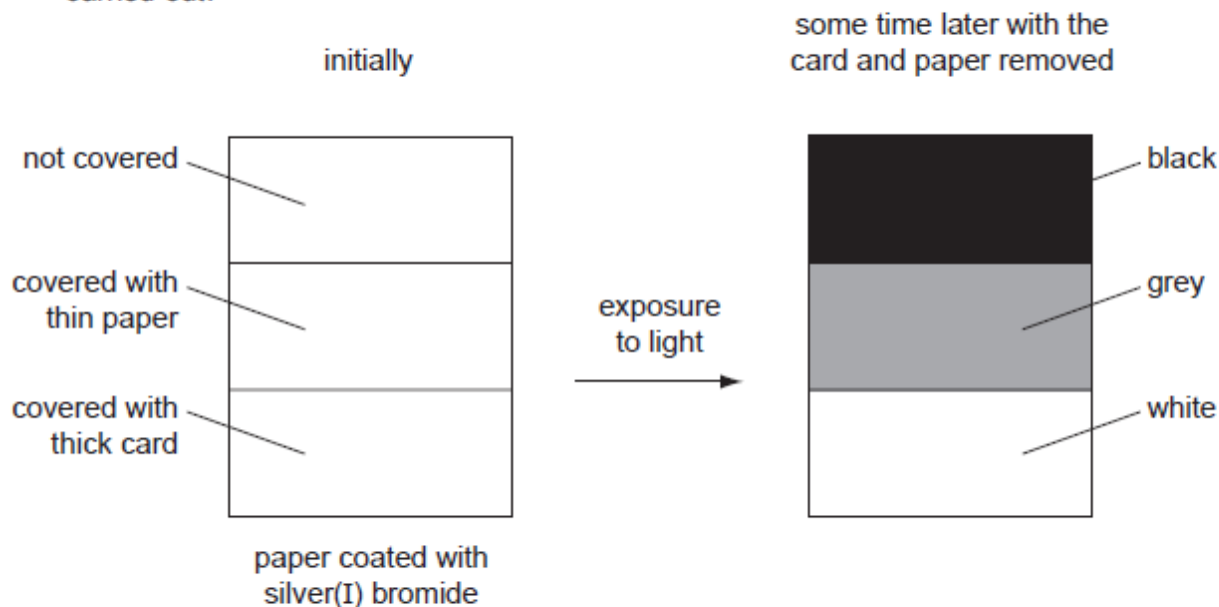
..... [1]

The decomposition of silver(I) bromide is the basis of film photography. The equation for this decomposition is:



This reaction is photochemical.

A piece of white paper was coated with silver(I) bromide and the following experiment was carried out.



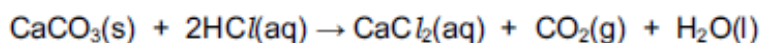
(b) Explain the results.

.....

 [3]

Q# 12/ iGCSE Chemistry/2007/w/Paper 3/

- 7 (a) A small piece of marble, calcium carbonate, was added to 5 cm³ of hydrochloric acid at 25 °C. The time taken for the reaction to stop was measured.



Similar experiments were performed always using 5 cm³ of hydrochloric acid.

experiment	number of pieces of marble	concentration of acid in mol / dm ³	temperature / °C	time / min
1	1	1.00	25	3
2	1	0.50	25	7
3	1 piece crushed	1.00	25	1
4	1	1.00	35	2



Explain each of the following in terms of **collisions between reacting particles**.

(i) Why is the rate in experiment 2 slower than in experiment 1?

.....
..... [2]

(ii) Why is the rate in experiment 3 faster than in experiment 1?

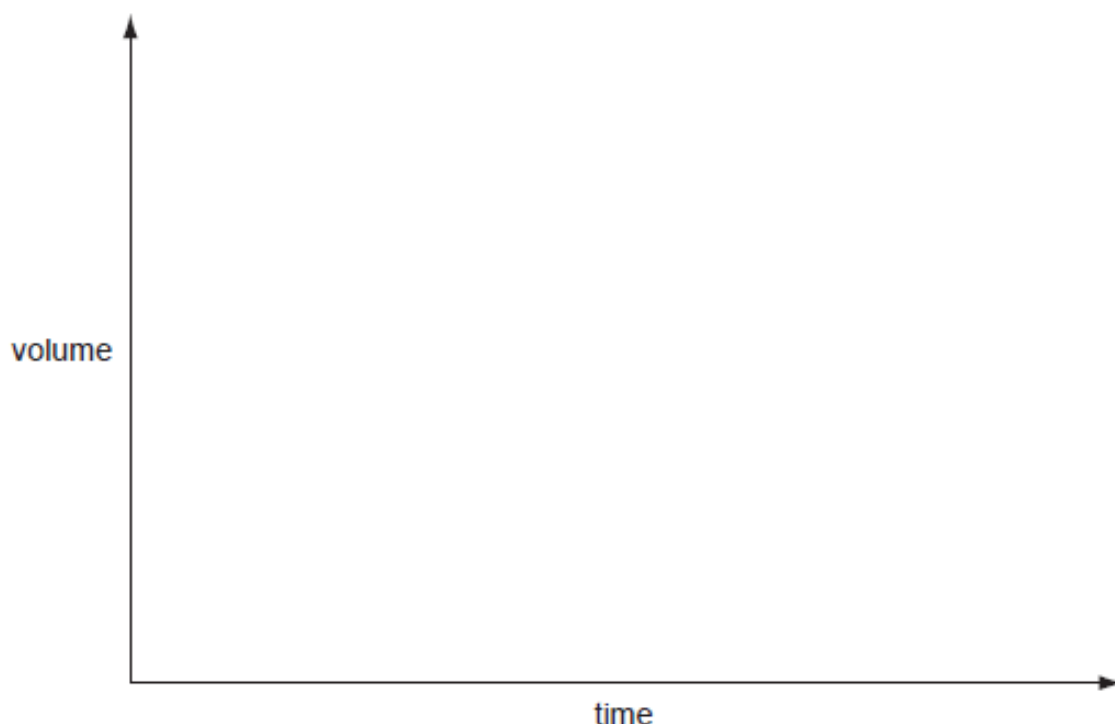
.....
..... [2]

(iii) Why is the rate in experiment 4 faster than in experiment 1?

.....
..... [2]

(b) An alternative method of measuring the rate of this reaction would be to measure the volume of carbon dioxide produced at regular intervals.

(i) Sketch this graph

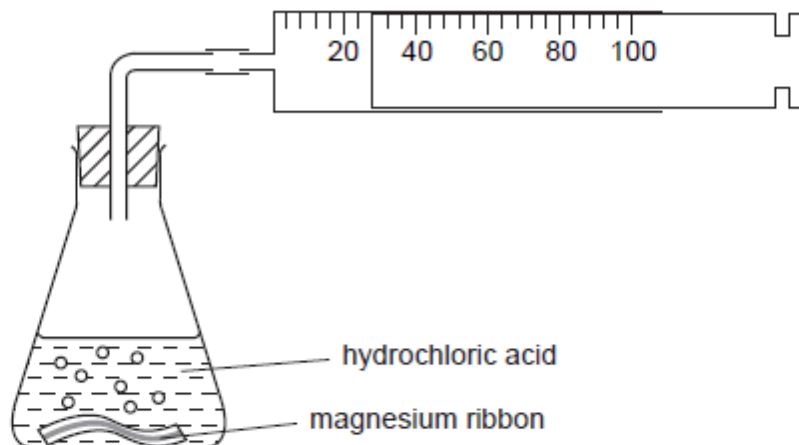


[2]

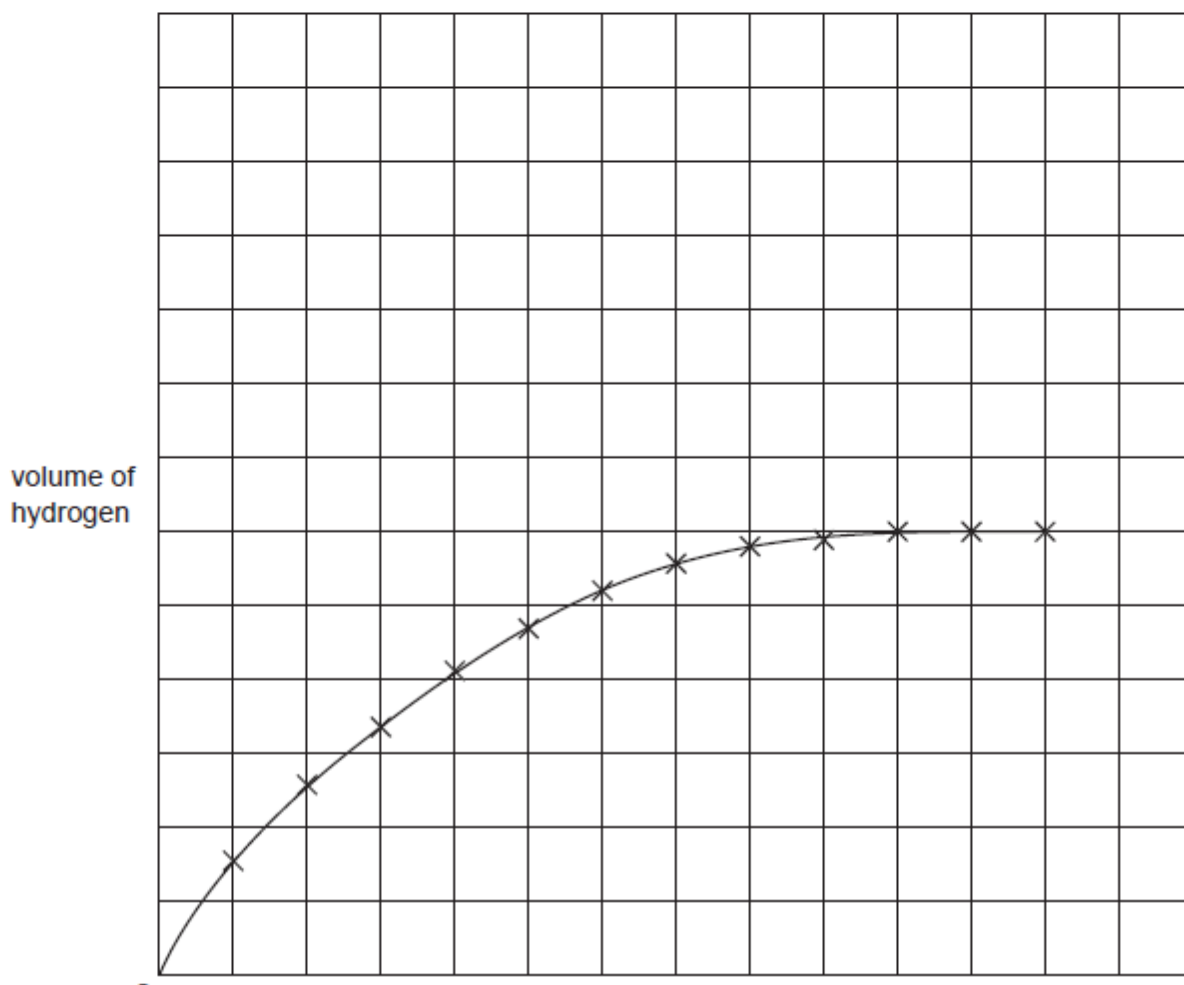


- 7 The rate of a reaction depends on concentration of reactants, temperature and possibly a catalyst or light.

(a) A piece of magnesium ribbon was added to 100 cm^3 of 1.0 mol/dm^3 hydrochloric acid. The hydrogen evolved was collected in a gas syringe and its volume measured every 30 seconds.



In all the experiments mentioned in this question, the acid was in excess.
The results were plotted to give a graph.



- (i) The experiment was repeated. Two pieces of magnesium ribbon were added to 100 cm^3 of 1.0 mol/dm^3 hydrochloric acid. Sketch this graph on the same grid and label it X.

[2]

- (ii) The experiment was repeated using one piece of magnesium ribbon and 100 cm^3 of 1.0 mol/dm^3 ethanoic acid. Describe how the **shape** of this graph would differ from the one given on the grid.

..... [2]

- (b) Reaction rate increases when concentration or temperature is increased. Using the idea of reacting particles, explain why;

increasing concentration increases reaction rate,

..... [2]

increasing temperature increases reaction rate.

..... [2]

- (c) The rate of a photochemical reaction is affected by light. A reaction, in plants, between carbon dioxide and water is photochemical.

- (i) Name the **two** products of this reaction.

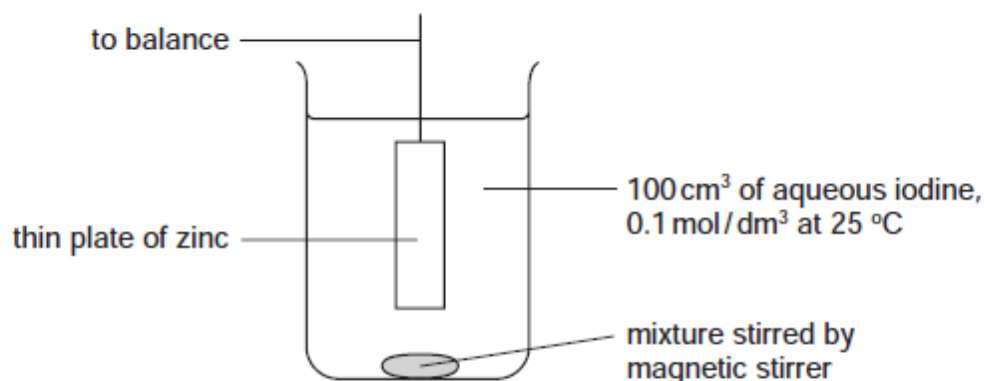
..... [2]

- (ii) This reaction will only occur in the presence of light and another chemical. Name this chemical.

..... [1]

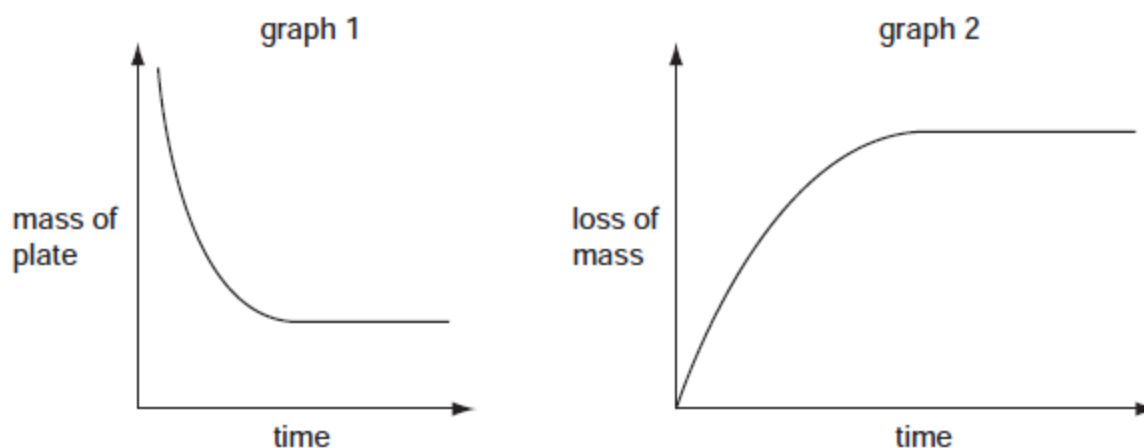


- 2 The following apparatus was used to measure the rate of the reaction between zinc and iodine.



The mass of the zinc plate was measured every minute until the reaction was complete.

- (c) From the results of this experiment two graphs were plotted.



- (i) Which reagent iodine or zinc was in excess? Give a reason for your choice.

..... [1]

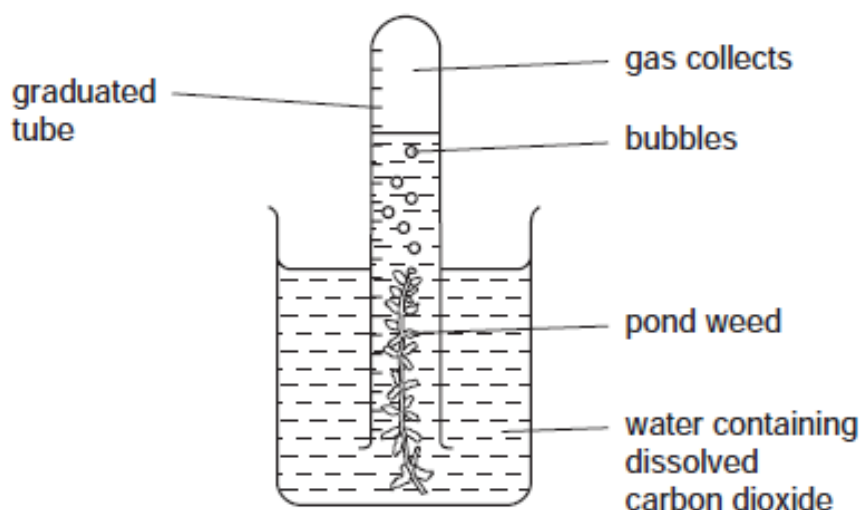
- (ii) Describe how the shape of graph 1 would change if 100cm³ of 0.05 mol/dm³ iodine had been used.

..... [2]

- (iii) On graph 2, sketch the shape if the reaction had been carried out using 100 cm³ of 0.1 mol/dm³ iodine at 35 °C instead of at 25 °C. [2]



(d) The rate of photosynthesis of pond weed can be measured using the following experiment.



(i) Describe how you could show that the gas collected in this experiment is oxygen.

[1]

(ii) What measurements are needed to calculate the rate of this reaction?

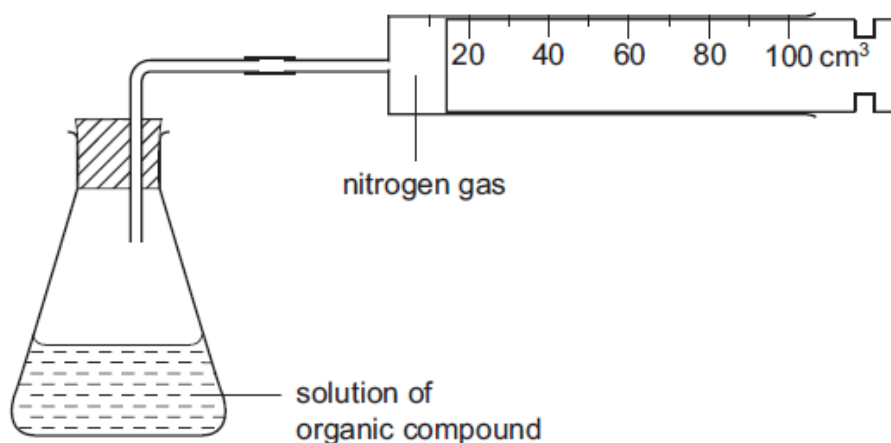
[2]

(iii) What would be the effect, and why, of moving the apparatus further away from the light?

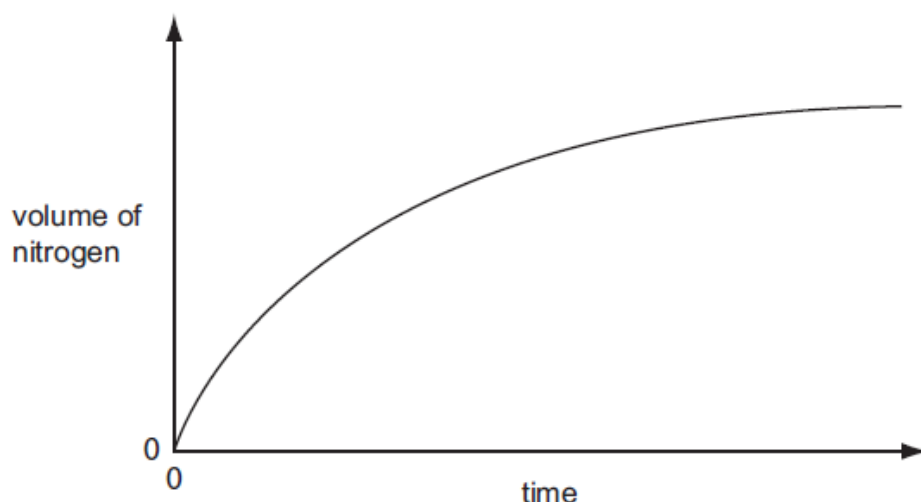
[2]

Q# 16/ iGCSE Chemistry/2004/s/Paper 3/ Q3

(c) The rate of this reaction can be measured using the following apparatus.



The results of this experiment are shown on the graph below.



(i) How does the rate of this reaction vary with time?

.....
 [1]

(ii) Why does the rate vary?

.....
 [2]

(iii) The reaction is catalysed by copper powder. Sketch the graph for the catalysed reaction on the same grid. [2]

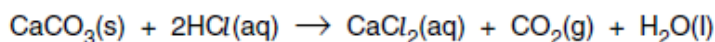
(iv) Why is copper powder more effective as a catalyst than a single piece of copper?

..... [1]

Q# 17/ iGCSE Chemistry/2003/w/Paper 3/

2 Some of the factors that can determine the rate of a reaction are concentration, temperature and light intensity.

(a) A small piece of calcium carbonate was added to an excess of hydrochloric acid. The time taken for the carbonate to react completely was measured.



The experiment was repeated at the same temperature, using pieces of calcium carbonate of the same size but with acid of a different concentration. In all the experiments an excess of acid was used.

concentration of acid / mol dm ⁻³	4	2	2	.....
number of pieces of carbonate	1	1	2	1
time / s	.....	80	.....	160



(i) Complete the table (assume the rate is proportional to both the acid concentration and the number of pieces of calcium carbonate). [3]

(ii) Explain why the reaction rate would increase if the temperature was increased.

.....
[2]

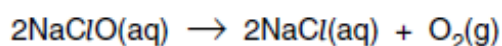
(iii) Explain why the rate of this reaction increases if the piece of carbonate is crushed to a powder.

.....[1]

(iv) Fine powders mixed with air can explode violently. Name an industrial process where there is a risk of this type of explosion.

.....
[1]

(b) Sodium chlorate(I) decomposes to form oxygen and sodium chloride. This is an example of a photochemical reaction. The rate of reaction depends on the intensity of the light.



(i) Describe how the rate of this reaction could be measured.

.....
[2]

(ii) How could you show that this reaction is photochemical?

.....
[1]

13.8.1 ESSENTIAL EXAM QUESTIONS Paper 3/4 T7.1 & 7.2 139marks Mark Scheme

Q# 1/ iGCSE Chemistry/2015/w/Paper 31/

7(b)	<i>prediction:</i> the 'not covered' section will be black; the 'covered in thick card' section will be white/ cream; the 'covered in thin card' section will be grey; <i>explanation:</i> the more light, the more silver ions are reduced;	1 1 1 1
7(c)(i)	carbon dioxide + water → glucose + oxygen reactants correct; products correct;	1 1
7(c)(ii)	chlorophyll;	1



Q# 2/ iGCSE Chemistry/2015/s/Paper 31/

3(b)(i)	zinc displaces copper or zinc more reactive than copper; $\text{Zn} + \text{CuCl}_2 \rightarrow \text{ZnCl}_2 + \text{Cu}$ OR $\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Cu} + \text{Zn}^{2+}$;		A copper less reactive than zinc I zinc reacts with copper ions or with Cu^{2+} or with copper chloride I zinc reacts with copper I Cu^{2+} ions are reduced A multiples I state symbols
3(b)(ii)	steeper (line) or higher gradient; (means an) increased rate; but the same (final) volume;		A less time to complete the reaction/same amount of gas in less time/faster reaction/ more gas in the same time period A same volume of hydrogen produced A "amount" for volume 3 A no extra gas is made

Q# 3/ iGCSE Chemistry/2014/s/Paper 31/

6 (a) (i) rate at t_2 less than at t_1 or the rate decreases (1)

rate at t_3 zero / reaction stopped (1) [2]

(ii) rate at t_2 less than at t_1 because **concentration** of hydrogen peroxide is less
at t_2 or **concentration** of hydrogen peroxide is decreasing. (1)

(rate at t_3 zero / reaction stopped because) hydrogen peroxide is used up (1) [2]

(b) (i) steeper and must come from the origin (1)
final volumes the same (1) [2]

(ii) Any **two** from: [2]
steeper curve because of a faster rate
faster rate because of increased surface area
same amount / volume / mass / no of mol of hydrogen peroxide
ecf for M1 for a shallower curve because of slower rate.

(c) filter (and rinse / wash) (1)

dry manganese (IV) oxide (1)

weigh / measure mass manganese(IV) oxide after reaction (1)

the mass should be 0.1 g or unchanged. (1) [4]

Q# 4/ iGCSE Chemistry/2013/w/Paper 31/

4 (a) (i) (mass at $t = 0$) – (mass at $t = 5$) [1]
NOTE: must have mass at $t = 5$ not final mass

(ii) fastest at origin
slowing down between origin and flat section gradient = 0
where gradient = 0
three of above in approximately the correct positions [2]

(iii) 3 correct comments about gradient = [2]
2 correct comments about gradient = [1]
1 correct comment about gradient = [0] [2]

(b) start at origin and smaller gradient [1]
same final mass just approximate rather than exact [1]



- (c) (i) smaller surface area [1]
lower collision rate [1]
- (ii) molecules have more energy [1]
collide more frequently / more molecules have enough energy to react [1]

Q# 5/ iGCSE Chemistry/2013/s/Paper 31/

- 3 (a) (i) pieces have (same) surface area [1]
same amount / mass / quantity / volume / number of moles of carbonate [1]
- (ii) no more bubbles / carbon dioxide or piece disappears / dissolves [1]
- (b) experiment 1 $\text{Ca}^{2+} + \text{CO}_2 + \text{H}_2\text{O}$ [1]
- (c) (i) more concentrated or higher concentration (of acid) (in experiment 1) [1]
accept: arguments based on collision theory
- (iii) lower temperature (particles) have less energy [1]
moving more slowly [1]
fewer collisions / lower collision rate [1]
or
lower temperature (particles) have less energy [1]
fewer particles collide [1]
with the necessary energy to react [1]
note: less energy fewer successful collisions gains all 3 marks

Q# 6/ iGCSE Chemistry/2012/w/Paper 31/

- 5 (a) (i) rate of reaction; [1]
influenced by light / only happens in light; [1]
or:
turns light into chemical energy = [2]
accept: light is catalyst = [1]
- (ii) reduction of silver halides; [1]
they are reduced to silver / $2\text{AgCl} \rightarrow 2\text{Ag} + \text{Cl}_2$; [1]
appropriate importance given; [1]
or:
photosynthesis;
correct comment about chemistry carbon dioxide to carbohydrates / carbon dioxide to oxygen;
anything sensible e.g. its role in the food chain or decrease greenhouse effect or oxygen for respiration;
or:
chlorination;
making chloroalkanes;
appropriate importance given;

Q# 7/ iGCSE Chemistry/2012/w/Paper 31/ Q5

- (iii) keeps rate high / increase rate at lower temperatures; [1]



Q# 8/ iGCSE Chemistry/2012/w/Paper 31/

- 3 (a) (i) any three from:
 particles have more energy;
 move faster;
 collide more frequently;
 more successful collisions; [3]
accept: atoms or molecules for particles
not: electrons
not: vibrate more
- (ii) reaction faster with temperature increase; [1]
 enzymes denatured / destroyed; [1]
not: killed
- (b) (i) bigger initial gradient; [1]
 same final volume of nitrogen; [1]
- (ii) decrease / slows down; [1]
- (iii) concentration of organic compound decreases; [2]
 compound used up = [1]
or: fewer particles;
 collision rate decreases;

Q# 9/ iGCSE Chemistry/2011/w/Paper 31/

- 5 (a) (i) rate of reaction decreases / gradient decreases [1]
 because concentration of bromine decreases [1]
 reaction stops because all bromine is used up [1]
- (ii) initial rate greater / gradient greater [1]
 because bigger surface area / more particles of iron exposed [1]
or:
 final mass the same [1]
 because mass of bromine is the same so the same mass of iron is used [1]
- (iii) increase / decrease / change rate of stirring / not stirred [1]
 measure new rate / compare results [1]

Q# 10/ iGCSE Chemistry/2010/s/Paper 31/ Q4

- (b) (i) with copper / first experiment [1]
- (ii) copper acts as a catalyst [1]
- (d) temperature / heat [1]
 increase temperature – reaction faster particles have more energy / particles move faster / particles collide more frequently / more particles have enough energy to react
not more excited
accept arguments for a decrease in temperature [1]
- powdered
 greater surface area
 greater collision rate / more particles exposed (to acid)
 any **two** [2]
not concentration / light / catalyst / pressure



Q# 11/ iGCSE Chemistry/2008/s/Paper 31/

- 6 (a) (i) (fine powder) large surface area [1]
high/faster/collision rate/more collisions/fast collisions
 (between solid and oxygen in air) [1]
- (ii) carbohydrate + oxygen → carbon dioxide + water [1]
ACCEPT flour
- (b) rate depends on light
 more light more silver **or** blacker
 thicker card less light [3]

Q# 12/ iGCSE Chemistry/2007/w/Paper 3/

- 7 (a) (i) lower concentration [1]
ACCEPT without reference to experiment 2
 but higher concentration must be referred to expt 1
COND fewer collisions **or** lower rate of collision [1]
- (ii) powdered so larger surface area [1]
COND so more collisions **or** higher rate of collisions [1]
- (iii) higher temperature particles move faster
or more particles have enough energy to react **or** have more energy
or more particles have E_a [1]
COND collide more frequently
or more particles have energy to react
or more collisions result in a reaction [1]
NOTE for conformity faster collisions = rate of collisions
- (b) (i) from origin [1]
 gradient decreases until = 0 [1]
 therefore has to be a curve

Q# 13/ iGCSE Chemistry/2006/w/Paper 3/

- 7 (a) (i) greater initial slope or levels off later [1]
 Twice final volume [1]
- (ii) smaller slope [1]
 same final volume [1]
- (b) more particles in same volume/particles closer together [1]
 greater collision rate [1]
 molecules move faster [1]
 greater collision rate [1]
OR molecules have more energy [1]
 so more will have sufficient energy to react [1]
- (c) (i) glucose [1]
 oxygen [1]
- (ii) chlorophyll [1]



Q# 14/ iGCSE Chemistry/2005/s/Paper 3/ Q2

- (c) (i) zinc and a reason [1]
Do not mark conseq to iodine in excess
- (ii) final mass of zinc bigger **or** the level section higher **or** less zinc used up [1]
gradient less steep **or** longer time **or** falls more slowly [1]
- (iii) steeper gradient [1]
same loss of mass of zinc [1]

Q# 15/ iGCSE Chemistry/2004/w/Paper 3/ Q1 iGCSE Chemistry/201

- (d) (i) glowing splint burst into flame or rekindled [1]
Must have glowing or equivalent idea
OR any similar description that includes the two points glowing and relights.
- (ii) measure volume **or** count bubbles [1]
time [1]
NOT units
- (iii) rate slows down [1]
Because the reaction is photochemical **or** rate depends on intensity of light
or light less bright **or** less light falling on plant **or** light provides energy for
photosynthesis etc. [1]

Q# 16/ iGCSE Chemistry/2004/s/Paper 3/ Q3

- (c) (i) decreases **or** reaction stops **or** rate becomes zero [1]
- (ii) concentration **or** number of effective collisions [1]
decreases [1]
used up **or** less chemical **or** less collisions etc [1] only
- (iii) greater initial slope [1]
same final point [1]
as long as new curve touches the original curve near
the top allocate the mark
- (iv) greater surface area [1]

Q# 17/ iGCSE Chemistry/2003/w/Paper 3/

- 2 (a) (i) 40 [1]
80 **or** 40 [1]
1 [1]
- (ii) particles have more energy **or** moving faster [1]
collide more frequently
or collide with more energy [1]
- (iii) greater surface area [1]
- (iv) flour mills **or** coal mines **or** metal powders [1]
or fireworks **or** gunpowder
- (b) (i) collect and measure volume of oxygen [1]
or mass **or** count bubbles
time [1]
- (ii) measure rate in different light levels and comment [1]
accept if dark no reaction

13.9 ESSENTIAL EXAM QUESTIONS Paper 6 Topic 7.1 and 7.2 151marks



- 2 A student investigated the rate of reaction between solution **L**, solution **M** and hydrochloric acid. When these chemicals react they form iodine. Sodium thiosulfate solution and starch solution were used to show how fast the reaction proceeded.

Five experiments were done.

Experiment 1

- A measuring cylinder was used to add 10 cm³ of solution **L** to a conical flask.
- 10 cm³ of dilute hydrochloric acid, 10 cm³ of sodium thiosulfate solution and 1 cm³ of starch solution were then added to the conical flask.
- The reaction was started by using a measuring cylinder to add 10 cm³ of solution **M** to the conical flask. A timer was started immediately and the mixture was swirled.
- The time taken for the mixture to turn blue-black was measured.
- The conical flask was emptied and rinsed with distilled water.

Experiment 2

- A measuring cylinder was used to add 8 cm³ of solution **L** and 2 cm³ of distilled water to the conical flask.
- 10 cm³ of dilute hydrochloric acid, 10 cm³ of sodium thiosulfate solution and 1 cm³ of starch solution were then added to the conical flask.
- The reaction was started by using a measuring cylinder to add 10 cm³ of solution **M** to the conical flask. The timer was started immediately and the mixture was swirled.
- The time taken for the mixture to turn blue-black was measured.
- The conical flask was emptied and rinsed with distilled water.

Experiment 3

- Experiment 2 was repeated but 6 cm³ of solution **L** and 4 cm³ of distilled water were added to the conical flask before adding the other reagents.

Experiment 4

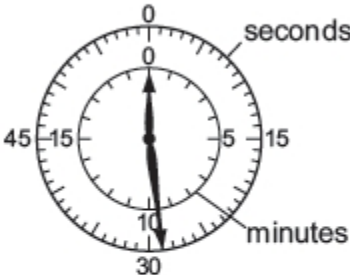
- Experiment 2 was repeated but 5 cm³ of solution **L** and 5 cm³ of distilled water were added to the conical flask before adding the other reagents.

Experiment 5

- Experiment 2 was repeated but 3 cm³ of solution **L** and 7 cm³ of distilled water were added to the conical flask before adding the other reagents.



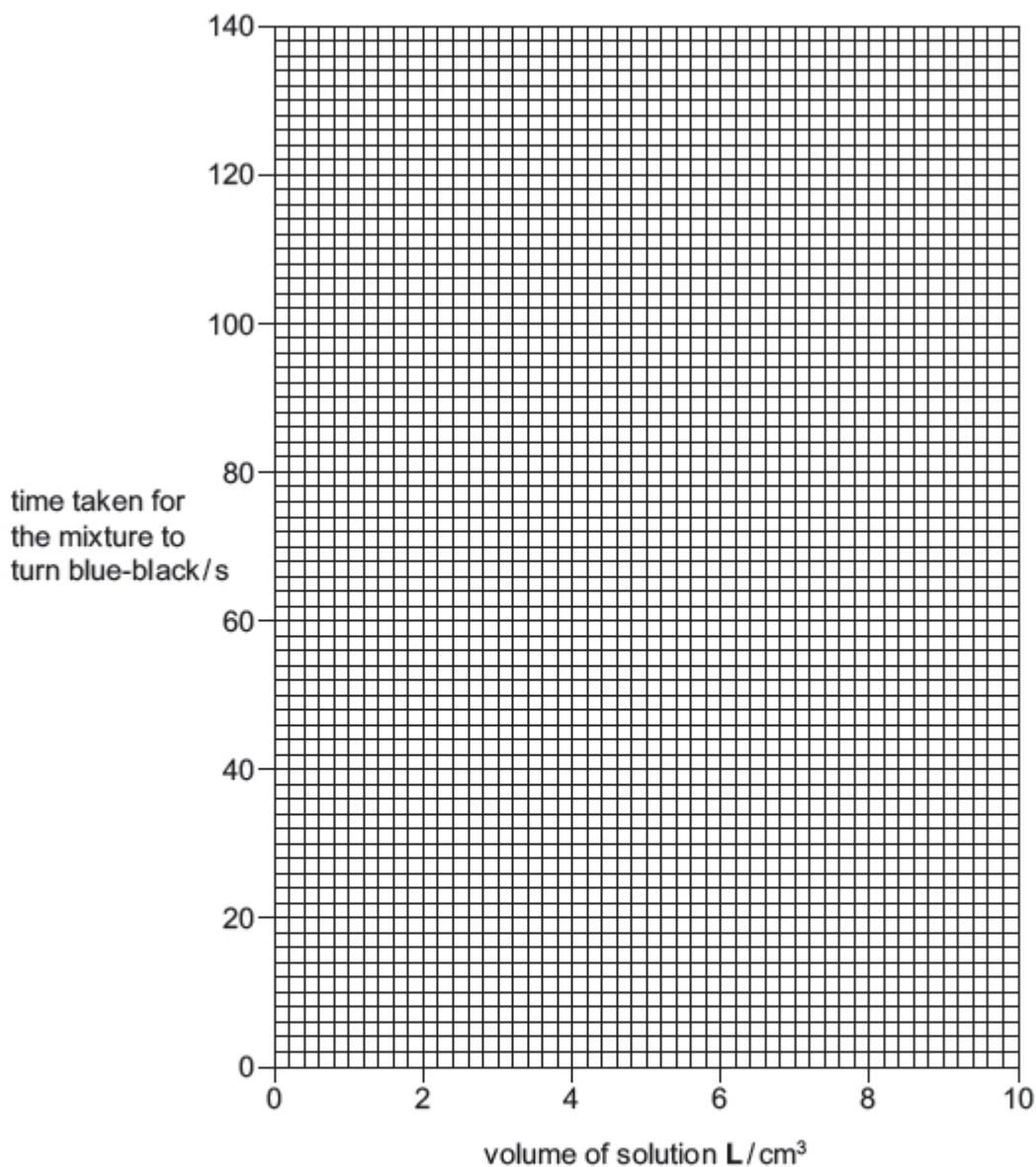
(a) Use the stop-clock diagrams to record the time taken for each experiment in the table.

experiment number	volume of solution L/cm^3	volume of distilled water cm^3	stop-clock diagram	time taken for the mixture to turn blue-black/s
1	10	0		
2	8	2		
3	6	4		
4	5	5		
5	3	7		

[4]



(b) Plot the results for Experiments 1–5 on the grid. Draw a smooth line graph.



[4]

(c) From your graph, deduce the time taken for the mixture to turn blue-black if Experiment 2 were repeated using 4 cm³ of solution L and 6 cm³ of distilled water.

Show clearly on the grid how you worked out your answer.

[3]



(d) (i) In which experiment, 1, 2, 3, 4 or 5, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....
.....
..... [2]

(e) (i) Suggest an advantage of using a graduated pipette instead of a measuring cylinder to measure solution L.

..... [1]

(ii) Suggest and explain a disadvantage of using a graduated pipette instead of a measuring cylinder to measure solution M.

.....
..... [2]

(f) Suggest **one** way to improve the reliability of the results of these experiments.

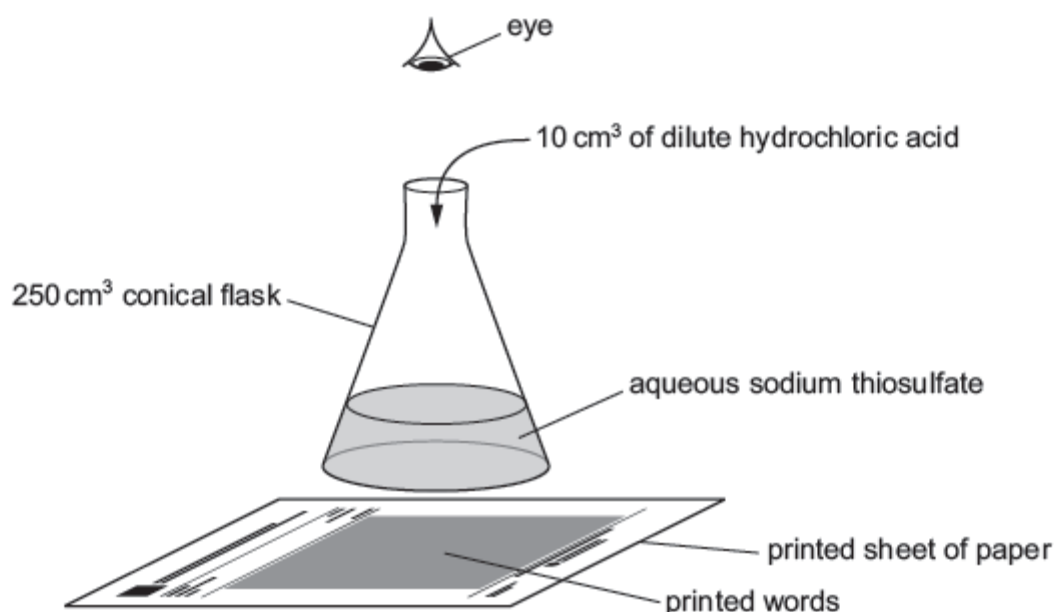
..... [1]

[Total: 18]

Q# 2/ iGCSE Chemistry/2018/s/Paper 61/Q2

2 A student investigated the rate of reaction between dilute hydrochloric acid and aqueous sodium thiosulfate. When these chemicals react they form a precipitate which makes the solution go cloudy. The formation of this precipitate can be used to show how fast the reaction proceeds.

Five experiments were done using the apparatus shown.



Experiment 1

- A large measuring cylinder was used to pour 50 cm³ of aqueous sodium thiosulfate into a 250 cm³ conical flask. The conical flask was placed on a printed sheet of paper.
- 10 cm³ of dilute hydrochloric acid was added to the solution in the conical flask. A timer was started immediately and the mixture was swirled.
- The time taken for the printed words to disappear from view was measured.

Experiment 2

- The large measuring cylinder was used to pour 40 cm³ of aqueous sodium thiosulfate into a conical flask, followed by 10 cm³ of distilled water. The conical flask was placed on the printed sheet of paper.
- 10 cm³ of dilute hydrochloric acid was added to the solution in the conical flask. The timer was started immediately and the mixture was swirled.
- The time taken for the printed words to disappear from view was measured.

Experiment 3

- Experiment 2 was repeated but using 35 cm³ of aqueous sodium thiosulfate and 15 cm³ of distilled water.

Experiment 4

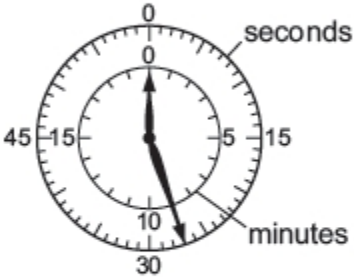
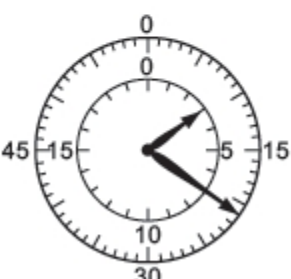
- Experiment 2 was repeated but using 30 cm³ of aqueous sodium thiosulfate and 20 cm³ of distilled water.

Experiment 5

- Experiment 2 was repeated but using 10 cm³ of aqueous sodium thiosulfate and 40 cm³ of distilled water.



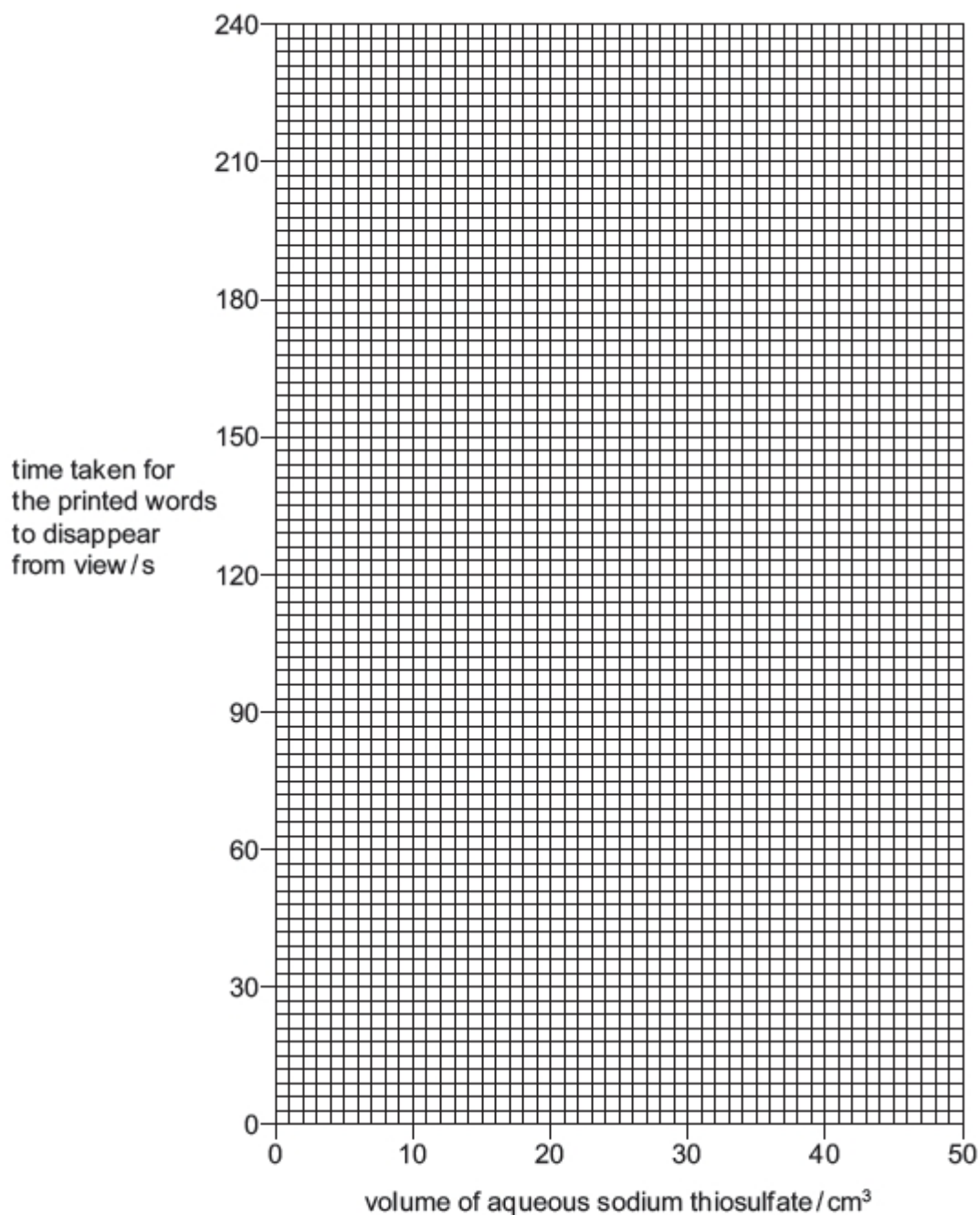
(a) Record the volumes of distilled water used in the table. Use the stop-clock diagrams to record the results in the table.

experiment	volume of aqueous sodium thiosulfate / cm ³	volume of distilled water / cm ³	stop-clock diagram	time taken for the printed words to disappear from view / s
1	50			
2	40			
3	35			
4	30			
5	10			

[3]



(b) Plot the results from Experiments 1–5 on the grid. Draw a smooth line graph.



[3]

(c) (i) **From your graph**, deduce the time taken for the printed words to disappear from view if Experiment 2 were repeated using 20 cm³ of aqueous sodium thiosulfate and 30 cm³ of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... s [2]



(ii) The rate of reaction can be calculated using the equation shown.

$$\text{rate of reaction} = \frac{1}{\text{time taken}}$$

Calculate the rate of reaction using your answer from (c)(i).

..... [1]

(d) (i) In which experiment, 1, 2, 3, 4 or 5, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....
.....
..... [2]

(e) Give the name of a more accurate piece of apparatus for measuring volumes than a measuring cylinder.

..... [1]

(f) Suggest the effect on the results of using a 100 cm³ conical flask instead of a 250 cm³ conical flask. Explain your answer.

.....
..... [2]

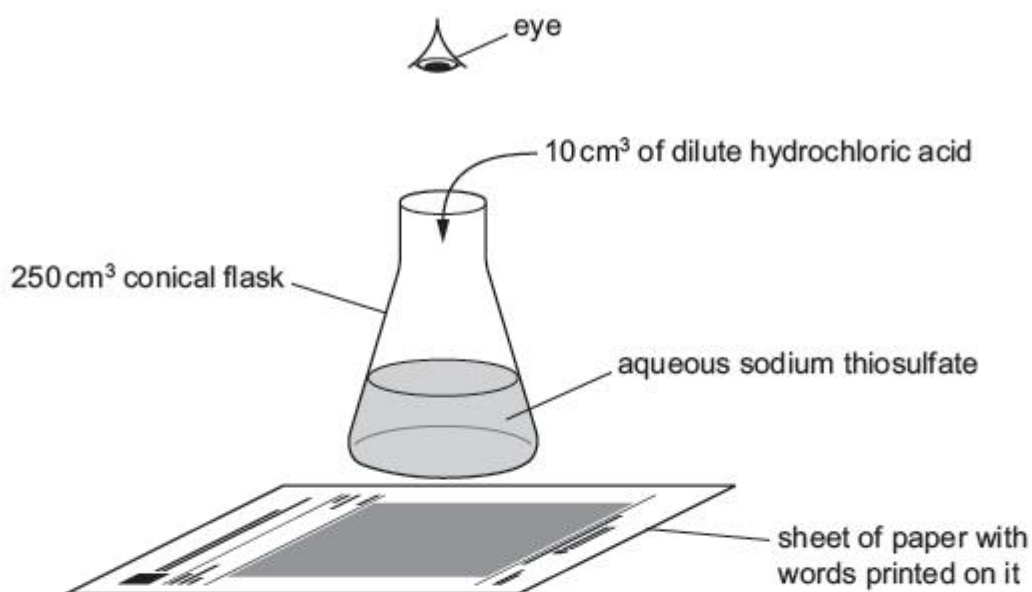
(g) Sketch **on the grid** the graph you would expect if all of the experiments were repeated at a **lower** temperature. Clearly label your graph. [1]

[Total: 16]



- 2 A student investigated the rate of reaction between dilute hydrochloric acid and aqueous sodium thiosulfate. When these chemicals react they form a precipitate which makes the solution go cloudy. The formation of this precipitate can be used to show how fast the reaction proceeds.

Five experiments were carried out using the apparatus shown.



Experiment 1

- Using a measuring cylinder, 50 cm³ of aqueous sodium thiosulfate were poured into a conical flask. The initial temperature of the solution was measured. The conical flask was placed on a sheet of paper with words printed on it.
- Using a measuring cylinder, 10 cm³ of dilute hydrochloric acid were added to the solution in the conical flask and a stopclock was started.
- The time taken for the printed words to disappear from view was measured.
- The final temperature of the mixture was measured.

Experiment 2

- Using a measuring cylinder, 50 cm³ of aqueous sodium thiosulfate were poured into a conical flask. The solution was heated to about **30 °C** and the temperature was measured. The conical flask was placed on a sheet of paper with words printed on it.
- Using a measuring cylinder, 10 cm³ of dilute hydrochloric acid were added to the solution in the conical flask and a stopclock was started.
- The time taken for the printed words to disappear from view was measured.
- The final temperature of the mixture was measured.

Experiment 3

- Experiment 2 was repeated but the 50 cm³ of aqueous sodium thiosulfate were heated to about **40 °C** before adding the dilute hydrochloric acid.

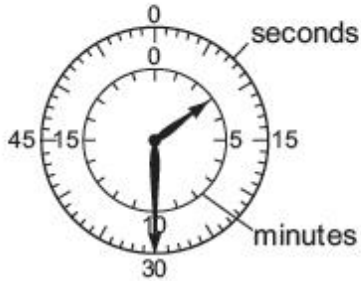
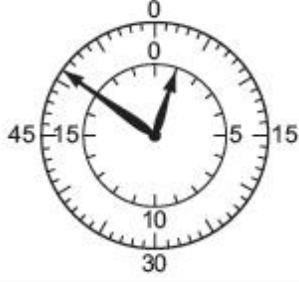
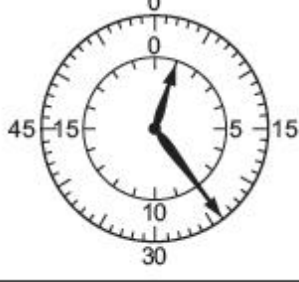
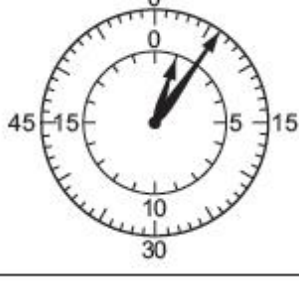
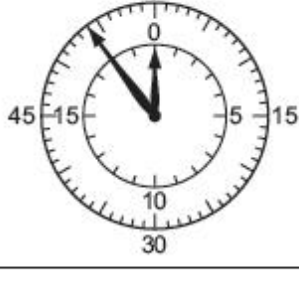
Experiment 4

- Experiment 2 was repeated but the 50 cm³ of aqueous sodium thiosulfate were heated to about **50 °C** before adding the dilute hydrochloric acid.

Experiment 5

- Experiment 2 was repeated but the 50 cm³ of aqueous sodium thiosulfate were heated to about **60 °C** before adding the dilute hydrochloric acid.

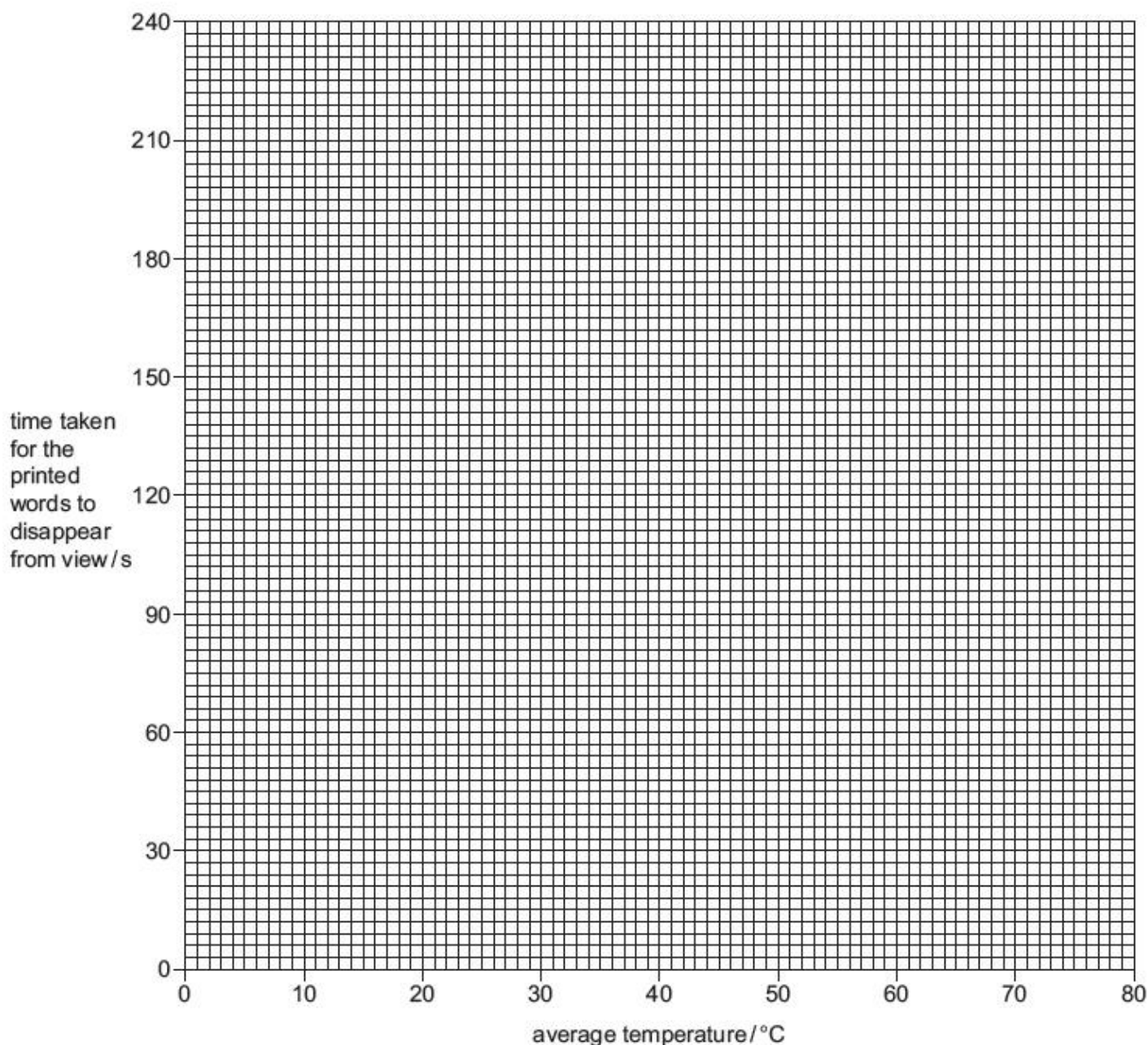
- (a) Calculate the average temperatures and record them in the table.
Use the stopclock diagrams to record the times in the table.

experiment number	initial temperature of the solution / °C	final temperature of the mixture / °C	average temperature / °C	stopclock diagram	time taken for the printed words to disappear from view / s
1	19	17			
2	32	30			
3	42	40			
4	54	52			
5	65	61			

[3]



(b) Plot the results of Experiments 1–5 on the grid. Draw a smooth line graph.



[4]

(c) **From your graph**, deduce the time taken for the printed words to disappear from view when Experiment 2 was repeated at an initial temperature of 73 °C. The final temperature of the mixture was 71 °C.

Show clearly **on the grid** how you worked out your answer.

[3]

(d) Sketch **on the grid** the graph you would expect if all of the experiments were repeated using a more dilute solution of aqueous sodium thiosulfate.

[1]



(e) (i) In which experiment, 1, 2, 3, 4 or 5, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....
.....
.....
..... [2]

(f) Suggest and explain the effect on the results of using

(i) a burette to measure the volumes,

.....
.....
..... [2]

(ii) a 100 cm³ conical flask instead of a 250 cm³ conical flask.

.....
.....
..... [2]

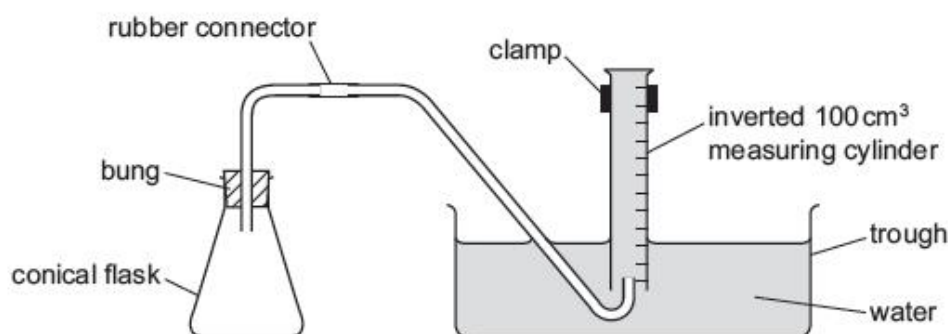
Q# 4/ iGCSE Chemistry/2017/s/Paper 63/Q2

- 2 A student investigated the rate of reaction between magnesium ribbon and two different solutions of dilute sulfuric acid, solution **G** and solution **H**. The acid was in excess in both experiments.

Two experiments were carried out.

Experiment 1

- The apparatus was set up as shown in the diagram.



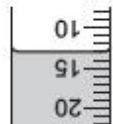
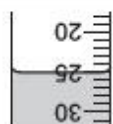
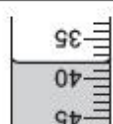
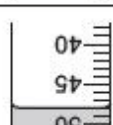
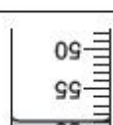
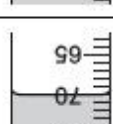
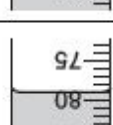
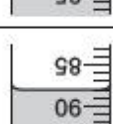
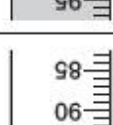
- Using a measuring cylinder, 50 cm³ of solution **G** were poured into the conical flask. A piece of magnesium ribbon was added to the conical flask and the bung replaced.
- The timer was started immediately and the total volume of gas collected in the measuring cylinder was measured every 20 seconds for 180 seconds (3 minutes).



Experiment 2

- Experiment 1 was repeated using 50 cm³ of solution **H** instead of solution **G**.

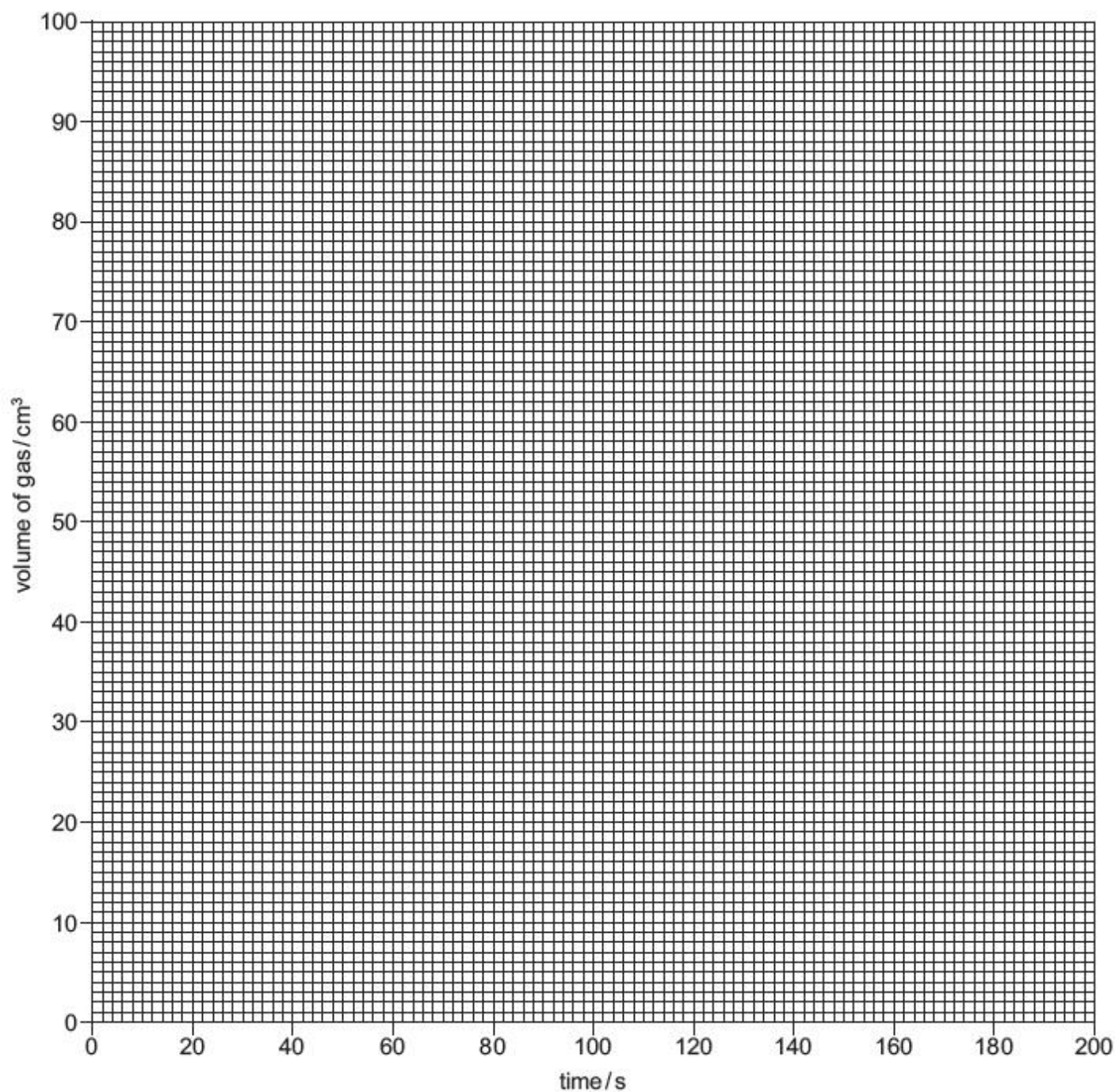
(a) Use the measuring cylinder diagrams to record the volumes of gas collected in Experiment 1.

time / s	Experiment 1		Experiment 2
	measuring cylinder diagram	volume of gas / cm ³	volume of gas / cm ³
0			0
20			8
40			14
60			21
80			27
100			33
120			39
140			45
160			50
180			55

[3]



- (b) Plot the results for Experiments 1 and 2 on the grid and draw **two** smooth line graphs. Clearly label your graphs.



[4]

- (c) Which experiment had the faster rate of reaction? Suggest a reason why the rate was faster in this experiment.

.....
.....

[2]



(d) The average rate of this reaction can be calculated using the equation shown.

$$\text{average rate} = \frac{\text{volume of gas / cm}^3}{\text{time taken / s}}$$

For Experiment 1, calculate the average rate of reaction for the first 30 seconds of the reaction. Include the units.

rate =

units = [3]

(e) Why, eventually, will no more gas be produced?

..... [1]

(f) Suggest the effect on the rate of reaction of using the same mass of magnesium powder instead of magnesium ribbon. Explain your answer.

.....
.....
..... [2]

(g) Give **one** advantage and **one** disadvantage of using a measuring cylinder to measure the volumes of solution **G** and solution **H**.

advantage
disadvantage [2]

(h) Suggest **one** improvement to these experiments.

.....
..... [1]



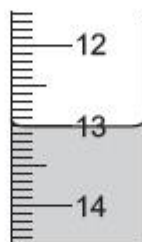
- 2 A student investigated the reaction between aqueous potassium manganate(VII), solution **A**, and two solutions of iron(II) sulfate, solution **B** and solution **C**, of different concentrations.

Two experiments were carried out.

Experiment 1

- A burette was filled with solution **A** to the 0.0 cm³ mark.
- A measuring cylinder was used to pour 25 cm³ of solution **B** into a conical flask.
- Solution **A** was added to the flask, while the flask was swirled, until the mixture just turned permanently pink. The burette reading was recorded.

- (a) Use the burette diagram to record the reading in the table and complete the table.



final reading

final burette reading / cm ³	
initial burette reading / cm ³	
difference / cm ³	

[2]

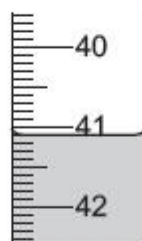
Experiment 2

- Experiment 1 was repeated using 25 cm³ of solution **C** instead of solution **B**. In Experiment 2 the burette was not filled to the 0.0 cm³ mark.

- (b) Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

final burette reading / cm ³	
initial burette reading / cm ³	
difference / cm ³	

[2]



(c) Why is an indicator **not** added to the conical flask?

..... [1]

(d) (i) Which solution of iron(II) sulfate, solution **B** or solution **C**, is the more concentrated? Explain your answer.

.....
..... [2]

(ii) How many times more concentrated is this solution of iron(II) sulfate?

..... [1]

(e) (i) If Experiment 2 were repeated using 50 cm³ of solution **C**, what volume of solution **A** would be needed? Explain your answer.

.....
..... [2]

(ii) Suggest a practical problem that using 50 cm³ of solution **C** in this investigation would cause. Suggest a practical solution to the problem.

problem

solution [2]

(f) Give **one** advantage and **one** disadvantage of using a measuring cylinder instead of a 25 cm³ pipette for solution **B**.

advantage

disadvantage [2]

(g) How would the results be improved by taking repeated measurements?

.....
..... [1]



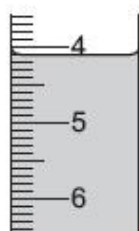
- 2 A student investigated the reaction between aqueous sodium thiosulfate and two different aqueous solutions of potassium iodate labelled solution C and solution D.

Two experiments were carried out.

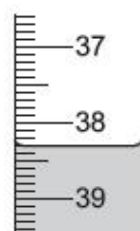
Experiment 1

- A burette was filled with aqueous sodium thiosulfate. The initial burette reading was recorded.
- Using a measuring cylinder, 20 cm^3 of solution C were poured into a conical flask. 10 cm^3 of dilute sulfuric acid and 1 g of potassium iodide were added to the flask to form a solution of iodine. The flask was swirled to mix the contents.
- Aqueous sodium thiosulfate was slowly added from the burette to the flask and swirled to mix thoroughly.
- When the contents of the flask turned pale yellow, starch solution was added and the solution turned blue-black.
- More aqueous sodium thiosulfate was then added slowly to the flask until the solution just turned colourless. The final burette reading was recorded.

- (a) Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

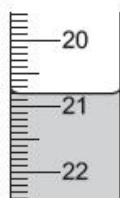
Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- Experiment 1 was repeated using solution D instead of solution C.

- (b) Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]



- (c) (i) Which solution of potassium iodate, solution **C** or solution **D**, is the more concentrated? Explain your answer.

.....
..... [2]

- (ii) How many times more concentrated is this solution of potassium iodate?

..... [1]

- (d) Predict the volume of aqueous sodium thiosulfate which would be needed to react completely with 30 cm³ of solution **D**.

.....
..... [2]

- (e) (i) State **two** sources of error in the experiments.

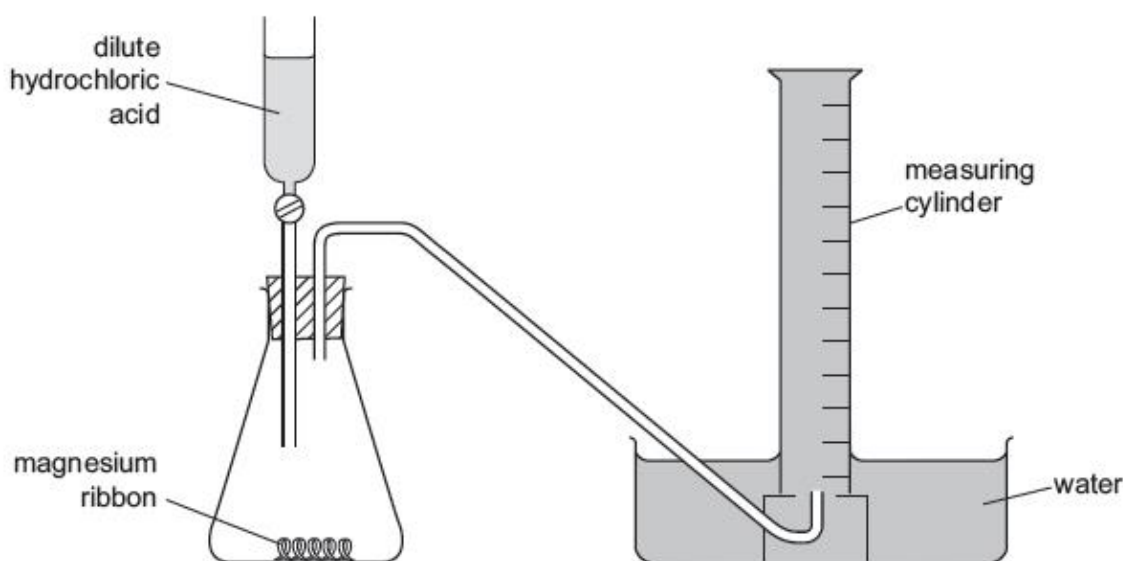
1.
2.
[2]

- (ii) Suggest **two** improvements to reduce the sources of error in (e)(i).

1.
2.
[2]

Q# 7/ iGCSE Chemistry/2016/w/Paper 62/Q2

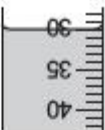
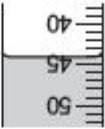
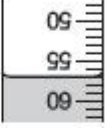
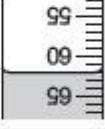
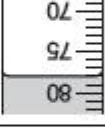
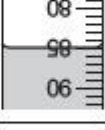
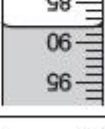
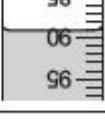
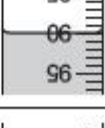
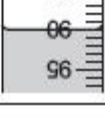
- 2** A student investigated the rate of reaction between dilute hydrochloric acid and excess magnesium at room temperature.
The apparatus was set up as shown in the diagram.



30 cm³ of dilute hydrochloric acid were added to the conical flask containing magnesium ribbon. The timer was then started and the volume of gas collected in the measuring cylinder was measured every 20 seconds for 180 seconds (3 minutes).



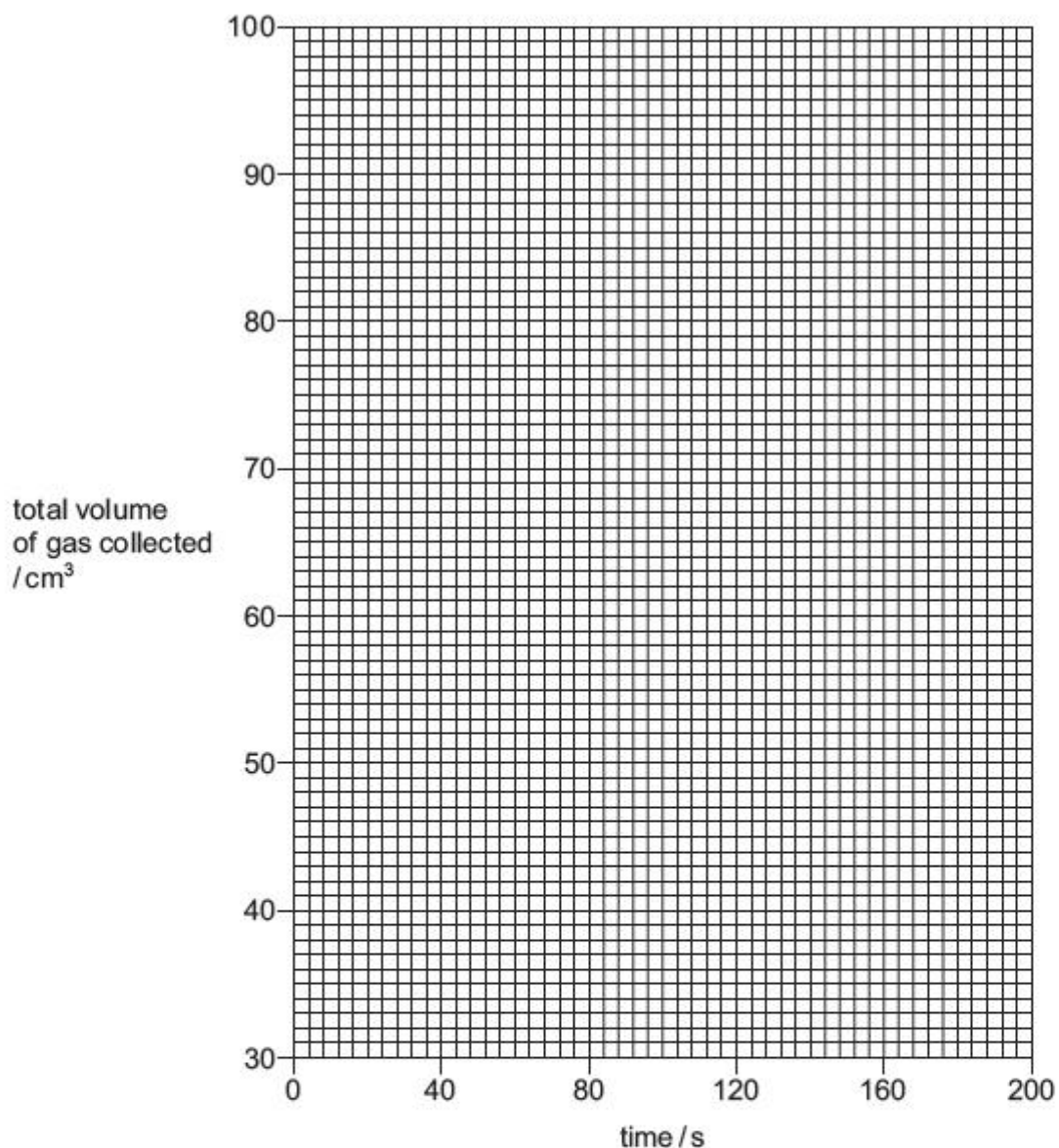
(a) Use the measuring cylinder diagrams to record the total volume of gas collected in the table.

time / s	measuring cylinder diagram	total volume of gas collected / cm ³
0		30
20		
40		
60		
80		
100		
120		
140		
160		
180		

[2]



(b) Plot the results on the grid and draw a smooth line graph.



[3]

(c) (i) Which result is anomalous?

..... [1]

(ii) Suggest a possible reason for this anomalous result.

..... [1]

(iii) **Use your graph** to deduce the total volume of gas that you would have expected to collect instead of this anomalous volume.

Show clearly **on the grid** how you worked out your answer.

..... cm³ [2]



(d) Explain why the total volume of gas collected does **not** increase after 160 seconds.

.....
..... [2]

(e) The average rate of the reaction can be calculated using the equation shown.

$$\text{average rate of reaction} = \frac{\text{volume of gas collected / cm}^3}{\text{time / s}}$$

(i) Calculate the volume of gas collected between 20 seconds and 40 seconds.

..... [1]

(ii) Calculate the average rate of reaction between 20 seconds and 40 seconds.
Include the unit.

average rate of reaction = [2]

(f) Room temperature was 20°C.

Sketch **on the grid** the graph you would expect if the experiment were repeated at 30°C. [2]

(g) Suggest why the reading on the measuring cylinder was 30 cm³ after the acid had been added and before the timer had been started.

.....
..... [1]

(h) Suggest and explain **one** improvement to this experiment.

.....
.....
..... [2]

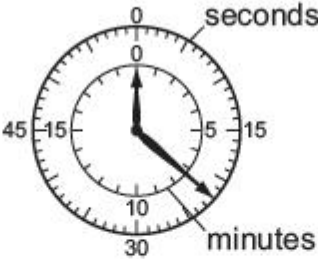
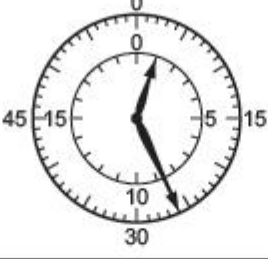
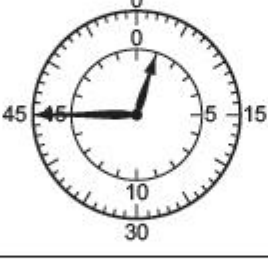
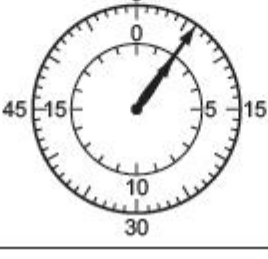


- 2 A student investigated the rate of reaction between hydrogen peroxide and aqueous potassium iodide. When these chemicals react they form iodine. Sodium thiosulfate solution reacts with iodine and can be used to show how fast the reaction proceeds.

(a) A burette was filled up to the 0.0 cm^3 mark with sodium thiosulfate solution.
Using a large measuring cylinder, 100 cm^3 of distilled water were poured into a conical flask.
Using a small measuring cylinder, 6 cm^3 of sulfuric acid, 1 cm^3 of starch solution and 4 cm^3 of aqueous potassium iodide were added to the flask.
 0.5 cm^3 of sodium thiosulfate solution was added from the burette to the mixture in the flask and swirled to mix.
The reaction was then started by adding 3 cm^3 of hydrogen peroxide solution to the mixture, and the timer started.
The time taken for a blue colour to appear was noted.
A further 0.5 cm^3 of sodium thiosulfate solution was added to the mixture in the conical flask, swirled and the blue colour disappeared. The time when the blue colour reappeared was noted.
The experiment continued by adding further 0.5 cm^3 portions of sodium thiosulfate solution until a total of 3.0 cm^3 of sodium thiosulfate solution had been added, noting the times at which the blue colour reappeared.

Use the timer diagrams on page 4 to record the times in seconds in the table.

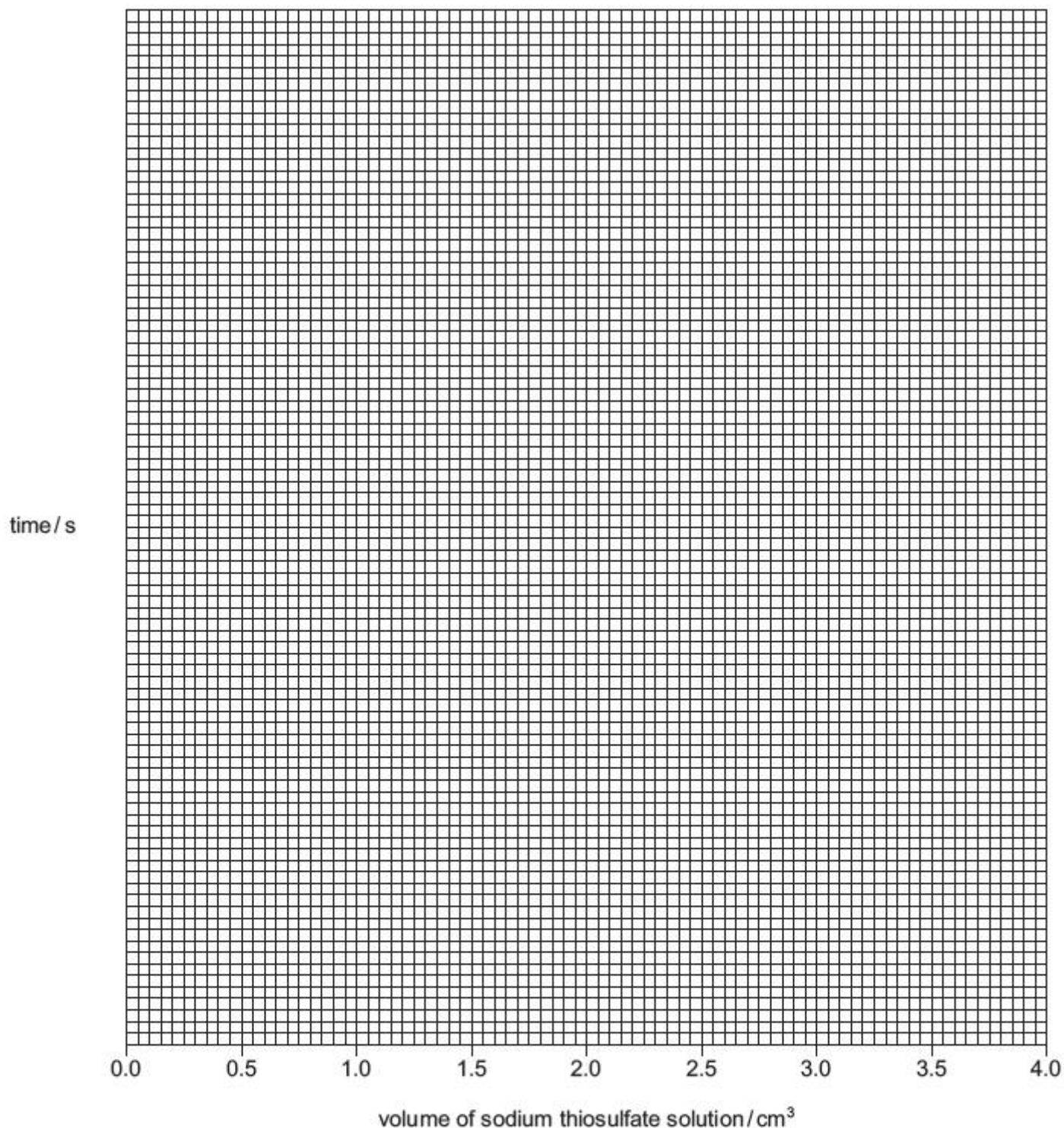


total volume of sodium thiosulfate solution added / cm ³	timer diagram	time at which blue colour appeared / s
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		

[3]



(b) Plot the results you have obtained on the grid and draw a best-fit straight-line graph.



[5]

- (c) (i) **From your graph** deduce the time at which the blue colour would appear if a total of 4.0 cm³ of sodium thiosulfate solution were added to the mixture in the conical flask. Show clearly **on the grid** how you worked out your answer.

[3]

- (ii) Sketch **on the grid** the graph you would expect if the experiment was repeated at a higher temperature.

[1]



(d) Suggest the purpose of the starch solution.

..... [1]

(e) (i) Suggest **one** advantage of using a pipette to measure the volume of the hydrogen peroxide.

..... [1]

(ii) Suggest and explain **one** disadvantage of using a pipette to measure the volume of the hydrogen peroxide.

..... [2]

(f) Explain **one** disadvantage of using a beaker instead of a conical flask.

..... [1]

Q# 9/ iGCSE Chemistry/2016/m/Paper 62/Q2

2 A teacher investigated the rate of a reaction between two solutions, **J** and **K**, and sulfuric acid at different temperatures.

Four experiments were carried out.

(a) *Experiment 1*

A large measuring cylinder was used to pour 50 cm³ of distilled water and 40 cm³ of sulfuric acid into a 250 cm³ conical flask.

A small measuring cylinder was used to add 2 cm³ of methyl orange and 5 cm³ of solution **J** to the mixture in the conical flask. The temperature of the mixture was measured.

The reaction was started by adding 5 cm³ of solution **K** to the conical flask, immediately starting the timer and swirling the mixture.

The time taken for the mixture to turn pale yellow was measured. The final temperature of the mixture was measured.

Experiment 2

Experiment 1 was repeated but the mixture in the conical flask was heated to about 30 °C **before** adding the solution **K**. The temperature of the mixture was measured.

5 cm³ of solution **K** was added to the conical flask. The timer was started and the mixture swirled.

The time taken for the mixture to turn pale yellow was measured. The final temperature of the mixture was measured.

Experiment 3

Experiment 1 was repeated but the mixture in the conical flask was heated to about 40 °C before adding the solution **K** to the flask. The same measurements were taken.



Experiment 4

Experiment 1 was repeated but the mixture in the conical flask was heated to about 50°C before adding the solution **K** to the flask. The same measurements were taken.

Stop-clock diagrams for these experiments are on page 4.

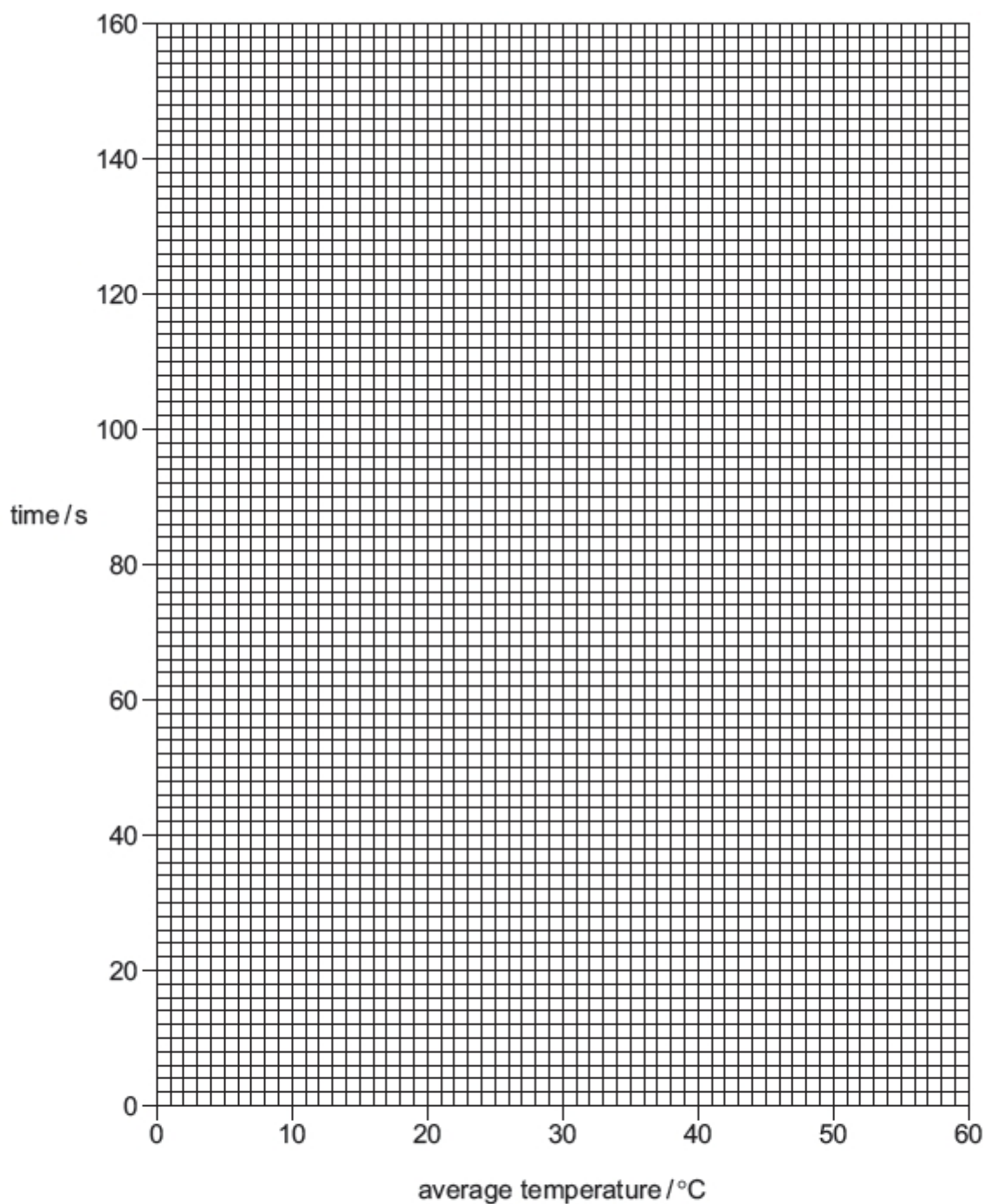
Use the stop-clock diagrams to record the times in the table.

Work out the average temperatures to complete the table.

experiment	stop-clock diagram	time taken for mixture to turn pale yellow /s	initial temperature /°C	final temperature /°C	average temperature /°C
1			17	15	
2			28	26	
3			42	40	
4			51	49	

[4]

(b) Plot the results on the grid and draw a smooth line graph.



[4]

(c) **From your graph** deduce the time taken for the mixture to turn pale yellow if Experiment 1 was repeated at an average temperature of 60 °C.
Show clearly **on the grid** how you worked out your answer.

[2]



Q# 2/ iGCSE Chemistry/2018/s/Paper 61/Q2

2(a)	volume boxes completed correctly in seconds 0, 10, 15, 20, 40	1
	time boxes completed correctly 27, 33, 45, 66, 201	2
2(b)	all points plotted correctly (□ half a small square)	2
	smooth line graph	1
2(c)(i)	value from graph	1
	with clear indication	1
2(c)(ii)	1 □ value from (c)(i)	1
2(d)(i)	experiment 1	1
2(d)(ii)	more particles of thiosulfate (in a given volume)	1
	more chance of collision	1
2(e)	use a pipette / burette	1
2(f)	times would be shorter	1
	idea of depth of solution is greater	1
2(g)	sketch curve roughly same shape and above original	1

Q# 3/ iGCSE Chemistry/2017/w/Paper 61/

2(a)	average temperatures completed for all five experiments: 18, 31, 41, 53, 63	1
	times completed for all five experiments: 210, 111, 84, 66, 54	1
	all times in seconds	1
2(b)	all five points plotted	3
	smooth line graph	1
2(c)	value from graph for average temperature 72 °C	1
	unit (s)	1
	shown clearly	1
2(d)	line above experimental line	1
2(e)(i)	Experiment 5	1
2(e)(ii)	particles move faster / particles have more energy	1
	more (frequent) collisions / greater chance of collisions	1
2(f)(i)	more accurate	1
	comparison to measuring cylinder	1
2(f)(ii)	time shorter / cross disappears faster	1
	depth greater	1

Q# 4/ iGCSE Chemistry/2017/s/Paper 63/

2(a)	all volume boxes completed correctly: 0, 13, 25, 38, 48, 59, 70, 79, 88, 96	3
2(b)	origin plotted	1
	other points correctly plotted	1
	two smooth lines	1
	labelled	1
2(c)	Experiment 1	1
	more concentrated / stronger acid / the acid has a lower pH	1



2(d)	volume of gas at 30 s	1
	correct calculation of rate	1
	unit: cm^3/s OR $\text{cm}^3 \text{s}^{-1}$	1
2(e)	all the magnesium will have reacted	1
2(f)	faster reaction / increased rate	1
	magnesium powder has a higher surface area	1
2(g)	advantage: easy to use / quick	1
	disadvantage: not accurate	1
2(h)	use of burette / pipette / gas syringe / weighed amount of magnesium / repeat experiment (and average) / clean the magnesium / remove oxide layer	1

Q# 5/ iGCSE Chemistry/2017/s/Paper 62/

2(a)	initial volume completed correctly: 0.0 final volume completed correctly: 13.0	1
	difference: 13.0	1
2(b)	final volume, initial volume and difference completed correctly: 41.1, 2.1 and 39.0	1
	all readings in (a) and (b) to 1 d.p.	1
2(c)	there is a colour change at the end-point already	1
2(d)(i)	solution C	1
	a greater volume of potassium manganate(VII)/solution A was needed	1
2(d)(ii)	3 × as concentrated	1
2(e)(i)	double the volume of solution C was used / double the volume of solution A was needed	1
	78 cm^3	1
2(e)(ii)	problem: volume of potassium manganate(VII) solution added would be greater than 50 cm^3	1
	solution: use more than one burette / refill burette	1
2(f)	advantage: easy (to use) / quick	1
	disadvantage: not accurate	1
2(g)	can take average or mean / can spot anomalies / more reliable	1

Q# 6/ iGCSE Chemistry/2017/s/Paper 61/

2(a)	initial and final readings completed correctly: 4.1, 38.3	1
	difference completed correctly: 34.2	1
2(b)	initial and final readings completed correctly: 3.7, 20.8	1
	difference completed correctly: 17.1	1
2(c)(i)	solution C is more concentrated	1
	a greater volume of thiosulfate was needed	1
2(c)(ii)	2 × as concentrated	1



Q# 7/ iGCSE Chemistry/2016/w/Paper 62/

2(a)	table of results volume boxes completed correctly (30), 44, 57, 62, 78, 85, 88, 89, 90, 90	2
2(b)	all points correctly plotted smooth line graph	2 1
2(c)(i)	point at 60 s / 62 cm ³ / fourth point / measurement 4	1
2(c)(ii)	misread measuring cylinder / read too early	1
2(c)(iii)	value from graph (68–70) shown clearly	1 1
2(d)	the Reaction has finished all the <u>acid</u> has reacted / HCl is the limiting factor	1 1
2(e)(i)	value from graph or table (57–44 = 13 cm ³)	1
2(e)(ii)	13 / 20 = 0.65 cm ³ / s	1 1
2(f)	steeper curve to same level	1 1
2(g)	air is displaced (when the acid is added)	1
2(h)	improvement explanation use a burette / graduated pipette / gas syringe improves accuracy OR use cotton thread to hold a test-tube (containing the acid) in the flask no air is collected OR repeat the experiment take average / more frequent readings	1 1

Q# 8/ iGCSE Chemistry/2016/s/Paper 62/

2(a)	all 6 times completed correctly (2 marks) (22, 43, 64, 86, 105, 126) 5 times completed correctly (1 mark); in seconds;	2 1	3
2(b)	appropriate scale for y-axis / increasing at 20 s per large square; y-axis is a linear scale; all 6 points plotted correctly $\pm$ half a small square (2 marks); 5 points plotted correctly $\pm$ half a small square (1 marks); best-fit straight-line graph;	1 1 2 1	5
2(c)(i)	value from graph $\pm$ half a small square (typically 167–170); units / s; extrapolation;	1 1 1	3
2(c)(ii)	sketch line below original line and diverging;		1
2(d)	as an indicator;		1
2(e)(i)	(more) accurate;		1
2(e)(ii)	solution slow to run out of pipette; difficult to know when to start timer / reaction does not start at once / inaccurate time measurement owtte;	1 1	2
2(f)	difficulty in swirling / mixing / shaking;		1



Q# 9/ iGCSE Chemistry/2016/m/Paper 62/

2(a)	In each column: 4 correct = [2] 3 correct = [1] average temperature boxes completed correctly: 16, 27, 41, 50; times completed in seconds correctly: 128, 58, 27, 18;	4
2(b)	all points plotted correctly = [3] smooth line graph;	4
2(c)	value from graph: 12–13 s; extrapolation;	2
2(d)(i)	Experiment 4;	1
2(d)(ii)	any 2 from: highest temperature; more energy; more (chance of) collisions;	2
2(e)(i)	more accurate; than a measuring cylinder;	2
2(e)(ii)	insulation/use a lid; to reduce heat losses; OR repeats; average results; OR measure water or sulphuric acid or methyl orange using a burette /use a 2 d.p. stopwatch/ digital thermometer; reference to accuracy;	2

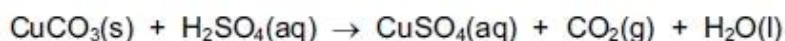
13.10 FUNDAMENTAL Assessed Activity 1 Keyword Test

Topic #	English	Meaning
7	enzymes	
7	photochemical reaction	
	denature	
7	photosynthesis	
7	reaction rate	
7	speed of reaction	



Q# 1/

14 Copper(II) carbonate reacts with dilute sulfuric acid.



The rate of the reaction can be changed by varying the conditions.

Which changes always increase the rate of this chemical reaction?

- 1 increasing the concentration of sulfuric acid
- 2 increasing the size of the pieces of copper(II) carbonate
- 3 increasing the temperature
- 4 increasing the volume of sulfuric acid

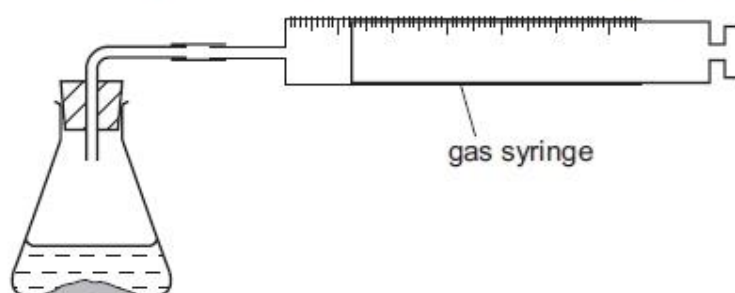
A 1, 3 and 4 B 1 and 3 only C 2 and 3 D 3 and 4 only

15 Which reaction is **not** affected by the presence of light?

- A a candle burning
- B methane reacting with chlorine
- C photosynthesis
- D silver bromide decomposing to form silver

Q# 2/

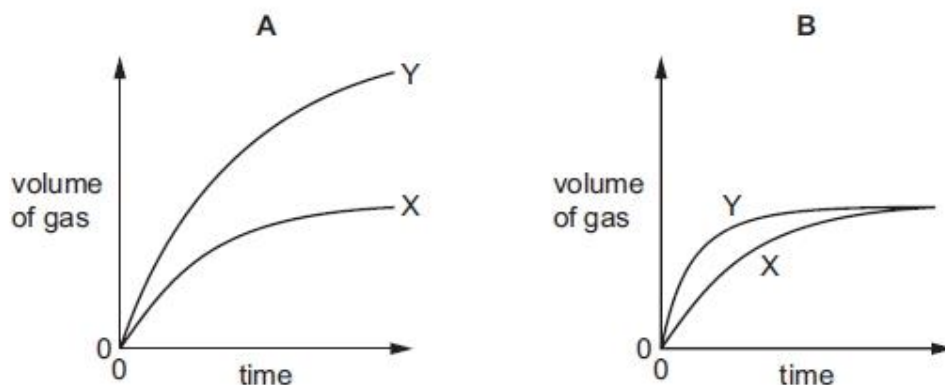
14 An experiment X is carried out between a solid and a solution using the apparatus shown.

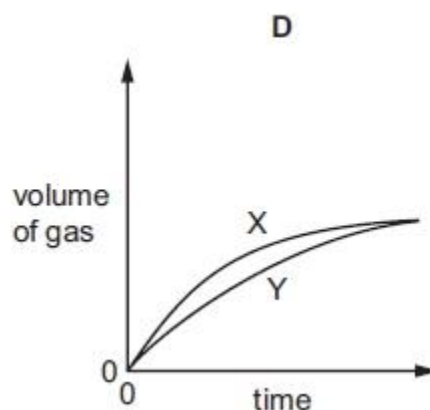
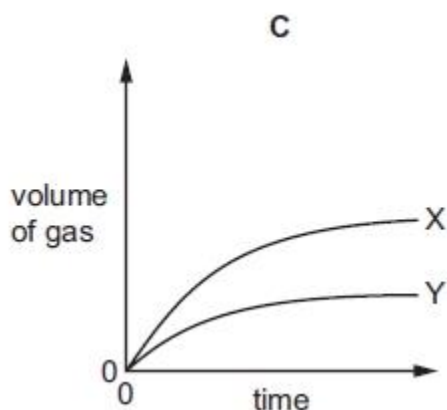


The volume of gas given off is measured at different times and the results plotted on a graph.

In a second experiment Y, the surface area of the solid is increased but all other factors remain the same.

Which graph shows the results of experiments X and Y?





15 Which change in conditions increases the energy of the particles in a reaction?

- A addition of a catalyst
- B increase in concentration
- C increase in surface area
- D increase in temperature

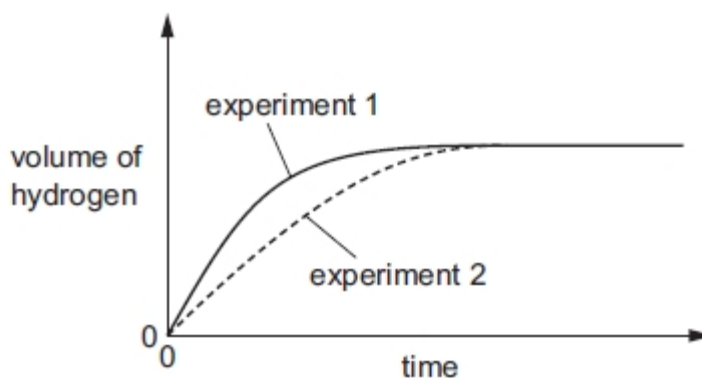
Q# 3/

14 Zinc granules are reacted with excess dilute hydrochloric acid.

The volume of hydrogen given off is measured at different times.

The results are shown on the graph, labelled experiment 1.

The results for a second experiment are also shown on the graph, labelled experiment 2.



Which change to the conditions was made in experiment 2?

- A The concentration of the hydrochloric acid was decreased.
- B The size of the zinc granules was decreased.
- C The surface area of the zinc granules was increased.
- D The temperature was increased.



- 15 In an experiment nitric acid is added to excess marble chips and the volume of carbon dioxide formed is measured.

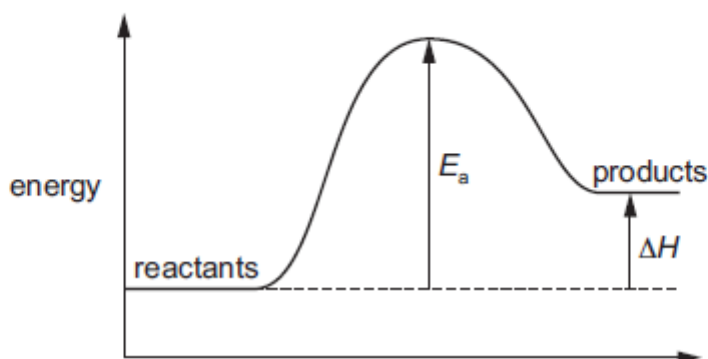
The experiment is repeated using smaller marble chips. All other conditions remain the same.

Which statement about the second experiment is correct?

- A The collisions are more frequent and higher energy.
- B The collisions are more frequent and the same energy.
- C The collisions are the same frequency and the same energy.
- D The collisions are the same frequency and higher energy.

Q# 4/

- 13 The energy level diagram for a reaction is shown.



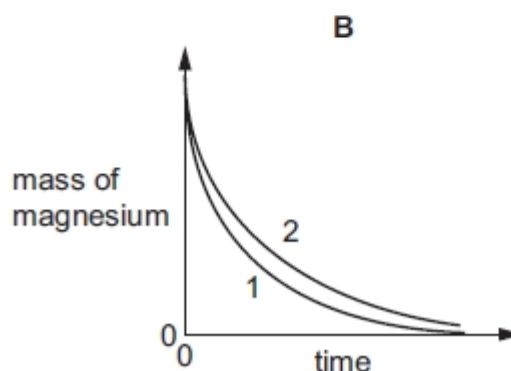
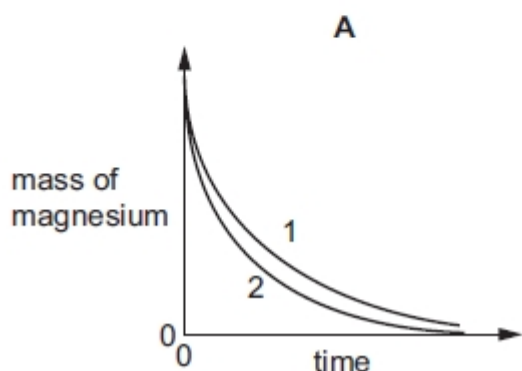
Which statement is **not** correct for this energy level diagram?

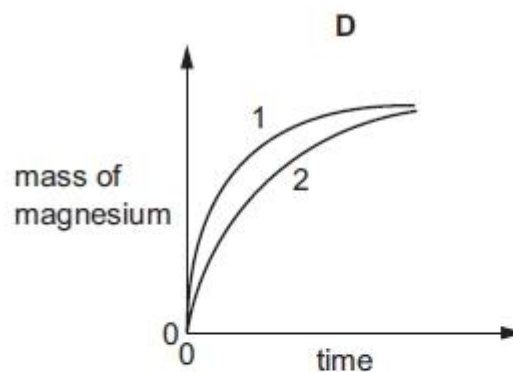
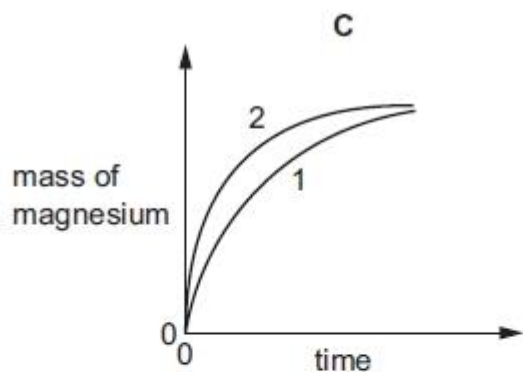
- A It could be the energy level diagram for the reaction when petrol is burnt.
 - B Less energy is released in bond forming than is needed for bond breaking.
 - C The activation energy, E_a , has a positive value.
 - D The energy change, ΔH , for the reaction is positive.
- 14 The rate of reaction between magnesium and excess dilute hydrochloric acid was followed by measuring the mass of magnesium present at regular time intervals.

Two experiments were performed.

Both experiments used 0.1g of magnesium ribbon. The acid in experiment 1 was less concentrated than in experiment 2.

Which graph shows the results of the experiments?





15 Which statement explains why coal dust forms an explosive mixture with air?

- A Coal dust catalyses the explosion.
- B Coal dust has a large surface area.
- C Crushing coal increases the concentration of the coal.
- D Crushing coal increases the temperature of the coal.

Q# 5/

15 Which row explains why increasing temperature increases the rate of reaction?

	particles collide more often	particles collide with more energy
A	✓	✓
B	✓	x
C	x	✓
D	x	x

Q# 6/

15 Which row describes how the energy of collision between particles changes when concentration and temperature are increased?

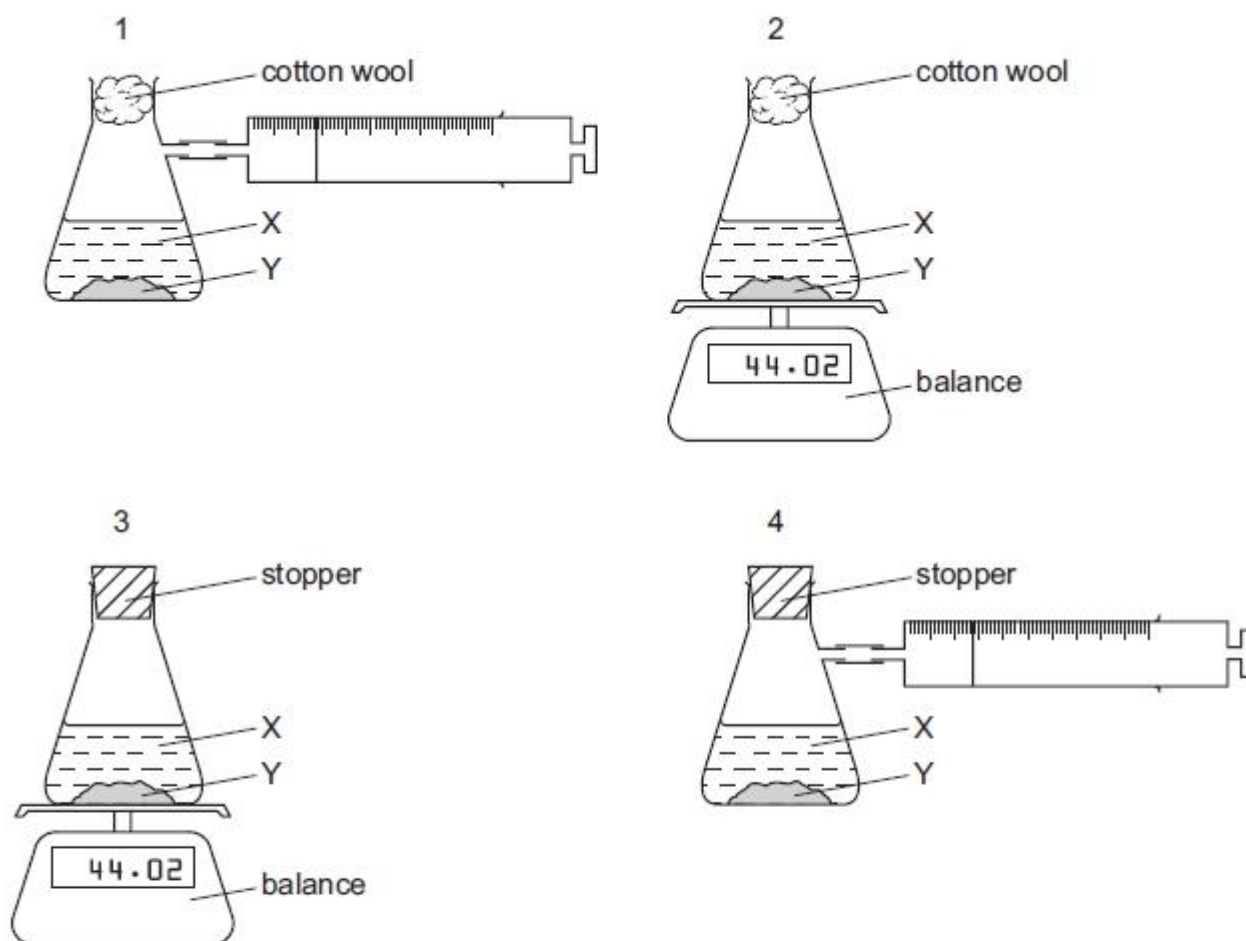
	concentration	temperature
A	increases	increases
B	increases	no change
C	no change	increases
D	no change	no change



Q# 7/

14 A liquid X reacts with solid Y to form a gas.

Which two diagrams show suitable methods for investigating the rate (speed) of the reaction?



- A 1 and 3 B 1 and 4 C 2 and 3 D 2 and 4

15 Which statements explain why increasing temperature increases the rate of a chemical reaction?

- 1 Heat makes the molecules move faster and collide more often.
- 2 Heat makes the molecules collide with more energy so they are more likely to react.
- 3 Increasing temperature lowers the activation energy for the reaction.

- A 1 and 2 B 1 and 3 C 1 only D 2 only

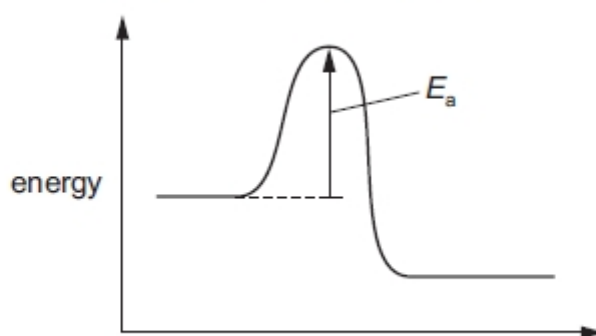
Q# 8/

15 Which statement about catalysts in chemical reactions is **not** correct?

- A Catalysts are not used up in the reaction.
- B Catalysts increase the energy of the reacting particles.
- C Catalysts increase the rate of the reaction.
- D Catalysts lower the activation energy.



17 The diagram shows an energy level diagram for a reaction.



The diagram shows that the reaction is1..... .

Increasing the temperature increases the rate of reaction. A reason for this is that the2..... .

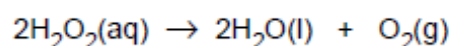
Which words correctly complete gaps 1 and 2?

	1	2
A	endothermic	activation energy decreases
B	endothermic	collision rate increases
C	exothermic	activation energy decreases
D	exothermic	collision rate increases

13.12 Extension Assessed Activity 3 Paper 3/4 17marks

Q# 18/

(c) Aqueous hydrogen peroxide decomposes to form water and oxygen.

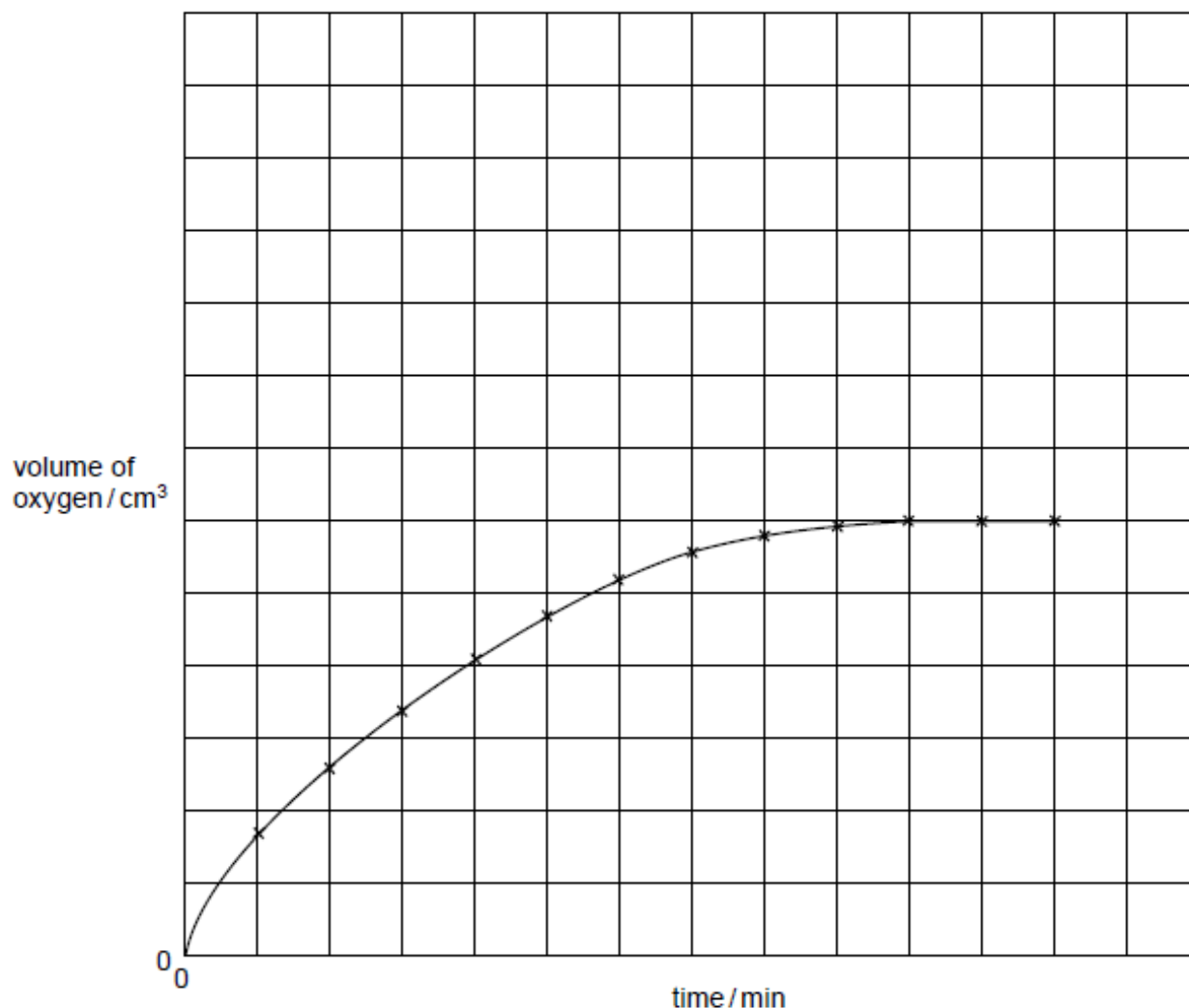


This reaction is catalysed by manganese(IV) oxide

The following experiments were carried out to investigate the rate of this reaction.

A 0.1 g sample of manganese(IV) oxide was added to 20 cm³ of 0.2 M hydrogen peroxide solution. The volume of oxygen produced was measured every minute. The results of this experiment are shown on the graph.





- (i) How does the rate of reaction vary with time? Explain why the rate varies.

.....
[3]

- (ii) The following experiment was carried out at the same temperature.

0.1 g of manganese(IV) oxide and 20 cm³ of 0.4 M hydrogen peroxide

Sketch the curve for this experiment on the same grid. [2]

- (iii) How would the shape of the graph differ if only half the mass of catalyst had been used in these experiments?

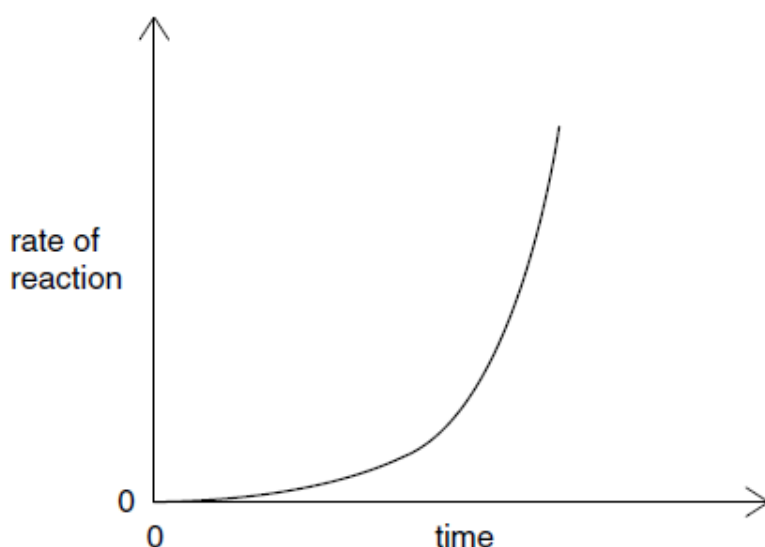
.....

[2]



Q# 19/

- (d) The graph shows how the rate of the exothermic reaction between aluminium and hydrochloric acid varies with time.



- (i) Suggest a reason why the reaction goes slowly at first.

.....[1]

- (ii) Suggest **two** reasons for the increase in rate.

.....
.....[2]

Q# 20/

- 2 Fermentation of sugars is one method of making ethanol. Vines produce glucose by photosynthesis. The glucose collects in the grapes which grow in clusters on the vine.

- (b) Explain how the vine produces glucose by photosynthesis.

.....
.....
.....
.....[4]

Q# 21/

- (v) Give another example of a reaction that is influenced by light. Describe **one** important application of this reaction.

reaction

application[3]



13.13 ESSENTIAL End of Topic Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?



13.14 EXTENSION Mind Map For Topic 7.1 & 7.2



13.15 EXCEPTIONAL Additional Activities, Further Reading and Exploring Beyond the Syllabus

Possible ideas for a presentation

For extremely unreactive elements check out this information:

- https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_09d1ac89ec85489bbc6d57fb6a437c9d.docx?dn=iG%20Chem%207.2%20INFO%20Wikipedia%20Noble%20metal%209
- https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_a807fc32486a4f7a80ee6d250fc9392b.docx?dn=iG%20Chem%207.2%20INFO%20Wikipedia%20Helium%20Least%20

Some rates are extremely fast, like those involved in the middle of a reaction, these involve things like transition states and intermediates. Try to find out about these very short lived compounds (usually called species) from this website: Chemguide:

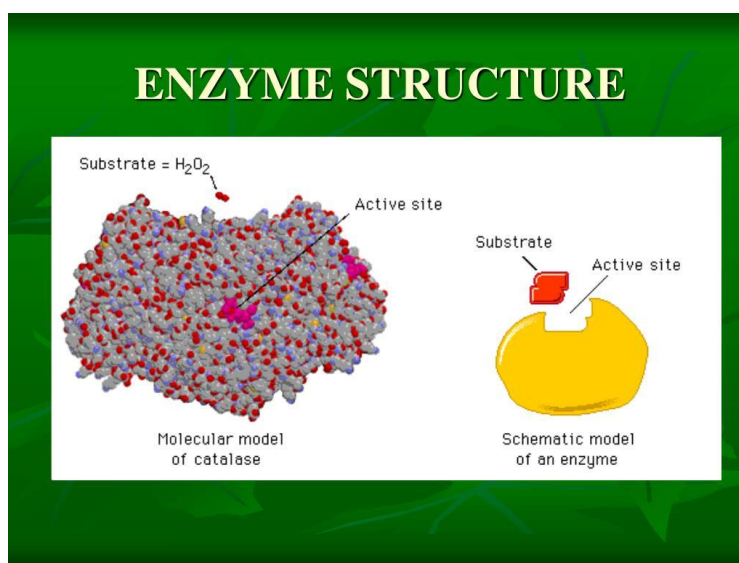
<https://www.chemguide.co.uk/physical/basicrates/energyprofiles.html>

For a much more complicated introduction to a process known as “Flash Photolysis”, be aware though that you might not understand much of this, or anything at all, but it is good to find out where your academic career might take you one day!

https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_302ada967ced4f779fb62f8443008894.pdf?index=true

13.16 Exceptional Extra Credit Science in Context Topic 7.1 and 7.2

Some rates of reaction are very slow, life uses enzymes to carefully control the rates of certain reactions within a cell. A growing field of investigation is creating artificial enzymes, use the links below to find out more about these catalysts which some people think will revolutionise the way we make all of the materials, from our clothes to our buildings in the decades to come:



Enzymes in general: https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_e152e10a08314c70b4eaeef061c9e5d.docx?dn=iG%20Chem%207.2%20INFO%20Wikipedia%20Enzyme%2028Pgs.

How much faster enzymes speed up a reaction: https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_1ef6e8f0b7f64dcc8197e710137e2443.pdf?index=true

Artificial enzymes: https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_b3e22e817cb74bf9b78ab3a53a4037a4.pdf

This website provides free academic articles about the biosciences, check it out!

<https://www.webmedcentral.com/#>



14 Topics 7.3 Reversible Reactions, 11.3 Nitrogen & Fertilisers & 12 Sulfur (Equilibria)

14.1 End of Topic 7.3, 11.3 and 12 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTENSION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTENSION
	Scored over 95%		SMASHING!!!



Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book <u>you enjoy</u> (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book <u>you enjoy</u> (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book <u>you enjoy</u> in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book <u>you enjoy</u> in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

14.2 Topics 7.3, 11.3 & 12 Equilibria Syllabus

Topic 7 Chemical Reactions

7.3 Reversible reactions

Core

- Understand that some chemical reactions can be reversed by changing the reaction conditions. (Limited to the effects of heat and water on hydrated and anhydrous copper(II) sulfate and cobalt(II) chloride.) (Concept of equilibrium is **not** required.)

Supplement

- Predict the effect of changing the conditions (concentration, temperature and pressure) on other reversible reactions
- Demonstrate knowledge and understanding of the concept of equilibrium

7.4 Redox

Core

- Define *oxidation* and *reduction* in terms of oxygen loss/gain. (Oxidation state limited to its use to name ions, e.g. iron(II), iron(III), copper(II), manganate(VII).)

Supplement

- Define *redox* in terms of electron transfer
- Identify redox reactions by changes in oxidation state and by the colour changes involved when using acidified potassium manganate(VII), and potassium iodide. (Recall of equations involving KMnO_4 is **not** required.)
- Define *oxidising agent* as a substance which oxidises another substance during a redox reaction. Define *reducing agent* as a substance which reduces another substance during a redox reaction.
- Identify oxidising agents and reducing agents from simple equations

Top 11 Air and Water



11.3 Nitrogen and fertilisers

Core

- Describe the need for nitrogen-, phosphorus- and potassium-containing fertilisers
- Describe the displacement of ammonia from its salts

Supplement

- Describe and explain the essential conditions for the manufacture of ammonia by the Haber process including the sources of the hydrogen and nitrogen, i.e. hydrocarbons or steam and air

12 Sulfur

12.1 Sulfur

Core

- Name some sources of sulfur
- Name the use of sulfur in the manufacture of sulfuric acid
- State the uses of sulfur dioxide as a bleach in the manufacture of wood pulp for paper and as a food preservative (by killing bacteria)

Supplement

- Describe the manufacture of sulfuric acid by the Contact process, including essential conditions and reactions
- Describe the properties and uses of dilute and concentrated sulfuric acid

14.3 ESSENTIAL Glossary for Keywords for this topic

English	英语
dynamic (chemical) equilibrium two chemical reactions, one the reverse of the other, taking place at the same time, where the concentrations of the reactants and products remain constant because the rate at which the forward reaction occurs is the same as that of the back reaction	动态（化学）平衡两个化学反应，一个同时发生，这是同时发生的，反应物和产物的浓度保持恒定，因为发生正向反应的速率与反向发生的速率相同反应
equilibrium a less precise name for dynamic equilibrium	平衡动态平衡的较不精确的名称
reversible reaction a chemical reaction which can go either forwards or backwards, depending on the conditions	可逆反应，取决于条件，可以向前或向后进行的化学反应
acid rain this has been made more acidic than normal by the presence of dissolved pollutants such as sulfur dioxide (SO ₂) and nitrogen oxides (NO _x)	酸雨由于溶解的污染物（例如二氧化硫（SO ₂ ）和氮氧化物（NO _x ））的存在，使酸雨比正常情况下更加酸性
artificial fertiliser a substance added to soil to increase the amount of elements such as nitrogen, potassium and phosphorus (NPK fertilisers): this enables crops to grow more healthily and produce higher yields	人工肥料一种添加到土壤中以增加氮，钾和磷等元素含量的物质（NPK肥料）：这可使农作物更健康地生长并产生更高的产量
carbon cycle the system by which carbon and its compounds in the air, oceans and rocks are interchanged	碳循环系统，通过该系统可以交换空气，海洋和岩石中的碳及其化合物
Haber process the industrial manufacture of ammonia by the reaction of nitrogen with hydrogen in the presence of an iron catalyst	Haber通过在铁催化剂的存在下使氮与氢反应来工业化生产氨
nitrogen cycle the system by which nitrogen and its compounds, both in the air and in the soil, are interchanged	氮循环系统，通过该系统可以交换空气和土壤中的氮及其化合物
Contact process the industrial manufacture of sulfuric acid using the raw materials sulfur and air	使用原料硫和空气进行接触式工业硫酸生产



14.4 ESSENTIAL Classroom Active Learning Tasks 1 The Haber Process

Write a number next to each of these statement to indicate the order that is needed to make ammonia I the Haber Process

Steam is reacted with methane to make hydrogen.

The gases are passed over an iron catalyst.

The gases are heated to 450°C.

Hydrogen is mixed with nitrogen, obtained from air.

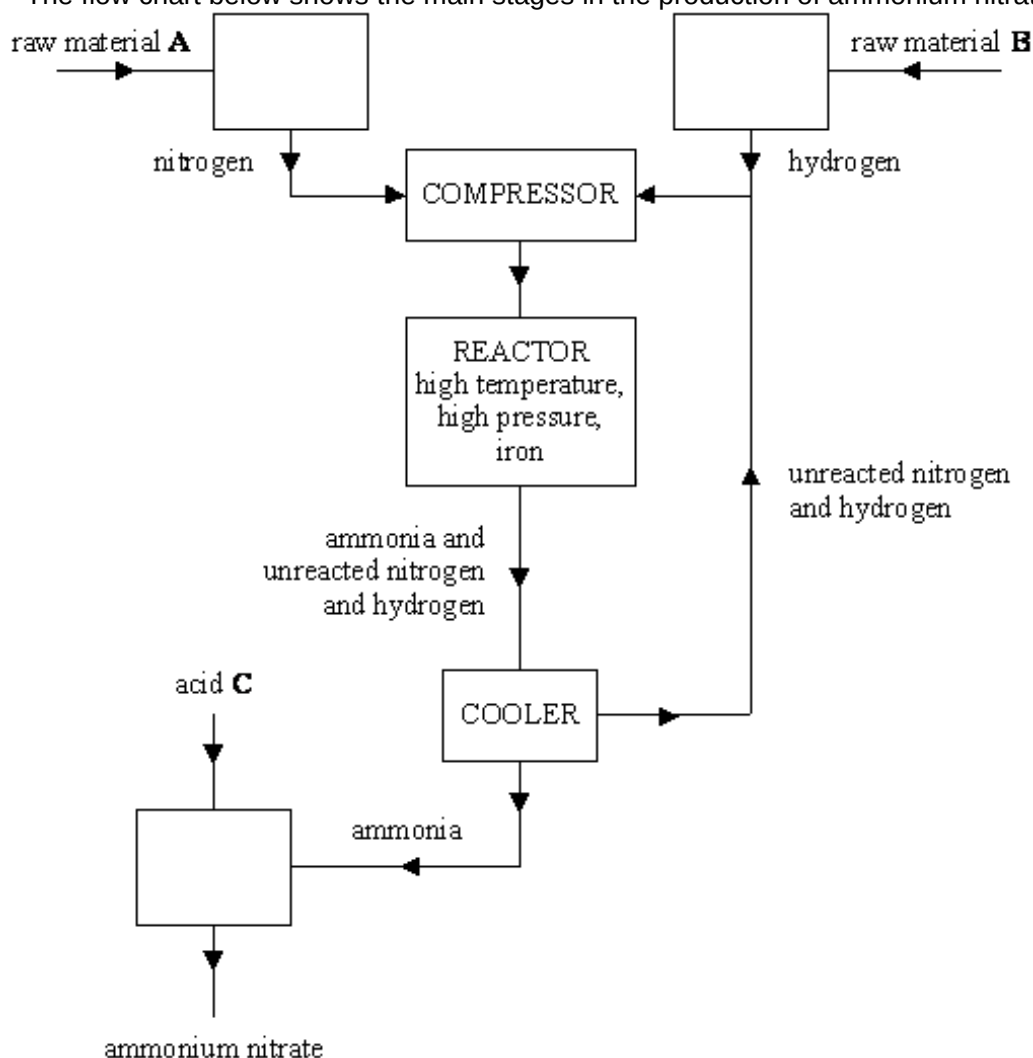
The gases are compressed to 200 atmospheres.

Ammonia gas is produced, then cooled to a liquid.

Liquid ammonia is pumped off to be sold.

Unreacted nitrogen and hydrogen are recycled.

Q6. The flow chart below shows the main stages in the production of ammonium nitrate.



(a) (i) Name the two raw materials shown in the flow chart as **A** and **B**.

Raw material **A**

Raw material **B**



(ii) What is the purpose of the iron in the reactor?

.....
.....

(1)

(ii) The table shows how temperature and pressure affect the amount of ammonia produced in this reaction.

TEMPERATURE (°C)	PRESSURE (ATM)	PERCENTAGE OF NITROGEN AND HYDROGEN CONVERTED TO AMMONIA (%)
250	200	75
250	1000	96
1000	1	0.01
1000	1000	1

Explain, as fully as you can, why a temperature of about 450°C and a pressure of about 100 atmospheres are normally used in the industrial process.

.....
.....
.....
.....
.....
.....
.....

(6)

14.5 ESSENTIAL Classroom Active Learning Tasks 2 The Contact Process

Complete this table

Reagent	Formula	Main Source (and other sources)	Chemical equation (if appropriate)	Reaction conditions, including catalysts, if any
Sulfur				
Sulfur Dioxide				
Sulfur Trioxide				
Oleum				
Sulfuric Acid				

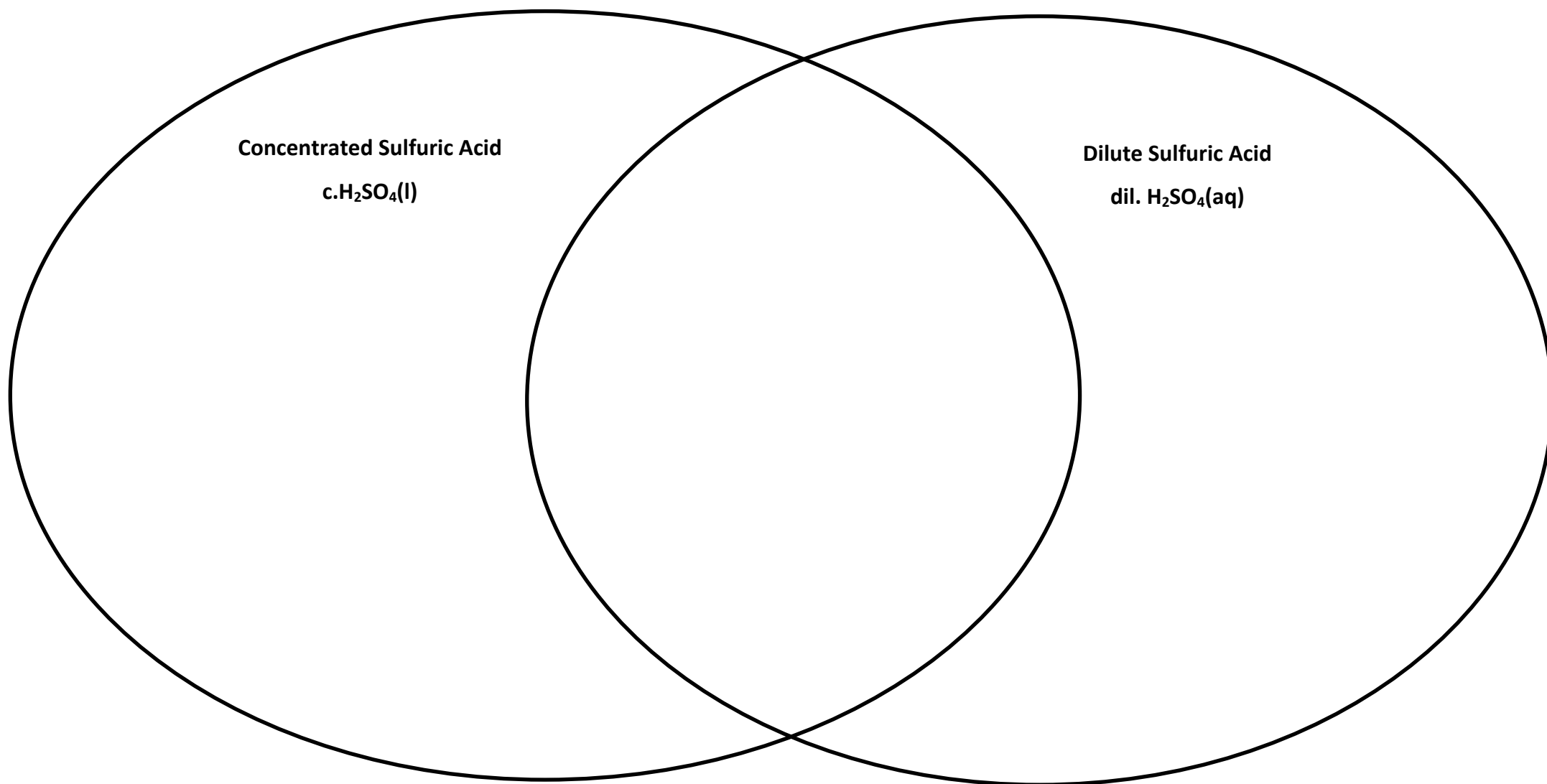


In the space below create a flow diagram, like one used to explain the Haber process in the activity before to show how sulfuric acid is made from sulfur. Include as many chemical equations, with state symbols, as you can



14.6 Extension Classroom Active Learning Task 2 Concentrated and dilute sulfuric acid Venn Diagram

Compare and contrast what these two concentrations of the same acid and show what they have in common and how are they different to each other



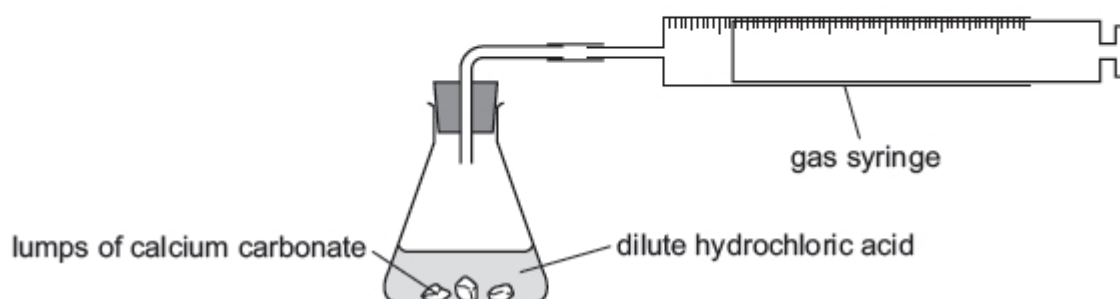
14.7 Extension Classroom Active Learning Tasks 3 Dealing with Multi-mark Questions about Equilibria 84marks

Q# 1/ IGCSE Chemistry/2018/w/Paper 43/Q5

- 5 A student investigates the rate of reaction between lumps of calcium carbonate and dilute hydrochloric acid using the apparatus shown.



The calcium carbonate was in excess.



- (a) Which measurements should the student make during the reaction to determine the rate of reaction?

.....
..... [2]

- (b) What happens to the rate of reaction as the reaction proceeds? Explain your answer.

.....
.....
.....
..... [3]

- (c) The student repeated the experiment at a higher temperature. All other conditions were kept the same. The student found that the rate of reaction increased.

Explain, in terms of collisions, why the rate of reaction increased.

.....
.....
.....
.....
..... [4]



Q# 2/ IGCSE Chemistry/2018/w/Paper 42/Q4

- (c) The original experiment was repeated at a higher temperature. All other conditions were kept the same.

Describe and explain, in terms of collisions between particles, the effect of using a higher temperature on the time taken for the reaction to finish.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

Q# 3/ IGCSE Chemistry/2018/w/Paper 41/Q5

- (d) A mixture of hydrogen gas and iodine gas is allowed to reach equilibrium.

- (i) Increasing the pressure of a gas increases its concentration.

State and explain the effect of increasing the pressure on the **rate** of the forward reaction.

.....

.....

..... [2]

- (ii) State and explain the effect of increasing the temperature on the **rate** of the reverse reaction.

.....

.....

.....

.....

..... [3]

Q# 4/ IGCSE Chemistry/2018/s/Paper 43/Q3

- (d) Cobalt reacts with dilute hydrochloric acid to make the salt cobalt(II) chloride. Bubbles of hydrogen gas are produced.



- (iii) Use collision theory to explain how heating the dilute hydrochloric acid makes the rate of reaction faster.

.....

.....

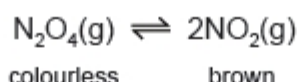
.....

.....

..... [3]

Q# 5/ IGCSE Chemistry/2017/w/Paper 43/

- (b) The chemical equation shows the equilibrium between dinitrogen tetroxide (N_2O_4 , a colourless gas) and nitrogen dioxide (NO_2 , a brown gas).



A mixture of dinitrogen tetroxide and nitrogen dioxide is allowed to reach equilibrium in a closed gas syringe.

- (i) In chemistry, what is meant by the term *equilibrium*?

.....

.....

..... [2]

- (ii) If the equilibrium mixture is heated at constant pressure, a darker brown colour is seen inside the gas syringe.

What does this information indicate about the decomposition of dinitrogen tetroxide?
Explain your answer in terms of the position of the equilibrium.

.....

.....

..... [2]

- (iii) Suggest what you would see if the pressure on the equilibrium mixture were increased at constant temperature.
Explain your answer in terms of the position of the equilibrium.

.....

.....

..... [2]

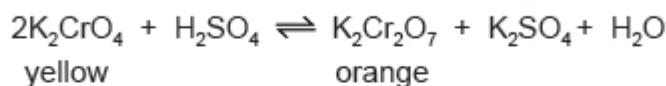


5 Some chemical reactions are reversible.

(a) Aqueous potassium chromate(VI), K_2CrO_4 , is a yellow solution.

Aqueous potassium dichromate(VI), $K_2Cr_2O_7$, is an orange solution.

The two compounds interconvert when the pH of the solution changes.



Solution Y is a mixture of aqueous potassium chromate(VI) and aqueous potassium dichromate(VI) at equilibrium.

- Explain, in terms of the position of the equilibrium, what you would **see** if sulfuric acid were added to solution Y.

.....

.....

.....

- Explain, in terms of the position of the equilibrium, what you would **see** if sodium hydroxide were added to solution Y.

.....

.....

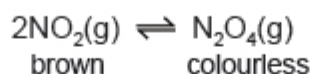
.....

.....

[5]

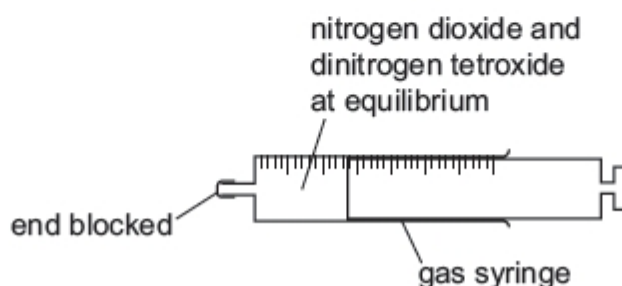
Q# 7/ IGCSE Chemistry/2017/w/Paper 41/Q5

- (c) Nitrogen dioxide, NO_2 , exists in equilibrium with dinitrogen tetroxide, N_2O_4 . Nitrogen dioxide is brown and dinitrogen tetroxide is colourless.



- (i) A sample of nitrogen dioxide and dinitrogen tetroxide at equilibrium was placed in a closed gas syringe.

The syringe plunger was pushed in. This increased the pressure in the gas syringe. The temperature was kept constant.



State how the colour of the gas in the syringe changed. Explain your answer in terms of the position of the equilibrium.

.....
.....
.....
..... [3]

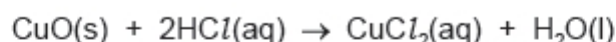
- (ii) A sealed tube containing nitrogen dioxide and dinitrogen tetroxide at equilibrium was cooled in an ice bath at constant pressure. The contents of the tube became paler.

Suggest an explanation for this observation in terms of the position of the equilibrium.

.....
.....
..... [2]

Q# 8/ IGCSE Chemistry/2017/w/Paper 41/

7 Copper(II) oxide reacts with dilute hydrochloric acid.



6.00 g of copper(II) oxide were added to 50.0 cm³ of 1.00 mol/dm³ hydrochloric acid. This was an excess of copper(II) oxide.

- (a) The rate of the reaction can be increased by increasing the concentration of the hydrochloric acid or by heating it.

- (i) In terms of collisions, explain why increasing the concentration of the hydrochloric acid increases the rate of the reaction.

.....
.....
.....
..... [2]

- (ii) In terms of collisions, explain why heating the hydrochloric acid increases the rate of the reaction.

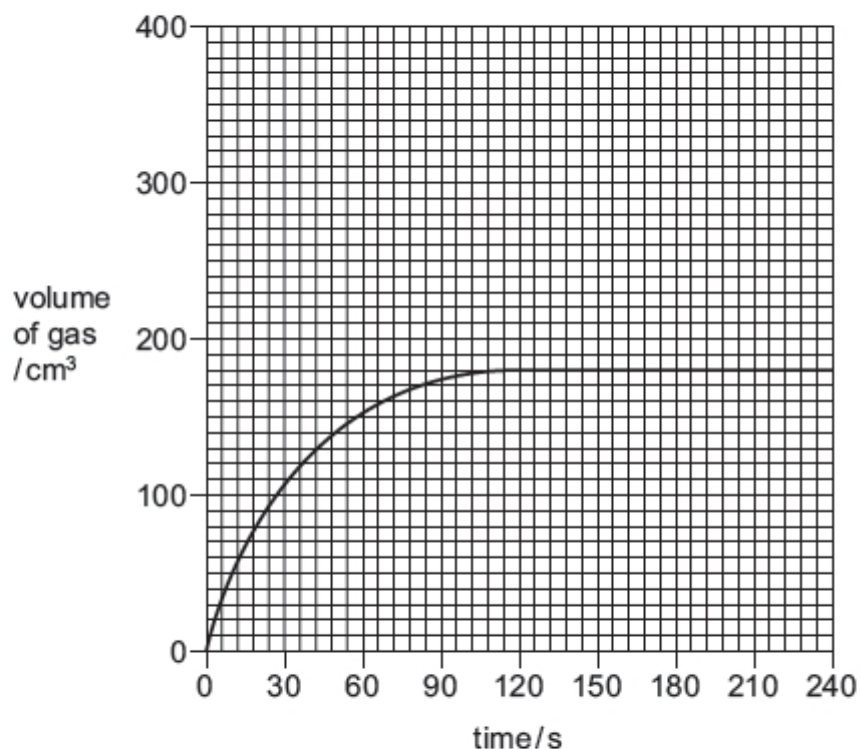
.....
.....
.....
..... [2]



(e) The original graph has been drawn again.

On the grid, draw the graph expected if the concentration of dilute hydrochloric acid is changed from 0.1 mol/dm^3 to 0.2 mol/dm^3 . All other conditions are the same as in the original experiment.

Explain, in terms of particles, why your graph is different from the original graph.

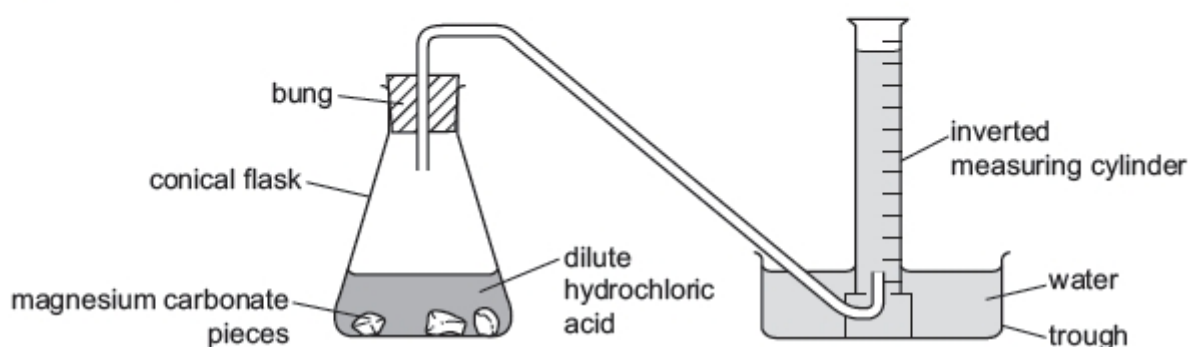


[4]

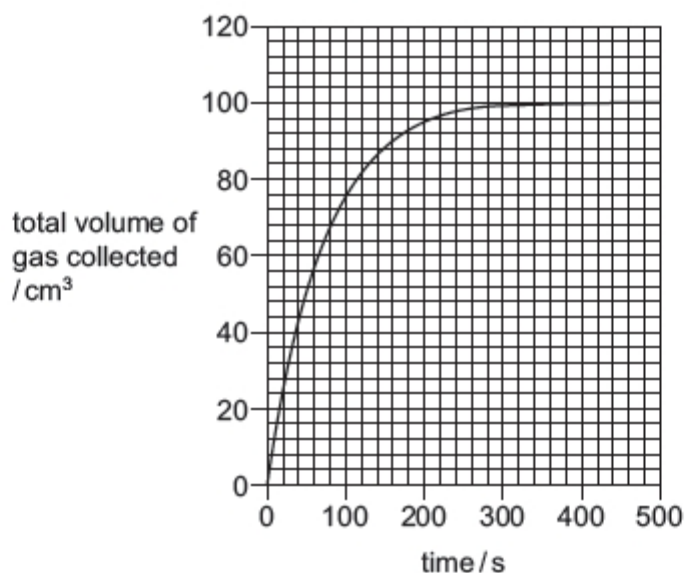
8 Magnesium carbonate reacts with dilute hydrochloric acid.



An excess of magnesium carbonate pieces was added to dilute hydrochloric acid. The apparatus in the diagram was used to measure the volume of gas produced. The total volume of gas collected was recorded every 20 seconds.



(a) The results obtained are shown on the graph.



(i) Describe how the rate of this reaction changed during the reaction. Explain why the rate changed in this way.

.....

.....

.....

.....

[4]

(ii) The experiment was repeated using the same mass of **powdered** magnesium carbonate with the same volume and concentration of dilute hydrochloric acid.

Explain how the initial rate of reaction and total volume of gas collected would compare to the first experiment.

initial rate of reaction

.....

.....

total volume of gas

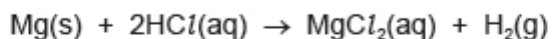
.....

.....

[4]



- (b) A piece of magnesium ribbon was cleaned. The experiment was repeated using this clean magnesium ribbon instead of magnesium carbonate.



This reaction is exothermic.

The rate of the reaction gradually increased over the first 2 minutes.

Explain why the rate of the reaction increased.

.....

.....

.....

.....

.....

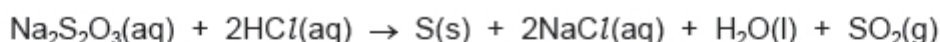
.....

.....

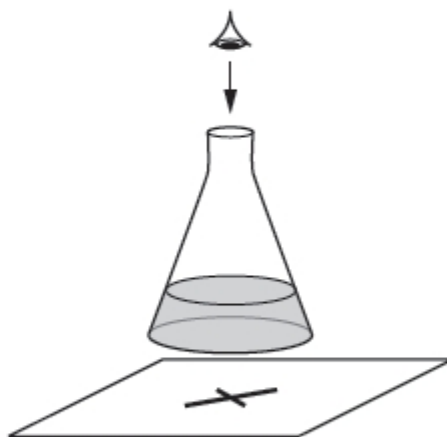
..... [5]

Q# 11/ IGCSE Chemistry/2016/s/Paper 41/

- 3 When aqueous sodium thiosulfate and dilute hydrochloric acid are mixed, a precipitate of insoluble sulfur is produced. This makes the mixture difficult to see through.



The time taken for the cross to disappear from view is measured.



A student adds the following volumes of aqueous sodium thiosulfate, dilute hydrochloric acid and distilled water to the conical flask.

The time taken for the formation of the precipitate of sulfur to make the cross disappear from view is recorded.



experiment number	volume of sodium thiosulfate / cm ³	volume of hydrochloric acid / cm ³	volume of distilled water / cm ³	time taken for cross to disappear from view / s
1	10	10	40	56
2	20	10	30	28
3				

- (ii) Use collision theory to explain why increasing the concentration of sodium thiosulfate would change the rate of reaction.

.....

 [2]

- (c) The student repeated experiment 1 at a higher temperature.

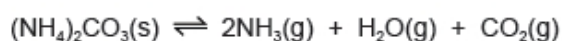
Use collision theory to explain why the rate of reaction would increase.

.....

 [3]

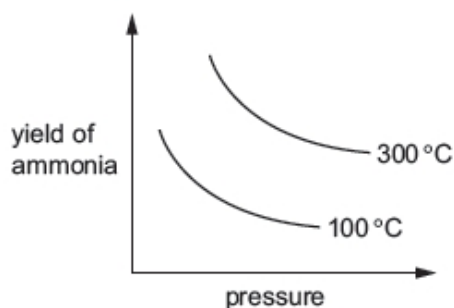
Q# 12/ IGCSE Chemistry/2016/w/Paper 41/

- (b) Ammonia is also made when ammonium carbonate decomposes.



The reaction is reversible and can reach a position of equilibrium.

The graph shows how the yield of ammonia at equilibrium changes with temperature and pressure.



- (i) What is meant by the term *equilibrium* for a reversible reaction?

.....

 [2]



- (iii) State and explain the effect of increasing the pressure on the yield of ammonia in this reaction.

.....

.....

.....

.....

..... [3]

Q# 13/ IGCSE Chemistry/2016/m/Paper 42/

5 This question is about compounds of nitrogen.

- (a) (i) Describe the Haber Process giving reaction conditions and a chemical equation. Reference to rate and yield is not required.

.....

.....

.....

.....

..... [5]

Q# 14/ IGCSE Chemistry/2018/w/Paper 41/Q4

4 (a) Sulfuric acid is made industrially by a four-step process.

step 1 Sulfur is burned in air to produce sulfur dioxide.

step 2 Sulfur dioxide is converted into sulfur trioxide.

step 3 Sulfur trioxide is reacted with concentrated sulfuric acid to produce oleum.

step 4 Oleum is reacted with water to produce concentrated sulfuric acid.

- (iii) Describe the conversion of sulfur dioxide into sulfur trioxide in **step 2**.

In your answer, include:

- a chemical equation for the reaction
- the essential reaction conditions.

.....

.....

.....

.....

.....

.....

.....

..... [5]



(b) Describe **step 2**, giving reaction conditions and a chemical equation. Reference to reaction rate and yield is not required.

[5]

Q# 1/ IGCSE Chemistry/2018/w/Paper 43/

5(a)	M1 volume of gas M2 time	2
5(b)	M1 rate decreases / reaction gets slower M2 concentration of acid decreases M3 fewer collisions per unit time	3
5(c)	M1 particles have more kinetic energy M2 particles move faster M3 more collisions per unit time M4 more of the particles have energy greater than or equal to activation energy / more of the collisions have energy greater than or equal to activation energy OR more of the particles have sufficient energy to react / more of the collisions have sufficient energy to react OR A greater percentage or greater proportion or greater fraction of collisions are successful	4

4(c)	M1 Time taken is less M2 (particles) have more energy M3 (particles) move faster M4 More collisions (of particles) occur per second / per unit time M5 More (of the) particles / collisions have energy greater than activation energy or More (of the) particles / collisions have sufficient energy to react or A greater percentage / proportion / fraction of collisions (of particles) are successful	5
------	---	---

Q# 3/ IGCSE Chemistry/2018/w/Paper 41/

5(d)(i)	M1 Faster and More particles per unit volume / $\text{dm}^3 / \text{cm}^3$ M2 More collisions per second / unit time or greater collision rate	2
5(d)(ii)	Reaction faster and (particles) have more energy or (particles) move faster	1
	more collisions per second or greater collision rate	1
	more (of the) particles / collisions have energy greater than the activation energy or more particles / collisions have sufficient energy to react or a greater percentage / proportion / fraction of collisions are successful	1

Q# 4/ IGCSE Chemistry/2018/s/Paper 43/

3(d)(iii)	(particles) have more energy / (particles) move faster	1
	more collisions per second / greater collision rate	1
	more of the colliding molecules have sufficient energy (activation energy) to react	1

Q# 5/ IGCSE Chemistry/2017/w/Paper 43/

5(b)(i)	reversible reaction in which the rate of the forward reaction equals the rate of the backward reaction	1
	concentration of all reactants and products becomes constant/ does not change	1
5(b)(ii)	forward reaction is endothermic	1
	(increased temperature) causes equilibrium to shift to the right/ to shift in the endothermic direction/ to form more nitrogen dioxide/ to form more product(s)	1
5(b)(iii)	less brown / lighter / paler / colour fades	1
	more molecules / moles / volume on the right OR OR equilibrium shifts in the direction of fewer molecules / moles / lower volume	1

Q# 6/ IGCSE Chemistry/2017/w/Paper 42/

5(a)	both colours referred to correctly as observations in both parts of the answer	1
	(if sulfuric acid is added to solution Y,) equilibrium moves to the right-hand side	1
	because the concentration of acid has increased	1
	(if sodium hydroxide is added to solution Y,) equilibrium moves to the left-hand side	1
	because sodium hydroxide reacts with / neutralises sulfuric acid	1
5(b)(ii)	fewer moles / molecules / particles (of gas) on the left-hand side	1
5(b)(iii)	endothermic	1
5(b)(iv)	increases rate (of reaction)	1

Q# 7/ IGCSE Chemistry/2017/w/Paper 41/Q5

5(c)(i)	becomes paler	1
	equilibrium moves right	1
	(because) fewer moles (of gas) on right	1
5(c)(ii)	equilibrium moved right / more N_2O_4 / less NO_2	1
	(forward) reaction exothermic	1

Q# 8/ IGCSE Chemistry/2017/w/Paper 41/

7(a)(i)	more particles (of acid) in a given volume / $\text{dm}^3 / \text{cm}^3$	1
	more collisions per second / unit time OR greater collision rate	1
7(a)(ii)	particles have more energy / particles move faster / more collisions per second / more collisions per unit time / greater collision rate	1
	more (of the) particles / collisions have energy greater than the activation energy / more particles have sufficient energy to react / more collisions have sufficient energy to react / a greater percentage of collisions are successful	1



Q# 9/ IGCSE Chemistry/2017/s/Paper 41/

5(d)	curve starts from (0,0) and has a lower gradient than the original curve	1
	because lumps have a lower surface area	1
5(d)	curve starts from (0,0) and has a lower gradient than the original curve	1
	because lumps have a lower surface area	1

Q# 10/ IGCSE Chemistry/2016/w/Paper 41/

8(a)(i)	any 4 from: slowed down acid became less concentrated OR fewer particles per unit volume fewer collisions per second OR lower collision rate (then the reaction) stopped all the hydrochloric acid reacted	4
8(a)(ii)	any 4 from: faster (reaction) (powder has) larger surface area more collisions per second OR higher collision rate same volume of gas amount/moles hydrochloric acid is not changed	4
8(b)	any 5 from: temperature increased particles have more energy (particles) move faster more collisions per second OR higher collision rate more particles have sufficient energy to react/activation energy more of the collisions are successful	5

Q# 11/ IGCSE Chemistry/2016/s/Paper 41/

3(b)(ii)	M1 more particles per unit volume/particles are closer together; M2 increases the rate of collisions/there are more collisions per unit time;	1 1	2
3(c)	M1 particles gain more energy and move faster; M2 increasing rate of collisions/more collisions per unit time; M3 higher proportion of particles have sufficient energy to react/collisions have sufficient energy to react/are above the activation energy;	1 1 1	3

Q# 12/ IGCSE Chemistry/2016/w/Paper 41/

4(b)(i)	M1 forward and reverse reactions (occur) M2 amounts / moles / concentrations (of reagents and products) constant OR M2 rate of forward and reverse reactions equal	1 1	
4(b)(ii)	<u>endothermic</u> AND yield increases as temperature increases		1
4(b)(iii)	M1 yield decreases (as pressure increases) M2 because more moles / molecules (of gas) on the right M3 so position of equilibrium moves left	1 1 1	

Q# 13/ IGCSE Chemistry/2016/m/Paper 42/

5(a)(i)	pressure in range 150–300 atmospheres/ atm; temperature in range 370–470 °C; iron (catalyst); balanced equation: $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$; equilibrium/ reversible;	5
---------	---	---

Q# 14/ IGCSE Chemistry/2018/w/Paper 41/

4(a)(iii)	M1 vanadium pentoxide or vanadium(V) oxide or V_2O_5 (catalyst);	1
	M2 1–5 atmospheres; (Units required)	1
	M3 450°C; units required	1
	M4 $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$;	1
	M5 equilibrium / reversible reaction in equation or text	1



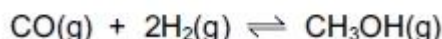
5(b)	M1 vanadium pentoxide /vanadium(V) oxide/ V_2O_5 (catalyst); M2 1–5 atmospheres (units required); M3 450°C (units required); M4 $2SO_2 + O_2 \rightarrow 2SO_3$; M5 equilibrium/reversible reaction;	1 1 1 1 1	5
------	--	-----------------------	----------

14.8 ESSENTIAL EXAM QUESTIONS Paper 2 Topic 7.3

Topic Chem 7 Q# 1/ iGCSE Chemistry/2016/s/Paper 23/

- 16** Methanol is manufactured by reacting carbon monoxide and hydrogen together in the presence of an aluminium oxide catalyst.

The equation for the reaction is shown.



The reaction is a reversible reaction.

The forward reaction is exothermic.

Which change in conditions increases the yield of methanol?

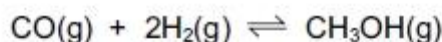
- A** decreasing the concentration of the carbon monoxide
- B** increasing the pressure
- C** increasing the rate of the reaction
- D** increasing the temperature

Topic Chem 7 Q# 2/ iGCSE Chemistry/2016/s/Paper 22/

- 16** Methanol is made by reacting carbon monoxide with hydrogen.

The reaction is exothermic and is a chemical equilibrium.

The equation for the reaction is shown.



Which changes in temperature and pressure increase the yield of methanol?

	temperature	pressure
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase



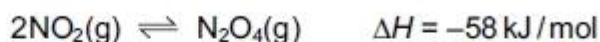
16 Steam reacts with carbon in an endothermic reaction.



Which conditions of temperature and pressure would give the largest yield of hydrogen?

	temperature	pressure
A	high	high
B	high	low
C	low	high
D	low	low

14 A reversible reaction is shown.



Which statement about an equilibrium mixture of NO_2 and N_2O_4 is correct?

- A** If the pressure is decreased the amount of N_2O_4 increases.
- B** If the temperature is increased the amount of N_2O_4 increases.
- C** The rates of formation and decomposition of N_2O_4 are not the same.
- D** The decomposition of N_2O_4 is an endothermic reaction.

28 Ammonia is manufactured by the Haber process from nitrogen and hydrogen.

Which row gives the main sources of these two gases?

	hydrogen	nitrogen
A	air	air
B	air	natural gas
C	natural gas	air
D	natural gas	natural gas

28 Which statement about the Haber process is correct?

- A** The hydrogen used is obtained from the air.
- B** The nitrogen used is obtained from nitrates in the soil.
- C** Nitrogen reacts with hydrogen to make ammonia.
- D** The reaction takes place at room temperature and pressure.



28 Which statement describes the role of iron in the Haber process?

- A It is used as a catalyst.
- B It is used as a reducing agent.
- C It is used to condense the ammonia gas into a liquid.
- D It is used to increase the yield of ammonia.

31 Ammonia is manufactured by reacting hydrogen with nitrogen in the Haber process.

Which row describes the sources of hydrogen and nitrogen and the conditions used in the manufacture of ammonia in the Haber process?

	source of hydrogen	source of nitrogen	temperature of reaction / °C	pressure of reaction / atm
A	air	natural gas	250	2
B	air	natural gas	250	200
C	natural gas	air	450	2
D	natural gas	air	450	200

33 The raw materials for the Haber process are hydrogen and nitrogen.

What are the sources of the hydrogen and nitrogen?

- A hydrogen from ethanol and nitrogen from NPK fertilisers
- B hydrogen from methane and nitrogen from air
- C hydrogen from sulfuric acid and nitrogen from air
- D hydrogen from water and nitrogen from ammonium nitrate

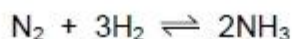
31 The Haber process for making ammonia is carried out at a temperature of 450 °C and a pressure of 200 atmospheres in the presence of a catalyst.

Which statement is **not** correct?

- A Lowering the pressure increases the rate at which ammonia is produced.
- B Lowering the temperature slows down the rate at which ammonia is produced.
- C Maintaining a very high pressure is very difficult and needs expensive equipment.
- D The reaction is a reversible reaction which can proceed forwards and backwards.



31 Ammonia is made by the Haber process.



What are the sources of the nitrogen and hydrogen used in the Haber process?

	nitrogen	hydrogen
A	fertilisers	reacting methane with steam
B	fertilisers	the air
C	the air	reacting methane with steam
D	the air	the air

31 Which row gives the catalyst for the Haber process and the sources of the raw materials?

	catalyst	source of hydrogen	source of nitrogen
A	iron	electrolysis	fertiliser
B	iron	methane	air
C	vanadium pentoxide	methane	air
D	vanadium pentoxide	methane	fertiliser

31 Which statement about the conditions used in the Haber process is **not** correct?

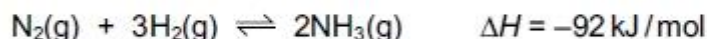
- A A high temperature is used because the forward reaction is exothermic.
- B A high pressure is used because there are fewer moles of gas in the products than in the reactants.
- C An iron catalyst is used to increase the rate of the forward reaction.
- D The unreacted hydrogen and nitrogen are recycled to increase the amount of ammonia produced.

32 Which row gives the conditions for the Haber process?

	temperature / °C	pressure / atm	catalyst
A	200	2	V ₂ O ₅
B	200	450	Fe
C	450	200	Fe
D	500	250	V ₂ O ₅



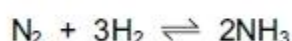
- 32 The Haber process for the manufacture of ammonia occurs at 450 °C and 250 atmospheres. The nitrogen and hydrogen are supplied in a 1:3 ratio by volume. The reaction is exothermic.



Which change causes an increase in the yield of ammonia?

- A decreasing the concentration of nitrogen
- B decreasing the pressure
- C decreasing the temperature
- D using equal amounts of the two reactants

- 32 Ammonia is manufactured by the Haber process, using an iron catalyst.

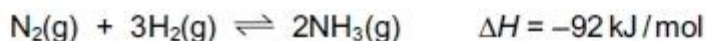


It is not possible to obtain 100% yield.

What is the reason for this?

- A A high pressure is used.
- B Ammonia decomposes at high temperature.
- C Some of the ammonia is recycled.
- D The ammonia reacts with the catalyst.

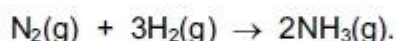
- 32 Ammonia is manufactured by the Haber process. The reaction is exothermic.



Which statement about the Haber process is correct?

- A The reaction is irreversible and produces only one product.
- B The reaction is reversible and produces less ammonia at high pressure.
- C The reaction is reversible and produces less ammonia at high temperature.
- D The reaction is slow because a catalyst is not used in the Haber process.

- 32 Ammonia is produced by the Haber process.

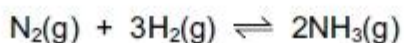


Which statement about the Haber process is **not** correct?

- A An iron catalyst is used to increase the rate of reaction.
- B The reaction is carried out at high temperature to increase the rate of reaction.
- C The reaction is carried out at low pressure to increase the yield of ammonia.
- D The reaction is reversible.



32 Ammonia is manufactured by a reversible reaction.

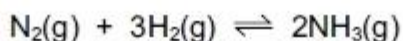


The forward reaction is exothermic.

What is the effect of increasing the pressure on the percentage yield and rate of formation of ammonia?

	percentage yield	rate of formation
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

32 Ammonia is formed by a reversible reaction.



The forward reaction is exothermic.

Which changes in conditions would increase the yield of ammonia?

	increase in pressure	increase in temperature
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

34 A farmer's soil is very low in both nitrogen (N) and phosphorus (P).

Which fertiliser would improve the quality of this soil most effectively?

	percentage		
	nitrogen (N)	phosphorus (P)	potassium (K)
A	11	11	27
B	12	37	10
C	28	10	10
D	31	29	9



32 Fertilisers are used to provide three elements needed to increase the yield of crops.

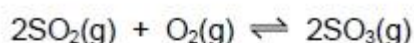
Which two compounds would provide all three of these elements?

- A** ammonium nitrate and calcium phosphate
- B** ammonium nitrate and potassium sulfate
- C** potassium nitrate and calcium phosphate
- D** potassium nitrate and potassium sulfate

33 Which statement about sulfur or one of its compounds is correct?

- A** Sulfur occurs naturally as the element sulfur.
- B** Sulfur dioxide is used to kill bacteria in drinking water.
- C** Sulfuric acid is a weak acid.
- D** Dilute sulfuric acid is a dehydrating agent.

15 In the Contact process, sulfur dioxide is converted into sulfur trioxide in a reversible reaction.



The forward reaction is exothermic.

Which conditions give the highest yield of sulfur trioxide at equilibrium?

	pressure /atmospheres	temperature
A	0.5	high
B	0.5	low
C	1.5	high
D	1.5	low

33 Element Z forms an oxide, ZO_2 . Three uses of ZO_2 are listed.

- bleaching agent
- killing bacteria
- manufacturing an important acid

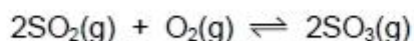
What is Z?

- A** carbon
- B** lead
- C** nitrogen
- D** sulfur



15 Sulfur dioxide reacts with oxygen at 2 atmospheres pressure. The forward reaction is exothermic.

The equation for the reaction is shown.



The reaction reaches equilibrium. The pressure is then doubled.

How and why does the amount of sulfur trioxide formed change?

	amount of sulfur trioxide	reason
A	decreases	the forward reaction is exothermic
B	decreases	there are fewer molecules on the right
C	increases	the forward reaction is exothermic
D	increases	there are fewer molecules on the right

33 Which row describes the uses of sulfur and sulfur dioxide?

	sulfur	sulfur dioxide
A	extraction of aluminium	food preservative
B	extraction of aluminium	water treatment
C	manufacture of sulfuric acid	food preservative
D	manufacture of sulfuric acid	water treatment

33 Which statement about sulfur and its compounds is **not** correct?

- A Sulfur dioxide is used as a food preservative.
- B Sulfur dioxide turns acidified aqueous potassium manganate(VII) from purple to colourless.
- C Sulfur forms a basic oxide.
- D Sulfur is used in the manufacture of sulfuric acid.

35 The Contact process is used to make sulfuric acid.

The steps in the process are listed.

- 1 Dissolve sulfur trioxide in 98% concentrated sulfuric acid.
- 2 Heat sulfur strongly in air.
- 3 Add oleum to water.
- 4 Pass sulfur dioxide over a vanadium(V) oxide catalyst.

Which sequence of steps is correct?

- A 4 → 1 → 2 → 3
- B 4 → 2 → 3 → 1
- C 2 → 1 → 4 → 3
- D 2 → 4 → 1 → 3



33 Which row shows the conditions used in the manufacture of sulfuric acid by the Contact process?

	temperature /°C	pressure /atm	catalyst
A	40	200	Fe
B	40	200	V ₂ O ₅
C	400	2	Fe
D	400	2	V ₂ O ₅

33 Which statement about sulfuric acid is correct?

- A** It is made by the Haber process.
- B** It is made in the atmosphere by the action of lightning.
- C** It reacts with ammonia to produce a fertiliser.
- D** It reacts with copper metal to produce hydrogen gas.

33 The ions present in ammonium sulfate are formed from the products of the Contact and Haber processes.

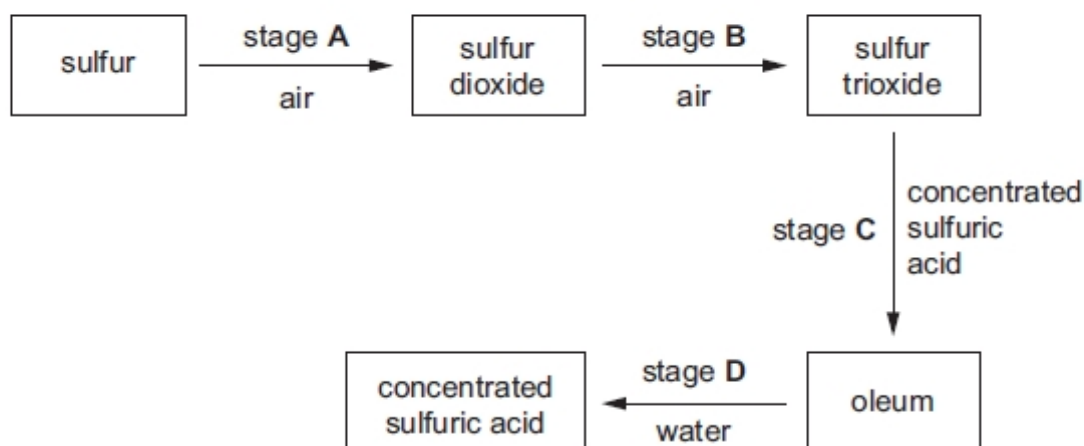
Both of these processes involve the use of a catalyst.

Which row is correct?

	ion	formed from	process	catalyst
A	ammonium	ammonia	Contact	iron
B	ammonium	ammonia	Haber	vanadium(V) oxide
C	sulfate	sulfuric acid	Contact	vanadium(V) oxide
D	sulfate	sulfuric acid	Haber	iron

33 The following scheme shows four stages in the conversion of sulfur to sulfuric acid.

In which stage is a catalyst used?



- 33** Sulfuric acid is manufactured by a series of chemical reactions, one of which is catalysed by vanadium(V) oxide.

What is the equation for the reaction catalysed by vanadium(V) oxide?

- A** $S + O_2 \rightarrow SO_2$
B $2S + 3O_2 \rightarrow 2SO_3$
C $2SO_2 + O_2 \rightarrow 2SO_3$
D $SO_3 + H_2O \rightarrow H_2SO_4$

- 33** Sulfuric acid is manufactured by the Contact process.

The most important reaction takes place in the presence of a catalyst.

What are the reactants and the catalyst for this reaction?

	reactants	catalyst
A	sulfur and oxygen	vanadium(V) oxide
B	sulfur dioxide and oxygen	vanadium(V) oxide
C	sulfur dioxide and steam	iron
D	sulfur trioxide and water	platinum

- 33** One step in the manufacture of sulfuric acid is the oxidation of sulfur dioxide to sulfur trioxide.

Which conditions are used for this step?

	temperature / °C	pressure / atmospheres	catalyst
A	450	1.5	iron
B	450	1.5	vanadium(V) oxide
C	450	200	iron
D	450	200	vanadium(V) oxide

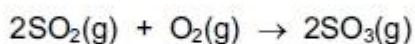
- 33** The Contact process is used for the manufacture of sulfuric acid.

Which statement about this process is **not** correct?

- A** A catalyst of iron is used.
B Oxygen from the air is used to react with sulfur dioxide.
C Sulfur trioxide dissolves in sulfuric acid to form oleum.
D The temperature used is around 450 °C.



33 The equation for an exothermic reaction in the Contact process is shown.



Which effects do increasing the temperature and using a catalyst have on the rate of formation of sulfur trioxide, SO_3 ?

	increasing the temperature	using a catalyst
A	rate decreases	rate decreases
B	rate decreases	rate increases
C	rate increases	rate decreases
D	rate increases	rate increases

Topic Chem 12 Q# 39/ iGCSE Chemistry/2016/m/Paper 22/

33 What is a property of concentrated sulfuric acid but **not** of dilute sulfuric acid?

- A It is a dehydrating agent.
- B It neutralises alkalis.
- C It produces a white precipitate with barium nitrate.
- D It reacts with metals to give a salt and hydrogen.



14.8.1 ESSENTIAL EXAM QUESTIONS Paper 2 Topic 7.3 Mark Scheme

Q# 1/ iGCSE Chemistry/2016/s/Paper 23/

16	B
----	---

Q# 2/ iGCSE Chemistry/2016/s/Paper 22/

16	B
----	---

Q# 3/ iGCSE Chemistry/2016/s/Paper 21/

16	B
----	---

Q# 4/ iGCSE Chemistry/2016/m/Paper 22/

14	D
----	---

Q# 5/ iGCSE Chemistry/2018/w/Paper 23/

28	C
----	---

Q# 6/ iGCSE Chemistry/2018/w/Paper 22/

28	C
----	---

Q# 7/ iGCSE Chemistry/2018/w/Paper 21/

28	A
----	---

Q# 8/ iGCSE Chemistry/2018/s/Paper 21/

31	D
----	---

Q# 9/ iGCSE Chemistry/2018/m/Paper 22/

33	B
----	---

Q# 10/ iGCSE Chemistry/2017/w/Paper 23/

31	A
----	---

Q# 11/ iGCSE Chemistry/2017/w/Paper 21/

31	C
----	---

Q# 12/ iGCSE Chemistry/2017/s/Paper 23/

31	B
----	---

Q# 13/ iGCSE Chemistry/2017/s/Paper 22/

31	A
----	---

Q# 14/ iGCSE Chemistry/2017/s/Paper 21/

32	C
----	---

Q# 15/ iGCSE Chemistry/2016/w/Paper 23/

32	C
----	---

Q# 16/ iGCSE Chemistry/2016/w/Paper 22/

32	B
----	---

Q# 17/ iGCSE Chemistry/2016/w/Paper 21/

32	C
----	---

Q# 18/ iGCSE Chemistry/2016/s/Paper 23/

32	C
----	---

Q# 19/ iGCSE Chemistry/2016/s/Paper 22/

32	D
----	---

Q# 20/ iGCSE Chemistry/2016/s/Paper 21/

32	B
----	---

Q# 21/ iGCSE Chemistry/2016/s/Paper 21/

34	D
----	---

Q# 22/ iGCSE Chemistry/2016/m/Paper 22/

32	C
----	---

Q# 23/ iGCSE Chemistry/2018/w/Paper 21/

29	A
----	---

Q# 24/ iGCSE Chemistry/2018/s/Paper 23/

15	D
----	---

Q# 25/ iGCSE Chemistry/2018/s/Paper 23/

33	D
----	---

Q# 26/ iGCSE Chemistry/2018/s/Paper 22/

15	D
----	---

Q# 27/ iGCSE Chemistry/2018/s/Paper 22/

33	C
----	---

Q# 28/ iGCSE Chemistry/2018/s/Paper 21/

29	C
----	---

Q# 29/ iGCSE Chemistry/2018/m/Paper 22/

35	D
----	---

Q# 30/ iGCSE Chemistry/2017/w/Paper 21/

33	D
----	---

Q# 31/ iGCSE Chemistry/2017/s/Paper 21/

33	C
----	---

Q# 32/ iGCSE Chemistry/2017/m/Paper 22/

33	C
----	---

Q# 33/ iGCSE Chemistry/2016/w/Paper 23/

33	B
----	---

Q# 34/ iGCSE Chemistry/2016/w/Paper 22/

33	C
----	---

Q# 35/ iGCSE Chemistry/2016/w/Paper 21/

33	B
----	---

Q# 36/ iGCSE Chemistry/2016/s/Paper 23/

33	B
----	---

Q# 37/ iGCSE Chemistry/2016/s/Paper 22/

33	A
----	---

Q# 38/ iGCSE Chemistry/2016/s/Paper 21/

33	D
----	---

Q# 39/ iGCSE Chemistry/2016/m/Paper 22/

33	A
----	---

34	C
----	---



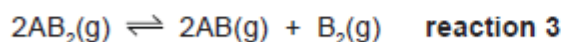
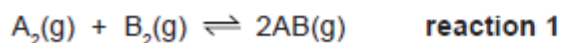


14.9 ESSENTIAL EXAM QUESTIONS Paper 3/4 Topic 7.3 56 marks

Topic Chem 7.3 **Q# 1/** iGCSE Chemistry/2011/w/Paper 31/



- 4 Reversible reactions can come to equilibrium. The following are three examples of types of gaseous equilibria.



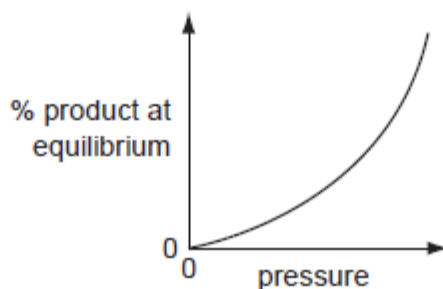
- (a) Explain the term *equilibrium*.

.....
 [2]

- (b) The following graphs show how the percentage of products of a reversible reaction at equilibrium could vary with pressure.

For each graph, decide whether the percentage of products decreases, increases or stays the same when the pressure is **increased**, then match each graph to one of the above reactions and give a reason for your choice.

(i)



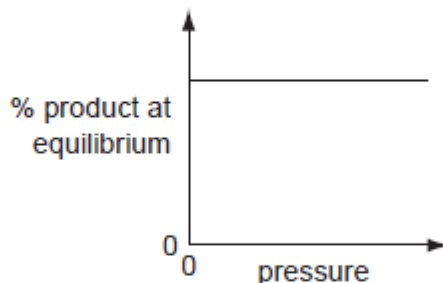
effect on percentage of products

reaction

reason

..... [3]

(ii)



effect on percentage of products

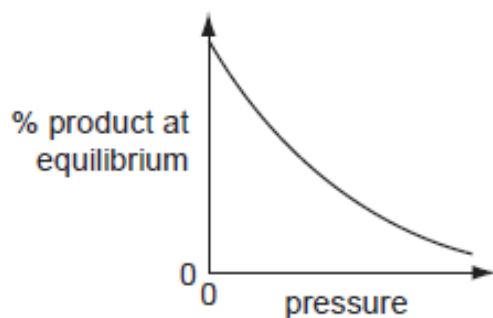
reaction

reason

..... [3]



(iii)



effect on percentage of products

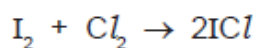
reaction

reason

[3]

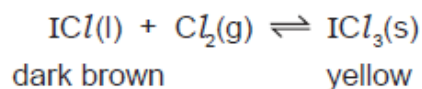
Topic Chem 7.3 Q# 2/ iGCSE Chemistry/2010/s/Paper 31/

6 Iodine reacts with chlorine to form dark brown iodine monochloride.



This reacts with more chlorine to give yellow iodine trichloride.

There is an equilibrium between these iodine chlorides.



(a) Explain what is meant by *equilibrium*.

.....
.....
.....

[2]

(b) When the equilibrium mixture is heated it becomes a darker brown colour.
Is the reverse reaction endothermic or exothermic? Give a reason for your choice.

.....
.....
.....

[2]



(c) The pressure on the equilibrium mixture is decreased.

(i) How would this affect the position of equilibrium and why?

It would move to the [1]

reason

..... [1]

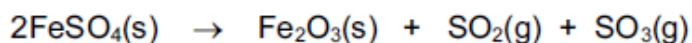
(ii) Describe what you would observe.

.....

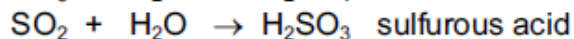
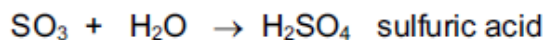
..... [1]

Topic Chem 7.3 Q# 3/ iGCSE Chemistry/2009/w/Paper 3/ Q6

(b) Sulfuric acid was first made in the Middle East by heating the mineral, green vitriol, $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$. The gases formed were cooled.



On cooling

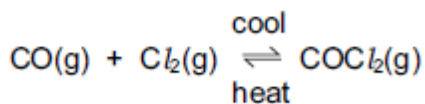


(i) How could you show that the first reaction is reversible?

.....
..... [2]

Topic Chem 7.3 Q# 4/ iGCSE Chemistry/2008/s/Paper 31/

5 Carbonyl chloride, COCl_2 , is a colourless gas. It is made by the following reaction.



(a) When the pressure on the equilibrium mixture is decreased, the position of equilibrium moves to left.

(i) How does the concentration of each of the three chemicals change?

.....
..... [2]



(ii) Explain why the position of equilibrium moves to left.

.....
..... [2]

(b) Using the information given with the equation, is the forward reaction exothermic or endothermic? Give a reason for your choice.

.....
..... [2]

Topic Chem 7.3 Q# 5/ iGCSE Chemistry/2007/w/Paper 3/ Q6

(c) Methanol is made from carbon monoxide.

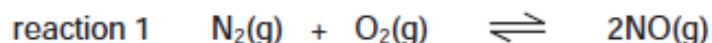


(iii) Which condition, high or low pressure, would give the maximum yield of methanol? Give a reason for your choice.

pressure
reason [2]

Topic Chem 7.3 Q# 6/ iGCSE Chemistry/2005/w/Paper 3/ Q3

(b) Both of the following reactions are reversible.



(i) Suggest a reason why an increase in pressure does not affect the position of equilibrium for reaction 1.

..... [1]

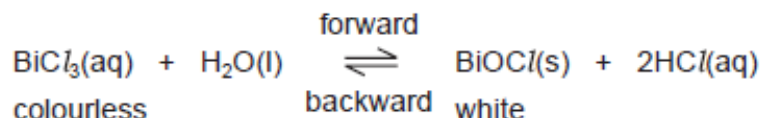
(ii) What effect would an increase in pressure have on the position of equilibrium for reaction 2? Give a reason for your answer.

.....
..... [2]



3 Reversible reactions can come to equilibrium. They have both a forward and a backward reaction.

(a) When water is added to an acidic solution of bismuth(III) chloride, a white precipitate forms and the mixture slowly goes cloudy.



(i) Explain why the rate of the forward reaction decreases with time.

.....
 [2]

(ii) Why does the rate of the backward reaction increase with time?

.....
 [1]

(iii) After some time why does the appearance of the mixture remain unchanged?

.....
 [2]

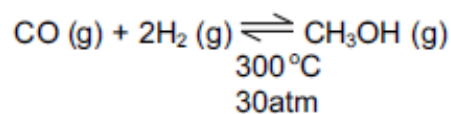
(iv) When a few drops of concentrated hydrochloric acid are added to the cloudy mixture, it changes to a colourless solution. Suggest an explanation.

.....
 [2]



3 The simplest alcohol is methanol.

(a) It is manufactured by the following reversible reaction.



(i) Reversible reactions can come to equilibrium. Explain the term *equilibrium*.

[1]

(ii) At 400 °C, the percentage of methanol in the equilibrium mixture is lower than at 300 °C. Suggest an explanation.

[2]

(iii) Suggest two advantages of using high pressure for this reaction.
Give a reason for each advantage.

advantage	
reason	

advantage	
reason	

[5]

Topic Chem 7.3 Q# 9/ iGCSE Chemistry/2001/w/Paper 3/ QiGCSE Chemistry/201



- (b) Carbon monoxide is used to purify nickel. Nickel reacts with carbon monoxide to form a gaseous compound.



- (i) What reaction condition will favour the back reaction and reform nickel metal?
Explain your choice.

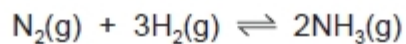
.....
.....[2]



14.10 ESSENTIAL EXAM QUESTIONS Paper 3/4 Haber process and nitrogen chemistry (Topic 11.1) 63 Marks

Topic Chem 11.3 Q# 1/ iGCSE Chemistry/2013/w/Paper 31/

3 Ammonia is manufactured by the Haber process.



The forward reaction is exothermic.

(a) Describe how the reactants are obtained.

(i) Nitrogen

.....
..... [2]

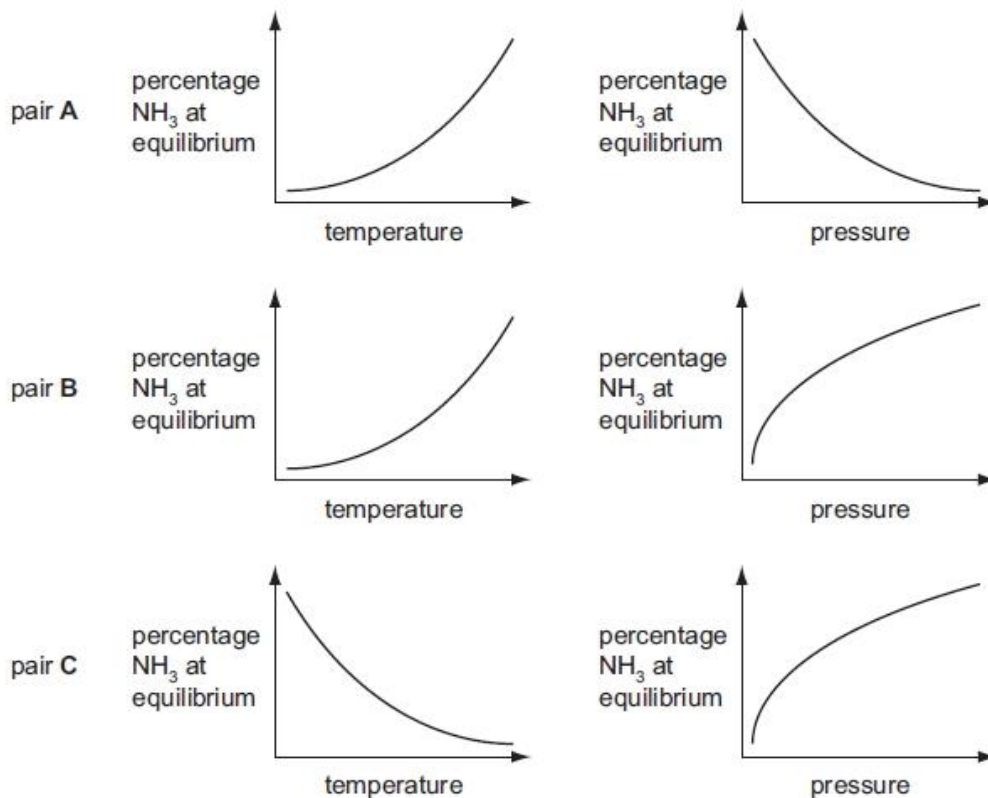
(ii) Hydrogen

.....
.....
..... [3]



(b) The percentage of ammonia in the equilibrium mixture varies with temperature and pressure.

(i) Which pair of graphs, A, B or C, shows correctly how the percentage of ammonia at equilibrium varies with temperature and pressure?



The pair with **both graphs correct** is [1]

(ii) Give a full explanation of why the pair of graphs you have chosen in (i) is correct.

.....

.....

.....

.....

.....

.....

.....

..... [6]



(iii) Catalysts do not alter the position of equilibrium. Explain why a catalyst is used in this process.

.....

.....

.....

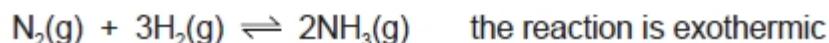
..... [2]

Topic Chem 11.3 Q# 2/ iGCSE Chemistry/2013/s/Paper 31/ Q6

(b) Ammonia is manufactured by the Haber Process. The economics of this process require that as much ammonia as possible is made as quickly as possible. Explain how this can be done using the following information.

The conditions for the following reversible reaction are:

- 450 °C
- 200 atmospheres pressure
- iron catalyst



.....

.....

.....

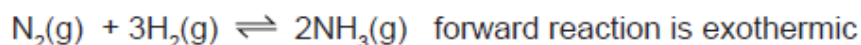
.....

.....

..... [5]



(b) Ammonia is made by the Haber Process.



The percentage of ammonia in the equilibrium mixture varies with conditions.

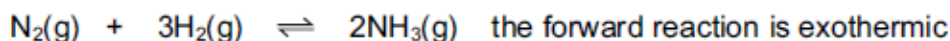
pressure / atmospheres	100	200	300	400
% ammonia at 300 °C	45	65	72	78
% ammonia at 500 °C	9	18	25	31

The conditions actually used are 200 atmospheres, 450 °C and an iron catalyst.

- (i) The original catalyst was platinum. Suggest a reason why it was changed to iron.
- [1]
- (ii) Explain why the highest pressure gives the highest percentage of ammonia in the equilibrium mixture.
-
- [2]
- (iii) What happens to the unreacted nitrogen and hydrogen?
-
- [1]
- (iv) State **one** advantage and **one** disadvantage of using a lower temperature.
- advantage
- [1]
- disadvantage
- [1]



6 Ammonia is manufactured by the Haber process.



(a) (i) Name the raw materials from which nitrogen and hydrogen are obtained.

nitrogen from [1]

hydrogen from [1]

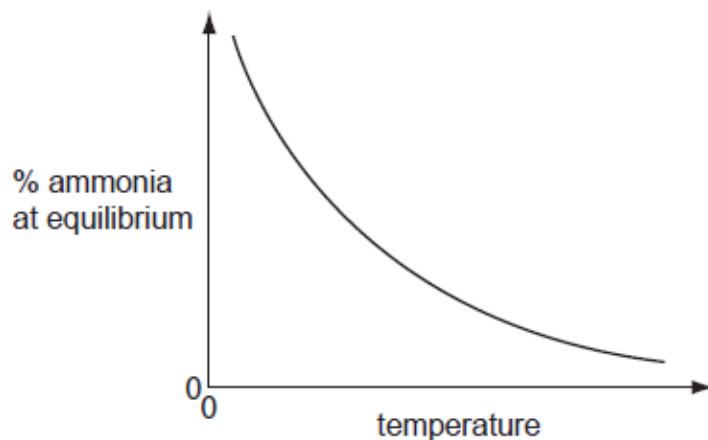
(ii) Name the catalyst used in this process.

..... [1]

(iii) What is the most important use of ammonia?

..... [1]

(b) The following graph shows how the percentage of ammonia in the equilibrium mixture changes with temperature.



(i) Explain the term *equilibrium*.

.....

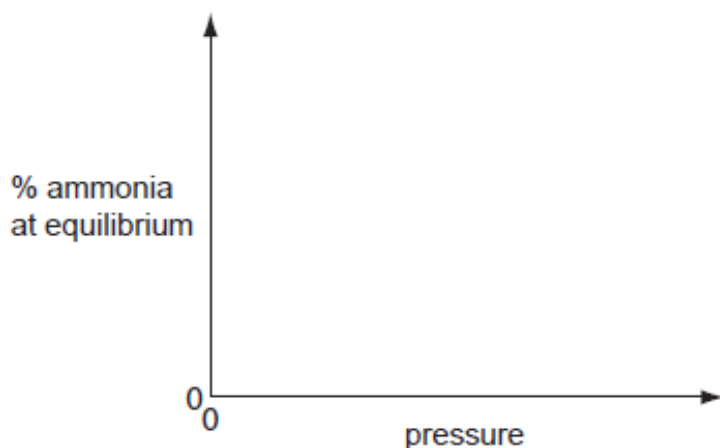
 [2]

(ii) How does the percentage of ammonia vary with temperature?

..... [1]



- (c) (i) Sketch a graph which shows how the percentage of ammonia in the equilibrium mixture varies with pressure.



[1]

- (ii) Explain why the graph has the shape shown.

.....

.....

..... [2]

Topic Chem 11.3 **Q# 5/** iGCSE Chemistry/2008/w/Paper 31/ Q5b

- (ii) Name an important chemical that is made from hydrogen.

..... [1]

Topic Chem 11.3 **Q# 6/** iGCSE Chemistry/2008/s/Paper 31/

- 8** Large areas of the Amazon rain forest are cleared each year to grow soya beans. The trees are cut down and burnt.

- (a) Why do these activities increase the percentage of carbon dioxide in the atmosphere?

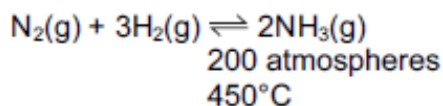
.....

..... [2]

Topic Chem 11.3 **Q# 7/** iGCSE Chemistry/2006/w/Paper 3/



5 Ammonia is manufactured by the Haber Process.



The forward reaction is exothermic.

(a) (i) What is the catalyst for this reaction?

..... [1]

(ii) Newer catalysts have been discovered for this process. Using these catalysts, the operating temperature is lowered from 450°C to 400°C. What is the advantage of using a lower temperature?
Explain your answer.

advantage

explanation

..... [2]

(b) After passing over the catalyst, the mixture contains 15% of ammonia. It is cooled and the ammonia liquefies and is separated from the unreacted nitrogen and hydrogen. They are recycled.

(i) How are the gases recycled?

..... [1]

(ii) Only ammonia gas liquefies. Suggest an explanation for this.

..... [1]

(c) Urea, $\text{CO}(\text{NH}_2)_2$, is one of the fertilisers manufactured from ammonia. Ammonia is heated with carbon dioxide.

(i) Write an equation for the manufacture of urea.

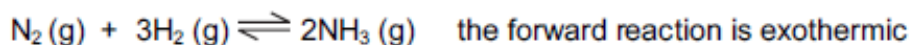
..... [2]

(ii) Explain why urea on its own might not be very effective in promoting crop growth.

..... [1]



- 7 In 1909, Haber discovered that nitrogen and hydrogen would react to form ammonia. The yield of ammonia was 8%.



catalyst platinum
temperature 600 °C
pressure 200 atm

- (a) Describe how hydrogen is obtained for the modern process.

.....
..... [2]

- (b) (i) What is the catalyst in the modern process?

..... [1]

- (ii) Explain why the modern process, which uses a lower temperature, has a higher yield of 15%.

.....
..... [2]

Topic Chem 11.3 Q# 9/ iGCSE Chemistry/2004/s/Paper 3/ Q2

- (b) About one third of this production of acid is used to make nitrogen and phosphorus-containing fertilisers.

- (i) Name the third element that is essential for plant growth and is present in most fertilisers.

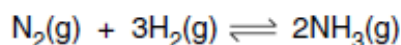
..... [1]

- (ii) Name a nitrogen-containing fertiliser that is manufactured from sulphuric acid.

..... [1]



- 1 Ammonia contains the elements nitrogen and hydrogen. It is manufactured from these elements in the Haber process.



The forward reaction is exothermic.

- (ii) Name **two** raw materials from which hydrogen is manufactured.

.....[2]

- (b) The table shows how the percentage of ammonia in the equilibrium mixture varies with pressure at 600 °C.

percentage ammonia	8	12	15	20
pressure/atm	200	300	400	500

- (i) Explain why the percentage of ammonia increases as the pressure increases.

.....[2]

- (ii) How would the percentage of ammonia change if the measurements had been made at a lower temperature?
Explain your answer.

.....[2]

- (iii) State **two** of the reaction conditions used in the Haber Process.

.....[2]

- 3 A major food retailer in the UK is going to distribute sandwiches using hydrogen-powered vehicles.



(c) Outline how hydrogen is manufactured from water.

.....

.....[2]



14.10.1 ESSENTIAL EXAM QUESTIONS Paper 3/4 Contact Process and Sulfur Chemistry
(Topic 12) 79 Marks

Topic Chem 12 **Q# 1/** iGCSE Chemistry/2014/w/Paper 31/



3 The main use of sulfur dioxide is the manufacture of sulfuric acid.

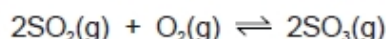
(a) State **two** other uses of sulfur dioxide.

.....
..... [2]

(b) One source of sulfur dioxide is burning sulfur in air.
Describe how sulfur dioxide can be made from the ore zinc sulfide.

.....
..... [2]

(c) The Contact process changes sulfur dioxide into sulfur trioxide.



the forward reaction is exothermic

temperature 400 to 450 °C

low pressure 1 to 10 atmospheres

catalyst vanadium(V) oxide

(i) What is the formula of vanadium(V) oxide?

..... [1]

(ii) Vanadium(V) oxide is an efficient catalyst at any temperature in the range 400 to 450 °C.
Scientists are looking for an alternative catalyst which is efficient at 300 °C.
What would be the advantage of using a lower temperature?

.....
.....
..... [2]

(iii) The process does not use a high pressure because of the extra expense.
Suggest **two** advantages of using a high pressure?
Explain your suggestions.

.....
.....
.....
.....
..... [4]

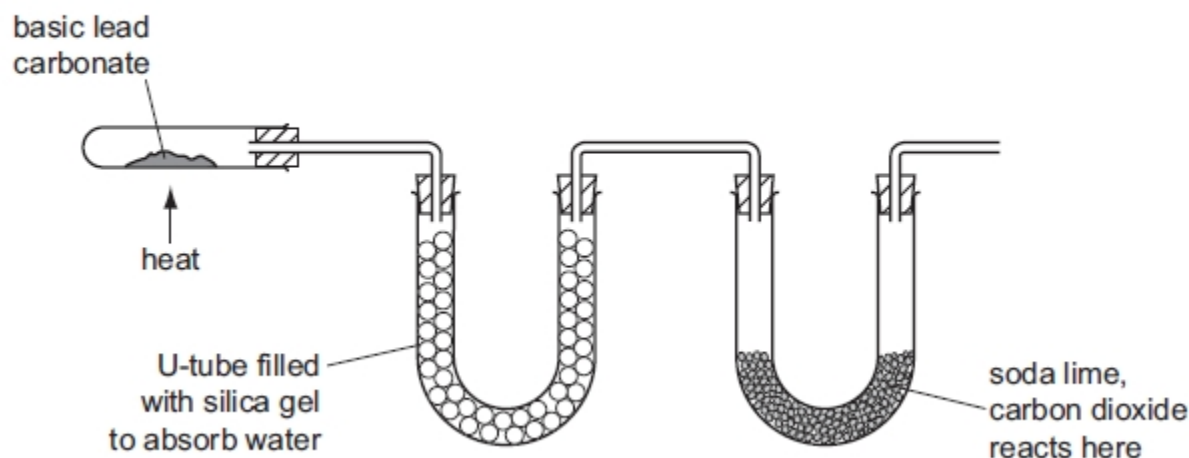


- (d) Sulfuric acid is made by dissolving sulfur trioxide in concentrated sulfuric acid to form oleum. Water is reacted with oleum to form more sulfuric acid. Why is sulfur trioxide not reacted directly with water?

..... [1]

Topic Chem 12 Q# 2/ iGCSE Chemistry/2013/w/Paper 31/ Q6

- (b) Basic lead(II) carbonate is heated in the apparatus shown below. Water and carbon dioxide are produced.



- (i) Silica gel absorbs water. Silica gel often contains anhydrous cobalt(II) chloride. When this absorbs water it changes from blue to pink. Suggest a reason.

..... [1]

- (ii) Soda lime is a mixture of sodium hydroxide and calcium oxide. Why do these two substances react with carbon dioxide?

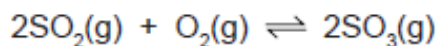
..... [2]

- (iii) Name **two** substances formed when soda lime reacts with carbon dioxide.

..... [2]



(b) Sulfur dioxide is used to make sulfur trioxide in the Contact Process.



The forward reaction is exothermic. The conditions used are:

temperature: 450 °C

pressure: 2 atmospheres

catalyst: vanadium(V) oxide

Explain, mentioning both position of equilibrium and rate, why these conditions give the most economic yield.

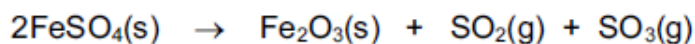
.....

.....

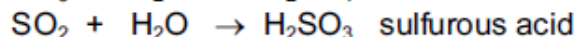
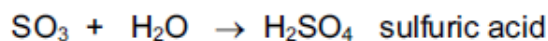
.....

..... [4]

(b) Sulfuric acid was first made in the Middle East by heating the mineral, green vitriol, $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$. The gases formed were cooled.



On cooling



(ii) Sulfurous acid is a reductant. What would you see when acidified potassium manganate(VII) is added to a solution containing this acid?

.....

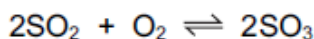
..... [2]

(iii) Suggest an explanation why sulfurous acid in contact with air changes into sulfuric acid.

..... [1]



6 (a) Sulfuric acid is made by the Contact process.



This is carried out in the presence of a catalyst at 450 °C and 2 atmospheres pressure.

(i) How is the sulfur dioxide made?

.....
..... [1]

(ii) Give another use of sulfur dioxide.

..... [1]

(iii) Name the catalyst used.

..... [1]

(iv) If the temperature is decreased to 300 °C, the yield of sulfur trioxide increases. Explain why this lower temperature is not used.

.....
..... [1]

(v) Sulfur trioxide is dissolved in concentrated sulfuric acid. This is added to water to make more sulfuric acid. Why is sulfur trioxide not added directly to water?

.....
..... [1]

1 For each of the following select an element from Period 4, potassium to krypton, that matches the description.

(g) One of its oxides is the catalyst in the Contact Process.

..... [iGCSE



4 Zinc is extracted from zinc blende, ZnS.

(a) Zinc blende is heated in air to give zinc oxide and sulphur dioxide. Most of the sulphur dioxide is used to make sulphur trioxide. This is used to manufacture sulphuric acid. Some of the acid is used in the plant, but most of it is used to make fertilisers.

(i) Give another use of sulphur dioxide.

..... [1]

(ii) Describe how sulphur dioxide is converted into sulphur trioxide.

.....
.....
..... [3]

(iii) Name a fertiliser made from sulphuric acid.

..... [1]

Topic Chem 12 **Q# 8/** iGCSE Chemistry/2006/s/Paper 3/ Q5 (b)

(iii) Explain, mentioning both rate and percentage yield, why the temperature used in the Contact process is 450°C.

.....
..... [2]

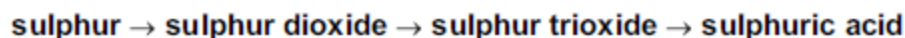
(iv) Describe how the sulphur trioxide is changed into concentrated sulphuric acid.

.....
..... [2]

Topic Chem 12 **Q# 9/** iGCSE Chemistry/2006/s/Paper 3/



5 Sulphuric acid is made by the Contact process in the following sequence of reactions.



(a) (i) How is sulphur dioxide made from sulphur?

..... [1]

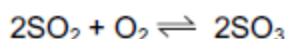
(ii) Sulphur dioxide has other uses.
Why is it used in the manufacture of paper?

..... [1]

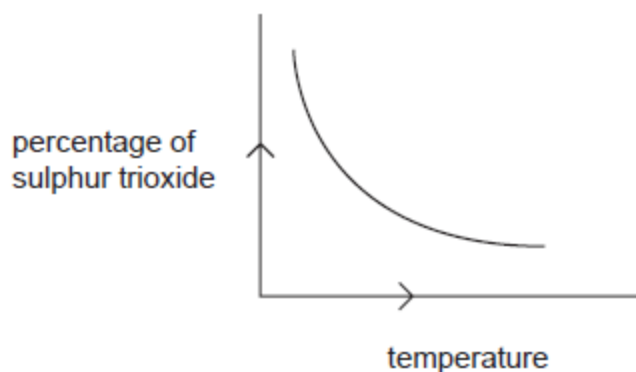
(iii) How does it preserve food?

..... [1]

(b) The equation for a stage of the Contact process is



The percentage of sulphur trioxide in the equilibrium mixture varies with temperature.



(i) How does the percentage of sulphur trioxide in the equilibrium mixture vary as the temperature increases? Circle the correct answer.

increases

stays the same

decreases

[1]

(ii) Is the forward reaction in the equilibrium $2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3$ exothermic or endothermic? Give a reason for your choice.

.....
..... [2]



- (c) Sulphuric acid is manufactured by the Contact Process. Sulphur dioxide is oxidised to sulphur trioxide by oxygen.



- (i) Name the catalyst used in this reaction.

..... [1]

- (ii) What temperature is used for this reaction?

..... [1]

- (iii) Describe how sulphur trioxide is changed into sulphuric acid.

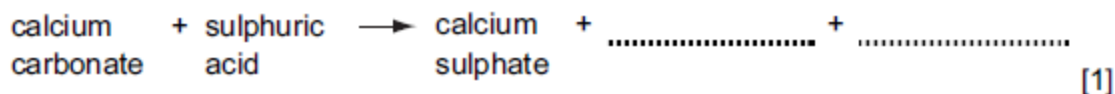
.....
..... [2]



- 4 The Carlsbad caverns in New Mexico are very large underground caves. Although the walls of these caves are coated with gypsum (hydrated calcium sulphate), the caves have been formed in limestone.

(a) It is believed that the caves were formed by sulphuric acid reacting with the limestone.

(i) Complete the word equation.



(ii) Describe how you could test the water entering the cave to show that it contained sulphate ions.

test

result [2]

(iii) How could you show that the water entering the cave has a high concentration of hydrogen ions?

..... [1]

(b) Hydrogen sulphide gas which was escaping from nearby petroleum deposits was being oxidised to sulphuric acid.

(i) Complete the equation for this reaction forming sulphuric acid.



(ii) Explain why all the hydrogen sulphide should be removed from the petroleum before it is used as a fuel.

.....

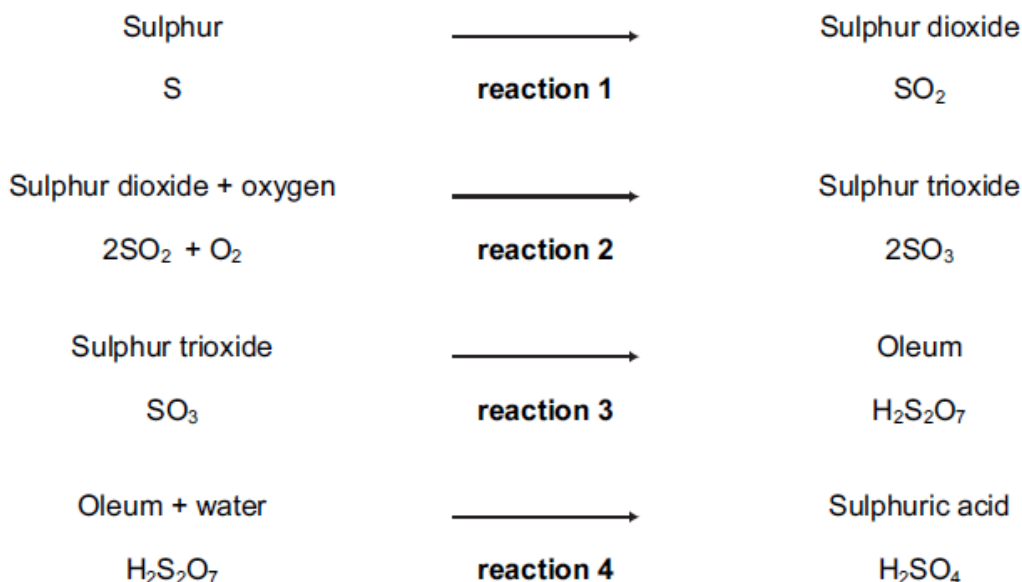
..... [1]





2 Sulphur is used to make sulphuric acid. In the UK, the annual production of the acid is about 2.5 million tonnes.

(a) The reactions in the manufacture of sulphuric acid by the Contact Process are shown below.



(i) Give a large scale source of the element sulphur.

..... [1]

(ii) State another use of sulphur dioxide.

..... [1]

(iii) How is sulphur changed into sulphur dioxide?

..... [1]

(iv) Name the catalyst used in reaction 2.

..... [1]

(v) Reaction 2 is exothermic. Why is a catalyst, rather than a higher temperature, used to increase the rate of this reversible reaction?

..... [2]

(vi) Write a word equation for reaction 3.

..... [1]

(vii) Write a symbol equation for reaction 4.

..... [1]



5 Sulphur dioxide, SO_2 , and sulphur trioxide, SO_3 , are the two oxides of sulphur.

(a) Sulphur dioxide can kill bacteria and has bleaching properties. Give a use of sulphur dioxide that depends on each of these properties.

(i) ability to kill bacteria[1]

(ii) bleaching properties[1]

(b) Sulphur trioxide can be made from sulphur dioxide.

(i) Why is this reaction important industrially?

.....[1]

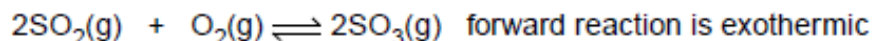
(ii) Complete the word equation.

sulphur dioxide + $\rightarrow$ sulphur trioxide [1]

(iii) What are the conditions for this reaction?

.....
.....[2]

1 (a) Sulphuric acid is made by the Contact Process.



(i) What are the reaction conditions for the Contact Process?

.....
.....[3]

(ii) Would the yield of sulphur trioxide increase, decrease or stay the same when the temperature is increased? Explain your answer.

.....
.....
.....[2]

(iii) Describe how sulphur trioxide is changed into concentrated sulphuric acid.

.....
.....[2]



- 5 (a) In the USA, sulphur is obtained from underground deposits. It burns to form sulphur dioxide. This is used in paper making, to preserve food and in the manufacture of sulphuric acid.

(i) Why is sulphur dioxide needed in paper making?

.....[1]

(ii) How does sulphur dioxide preserve food?

.....[1]

14.10.2 ESSENTIAL EXAM QUESTIONS Paper 3/4 Topic 7.3 56 marks Mark Scheme

- 4 (a) rate of forward reaction equals rate of back reaction [1]
 concentrations do not change / macroscopic properties remain constant (with time) [1]
 accept: amounts

(b) (i) increase [1]
 reaction 2 [1]
 $V_r > V_p$ [1]

(ii) same [1]
 reaction 1 [1]
 $V_r = V_p$ [1]

(iii) decrease [1]
 reaction 3 [1]
 $V_p > V_r$ [1]
 accept: moles of gas / molecules of gas as an alternative to volume

- 6 (a) rates equal [1]
 concentrations do not change / macroscopic properties remain constant [1]
 accept amounts do not change

(b) endothermic [1]
 cond favoured by high temperatures [1]

(c) (i) move to left [1]
 cond bigger volume / more moles etc [1]
 do not insist on "gas"

(ii) less yellow solid / more brown liquid [1]
 accept yellow to brown / less solid more liquid / goes brown



(b) (i) add water to yellow powder or to anhydrous salt
it would go green

[1]
[1]



Topic Chem 7.3 **Q# 4/** iGCSE Chemistry/2008/s/Paper 31/

- 5 (a) (i) (concentration) of reactants/CO and Cl_2 increases [1]
(concentration) of product decreases/ COCl_2 [1]
- (ii) (decrease in pressure favours side) [2]
with more molecules **or** moles **or** side with bigger volume (of gas)
NB [2] or [0]
- (b) forward reaction is exothermic [1]
COND because it is favoured by low temperatures **or** cool [1]
ACCEPT argument re back reaction

Topic Chem 7.3 **Q# 5/** iGCSE Chemistry/2007/w/Paper 3/ 6 (c)

- (iii) high pressure [1]
COND forward reaction volume decrease
or volume of reactants greater than that of products
or fewer moles of gas on the right
or fewer gas molecules on right [1]
NOTE accept correct arguments about either reactants **or** products

Topic Chem 7.3 **Q# 6/** iGCSE Chemistry/2005/w/Paper 3/ Q3

- (b)(i) No change in volume **or** same number of moles on [1]
both sides
- (ii) move to right [1]
Increase in pressure favour side with smaller volume **or**
smaller number of moles (of gas) **or** moves to side that
tends to reduce pressure [1]

Topic Chem 7.3 **Q# 7/** iGCSE Chemistry/2005/w/Paper 3/

- (a)(i) because concentration of BiCl_3 decreases [2]
bismuth chloride used up **ONLY** [1]
- (ii) products are being formed **or** concentration of products [1]
increases. Concentration mark given either (i) **or** (ii)
- (iii) reaction has come to equilibrium [1]
rates equal **or** no change in concentration [1]
- (iv) equilibrium to left **or** favours backward reaction **or** [1]
equilibrium moves to use up hydrochloric acid [1]
 BiOCl used up **or** BiCl_3 formed

Topic Chem 7.3 **Q# 8/** iGCSE Chemistry/2004/w/Paper 3/

- 3 (a) (i) no change in concentration of reagents **or** rates equal [1]
Accept no change in amounts or it is as if the reaction has Stopped
- (ii) back reaction is endothermic **or** the forward reaction is exothermic [1]
Increase in temperature favours the endothermic reaction which is the back
reaction or vice versa. [1]
NB look for correct conclusion re thermicity and comment re position of
equilibrium.



- (iii) increased rate [1]
 because molecules collide more frequently or concentration of molecules is increased or molecules are closer [1]
NOT they have more KE [1]
 increased yield [1]
 high pressure favours side with few molecules or smaller volume or moves to reduce the pressure [1]
 this is product side this can be implied [1]

Topic Chem 7.3 **Q# 9/** iGCSE Chemistry/2001/w/Paper 3/ QiGCSE Chemistry/201

- (b) (i) high temperature or heat [1]
 back reaction endothermic or moves to left [1]

 OR low pressure
 left side has higher volume of gases or more moles of gas

 OR remove carbon monoxide
 reaction try to replace it

 OR energy needed
 bonds breaking or to decompose Ni(CO)_4

14.10.2.1 ESSENTIAL EXAM QUESTIONS Haber process and nitrogen chemistry 63 Marks
 Mark Scheme

Topic Chem 11.3 **Q# 1/** iGCSE Chemistry/2013/w/Paper 31/



- 3 (a) (i) fractional distillation (liquid) air [1]
[1]
- (ii) cracking / heat in presence of catalyst of alkane / petroleum to give an alkene and hydrogen [1]
[1]
[1]
- OR: electrolysis (1)
named electrolyte (1)
hydrogen at cathode (1)
- OR: from methane (1)
react water / steam (1)
heat catalyst (1)
only **ACCEPT**: water with methane or electrolysis
- (b) (i) the pair with both graphs correct is C [1]
NOTE: mark (b)(ii) independent of (b)(i)
- (ii) high pressure favours side with lower volume / fewer moles [1]
this is RHS / product / ammonia [1]
%NH₃ / yield increases as pressure increases [1]
- the forward reaction is exothermic [1]
exothermic reactions favoured by low temperatures [1]
%NH₃ / yield decreases as temperature increases [1]
ACCEPT: reverse arguments
- (iii) increases reaction rate [1]
ACCEPT: reduces activation energy [1]
OR: decreases the amount of energy particles need to react
OR: economic rate at lower temperature so higher yield

[Total: 14]



(b) any five from:

- high pressure favours lower volume side / movement to right / ammonia side, or high pressure increases the yield
- high pressure increases rate
- low temperature favours exothermic reaction / increases yield / favours the forward reaction
- low temperature gives low rate or vice versa
- catalyst increases rate or lowers activation energy
- 450 °C low enough to give an economic yield but with catalyst gives a fast enough rate
note need whole concept to get this compromise temperature point [5]

- (b) (i) expensive metal / iron cheaper / better catalyst [1]
- (ii) high pressure favours side with smaller volume / fewer moles [1]
this is right hand side / product / ammonia side [1]
- (iii) recycled / sent over catalyst again [1]
accept used again
- (iv) advantage high yield [1]
disadvantage slow reaction rate etc [1]

- 6 (a) (i) air (liquid) [1]
petroleum or crude oil or alkanes or methane or water or steam or steam reforming or
suitable aqueous solution e.g. brine or sea water [1]
NOTE: cannot crack methane
- (ii) iron [1]
- (iii) (as a) fertiliser or to make fertilisers or to make nitric acid [1]
- (b) (i) concentrations/macrosopic properties do not change [1]
accept amounts stay the same
NOT no change
rate of forward and back reactions equal [1]
- (ii) it decreases with increase temperature [1]
or it increases with decrease temperature



- (c) (i) shows an increase either a line or curve [1]
(any decrease = 0)
- (ii) increase pressure favours the side with lower volume or molecules or moles [1]
that is RHS or products side [1]
ignore any mention of rates

Topic Chem 11.3 Q# 5/ iGCSE Chemistry/2008/w/Paper 31/ Q5

- (ii) ammonia or methanol or hydrogen chloride or margarine [1]
NOT nylon

Topic Chem 11.3 Q# 6/ iGCSE Chemistry/2008/s/Paper 31/

- 8 (a) burning wood produces carbon dioxide [1]
less photosynthesis or trees take up carbon dioxide [1]

Topic Chem 11.3 Q# 7/ iGCSE Chemistry/2006/w/Paper 3/

- 5 (a) (i) iron [1]
- (ii) advantage higher yield [1]
explanation lower temperature favours the exothermic reaction
(that is the forward reaction) [1]
- (b) (i) Sent over the catalyst again or used to make more ammonia [1]
NOT just reused
- (ii) It has the highest boiling point [1]
- (c) (i) $\text{CO}_2 + 2\text{NH}_3 = \text{CO}(\text{NH}_2)_2 + \text{H}_2\text{O}$ [2]
Not balanced [1]
- (ii) Any comment based on deficiency of PK/or ONLY provides Nitrogen as a nutrient [1]
NOT soil pH

Topic Chem 11.3 Q# 8/ iGCSE Chemistry/2005/w/Paper 3/

Question 7

- (a) from methane [1]
and water [1]
- OR electrolysis [1]
suitable electrolyte [1]
- OR alkane [1]
cracking [1] [2]
- (b)(i) iron [1]
- (ii) lower temperature moves equilibrium to right [1]
because forward reaction is exothermic [1]

Topic Chem 11.3 Q# 9/ iGCSE Chemistry/2004/s/Paper 3/ Q2

- (b) (i) potassium [1]
- (ii) ammonium sulphate [1]

Topic Chem 11.3 Q# 10/ iGCSE Chemistry/2003/w/Paper 3/



- 1 (a) (i) different boiling points [1]
 (ii) methane **or** water **or** petroleum **or** named petroleum fraction **or** alkane
Any TWO [2]
- (b) (i) volume decrease for forward reaction **or** fewer moles of gas on products side [1]
 favoured by increase in pressure [1]
or increase in pressure moves position of equilibrium to right
- (ii) increase [1]
 exothermic reaction favoured by lower temperature [1]
- (iii) 300 to 600 °C
 1:3 volume ratio
 iron (catalyst)
 150 to 300 atm
Any TWO [2]

Topic Chem 11.3 **Q# 11/** iGCSE Chemistry/2002/s/Paper 3/ Q3

- (c) (steam) and alkane [1]
 heat **or** catalyst **or** details of chemistry – forms carbon monoxide/dioxide and (hydrogen) [1]
- OR** electrolysis [1]
 brine **or** acidified water
or hydrogen forms at cathode [1]
- OR** carbon/coke [1]
 heat **or** details of chemistry – forms carbon monoxide/dioxide and (hydrogen) [1]

14.10.2.1 ESSENTIAL EXAM QUESTIONS Contact Process and Sulfur Chemistry 79 Marks Mark Scheme

Topic Chem 12 **Q# 1/** iGCSE Chemistry/2014/w/Paper 31/



- 3 (a) Any **two** from:
bleach/making wood pulp/making paper
food/fruit juice/wine preservative
fumigant/sterilising/insecticide [2]
- (b) heating/roasting/burning (zinc sulfides) [1]
in air/oxygen COND on M1 [1]
- (c) (i) V_2O_5 [1]
- (ii) position of equilibrium shifts right/yield increases
to save energy [1]
[1]
- (iii) faster reaction/rate [1]
more collisions per second/higher collision frequency [1]
fewer moles/molecules (of gas) on right [1]
(so) position of equilibrium shifts right/yield increases [1]
- (d) (the reaction is) too violent/too exothermic **or** produces mist/fumes (of acid) [1]

Topic Chem 12 **Q# 2/** iGCSE Chemistry/2013/w/Paper 31/ Q6

- (b) (i) anhydrous cobalt chloride becomes hydrated [1]
ACCEPT: hydrous
- (ii) carbon dioxide is acidic [1]
sodium hydroxide and calcium oxide are bases / alkalis [1]
- (iii) Any two of:
water, calcium carbonate and sodium carbonate [2]
ACCEPT: sodium bicarbonate

Topic Chem 12 **Q# 3/** iGCSE Chemistry/2011/s/Paper 31/ Q4

- (b) for a high yield need low temperature [1]
then rate would be too slow or uneconomic [1]
a discussion of optimum temperature could score mark 1 and 2
- presence of catalyst would increase rate (at same temperature) [1]
does not alter the yield (at that temperature) [1]
/ economic rate at lower temperature, therefore higher yield
- higher pressure which would increase yield / rate [1]
yield high enough / high pressure expensive [1]
max [4]
- accept** reverse arguments
note increase yield = position of equilibrium to right

Topic Chem 12 **Q# 4/** iGCSE Chemistry/2009/w/Paper 3/ Q6



(ii) change from purple or pink to colourless **NOT** clear [1]
[1]

(iii) reacts with oxygen in air [1]

Topic Chem 12 **Q# 5/** iGCSE Chemistry/2009/w/Paper 3/

6 (a) (i) burn sulfur in air or oxygen [1]
or heat a metal sulfide in air

(ii) bleach for wood pulp/cloth/straw or preserve food or sterilising
or making wine or fumigant or refrigerant [1]
Accept making paper

(iii) vanadium(V) oxide **accept** vanadium oxide or V_2O_5
or vanadium pentoxide [1]
oxidation state not essential but if given it has to be (V)

(iv) rate too slow or rate not economic [1]

(v) reaction too violent or forms a mist [1]

Topic Chem 12 **Q# 6/** iGCSE Chemistry/2008/s/Paper 31/ QiGCSE Chemistry/201

(g) vanadium [1]

ACCEPT name or symbol

Topic Chem 12 **Q# 7/** iGCSE Chemistry/2007/w/Paper 3/

4 (a) (i) bleach for wood pulp or preserving food or sterilising
or in wine making or as a refrigerant or in metallurgy or
(liquid) sulphur dioxide is used in the petroleum industry
or kill microbes(etc) or insecticide [1]

(ii) (react with) oxygen or air [1]
NOT burnt/burn in air/oxygen
450°C [1]

vanadium oxide catalyst (if oxidation state given has to be correct) or platinum [1]
If four conditions are given which include high pressure then **MAX** [2]
High pressure is incorrect **MAX** 10 atm.

(iii) ammonium sulphate or superphosphate [1]
or potassium sulphate or magnesium sulphate



- (iii) Low enough for good yield [1]
 High enough for (economic) rate [1]
 Any similar explanation will be awarded the mark
NOT just that it is the optimum temperature
- (iv) bubble into (conc) sulphuric acid [1]
 add water [1]
NOT consequential

- 5 (a) (i) Burn sulphur in air (or oxygen) [1]
 (ii) as a bleach [1]
 (iii) kill bacteria/micro-organisms [1]
NOT prevents food going bad or rotten or decaying
- (b) (i) decrease [1]
 (ii) exothermic [1]
COND increase temperature favours back reaction so it is endothermic, so forward reaction must be exothermic [1]
OR any similar explanation will be awarded the mark, for example The forward reaction is not favoured by an increase in temperature so it is exothermic (rather than endothermic)
- (iii) Low enough for good yield [1]
 High enough for (economic) rate [1]
 Any similar explanation will be awarded the mark
NOT just that it is the optimum temperature

- (c) (i) vanadium oxide **or** vanadium(V) oxide **or** vanadium pentoxide or V_2O_5 [1]
 Must be correct oxidation state if one given
- (ii) 400 to 500° C [1]
- (iii) add to (concentrated) sulphuric acid **NOT** dilute [1]
COND (upon sulphuric acid) above then add water [1]



- 4 (a) (i) correct word equation (carbon dioxide and water) [1]
Accept correct symbol equation
- (ii) Must have a correct reagent otherwise wc = 0
 add (acidified) barium chloride(aq) **or** nitrate **or** add barium ions [1]
COND white precipitate [1]
NOT lead(II) compounds
- (iii) low pH **or** universal indicator turns red(aq) [1]
 pH 3 **or** less
- (b) (i) $\text{H}_2\text{S} + 2\text{O}_2 = \text{H}_2\text{SO}_4$ [2]
 unbalanced [1]
- (ii) unpleasant smell **or** it is poisonous **or** when burnt forms acid rain **or** forms sulphur dioxide **or** forms sulphuric acid [1]
NOT it is a pollutant
- (iii) 2H to 1S
COND 8e around sulphur atom
 2e per hydrogen atom
THREE correct [2]
TWO from above [1]
 Ionic structure = [0]

Topic Chem 12 Q# 12/ iGCSE Chemistry/2004/s/Paper 3/

2. (a) (i) USA **or** Texas **or** Poland **or** Mexico **or** Japan **or** Ethiopia [1]
 Australia **or** Sicily
 accept other sources of sulphur eg petroleum
or natural gas **or** metal sulphides **or** volcanoes
NOT coal, **NOT** underground
- (ii) Preserving food **or** bleaching **or** sterilising **or**
 disinfecting **or** making paper **or** bleaching wood pulp [1]
or wine **or** jam **or** fumigation **or** making paper
NOT making wood pulp
- (iii) burnt/roast in oxygen or air [1]
- (iv) vanadium(V) oxide **or** vanadium oxide **or** platinum [1]
 ignore oxidation state of vanadium
- (v) Increase temperature (increases rate) but reduces yield [1]
 catalyst only increases rate **or** a catalyst does not [1]
 influence position of equilibrium
NOT a definition of a catalyst
- (vi) sulphur trioxide + sulphuric acid = oleum [1]
 correct symbol equation acceptable
- (vii) $\text{H}_2\text{S}_2\text{O}_7 + \text{H}_2\text{O} = 2\text{H}_2\text{SO}_4$ [1]

Topic Chem 12 Q# 13/ iGCSE Chemistry/2003/w/Paper 3/



- 5 (a) (i) preserve food **or** sterilising [1]
(ii) making paper [1]
- (b) (i) making sulphuric acid **or** Contact Process [1]
(ii) oxygen [1]
(iii) vanadium oxide as catalyst (ignore oxidation state)
400 to 500 °C
pressure less than 10 atm
Any TWO [2]



- 1 (a) (i) vanadium(V) oxide as catalyst - ignore oxidation state
and accept no oxidation state
temperature 300 to 600 °C
pressure up to 10 atmos, accept atmospheric pressure
volume ratio of gases either 2:1 or slight excess of oxygen
ANY three [3]
- (ii) decrease [1]
COND back reaction is endothermic or same argument based on
forward reaction is exothermic [1]
or increase in temp favours back reaction
- (iii) dissolve in (conc) sulphuric acid NOT dilute [1]
add water or dilute [1]

- 5 (a) (i) bleach [1]
- (ii) kills bacteria or germs or micro organisms [1]

14.11 FUNDAMENTAL Assessed Activity 1 Keyword Test

English	Meaning
reversible reaction	
carbon cycle	
acid rain this	
dynamic (chemical) equilibrium	
equilibrium	
artificial fertiliser	
Contact process	
nitrogen cycle	



Haber process	
---------------	--



Topic Chem 7 Q# 1/

15 The reversible reaction between methane and steam is shown.



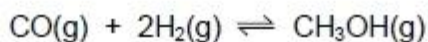
The forward reaction is endothermic.

Which changes in pressure and temperature move the equilibrium to the right?

	pressure	temperature
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

Topic Chem 7 Q# 2/

15 Methanol is prepared by the reversible reaction shown.



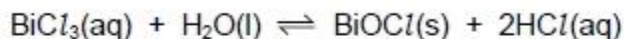
The forward reaction is exothermic.

Which conditions produce the highest equilibrium yield of methanol?

	temperature	pressure
A	high	high
B	high	low
C	low	high
D	low	low

Topic Chem 7 Q# 3/

15 When BiCl_3 reacts with water, a white precipitate of BiOCl is formed. The equation for the reaction is shown.



Which statements are correct?

- 1 The reaction is reversible.
- 2 When dilute hydrochloric acid is added to the reaction mixture, more of the white precipitate forms.
- 3 When aqueous sodium hydroxide is added to the reaction mixture, more of the white precipitate forms.

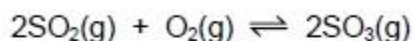
A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 and 3 only





15 The formation of sulfur trioxide is a reversible reaction.

The equation is shown.



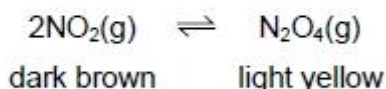
The forward reaction is exothermic.

Which conditions produce the highest equilibrium yield of sulfur trioxide?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

17 Some nitrogen dioxide gas was put in a gas syringe. The end of the gas syringe is sealed.

A reversible reaction occurs. The reaction reaches equilibrium.



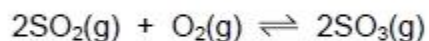
The forward reaction is exothermic.

Which statement about the reaction is correct?

- A** If the gas syringe is placed in a cold water bath, the colour becomes darker.
- B** If the gas syringe is placed in a hot water bath, the colour becomes lighter.
- C** If the volume in the gas syringe is increased, the colour becomes lighter.
- D** If the volume in the gas syringe is decreased, the colour becomes lighter.



16 The following reaction has reached equilibrium in a closed system.



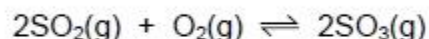
The forward reaction is exothermic.

Which row shows the effect of increasing the pressure on the equilibrium mixture?

	reaction rate	amount of SO_2	amount of SO_3
A	increases	decreases	increases
B	increases	increases	decreases
C	unchanged	decreases	increases
D	unchanged	increases	decreases

Topic Chem 7 **Q# 7/**

16 The formation of sulfur trioxide from sulfur dioxide is a reversible reaction.



The forward reaction is exothermic.

Which changes would increase the equilibrium yield of SO_3 ?

- 1 increasing the pressure
- 2 lowering the temperature
- 3 decreasing the concentration of oxygen

A 1, 2 and 3 **B** 1 and 2 only **C** 1 only **D** 2 and 3 only

Topic Chem 7 **Q# 8/**

16 Methane reacts with steam to produce hydrogen and carbon monoxide.

The equation for the reaction is shown.



The reaction is reversible. The forward reaction is endothermic.

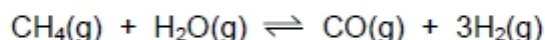
Which changes in temperature and pressure increase the equilibrium yield of carbon monoxide?

	temperature	pressure
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase



16 Hydrogen is produced when methane reacts with steam.

The equation for the reaction is shown.



The forward reaction is endothermic.

Which conditions produce the highest yield of hydrogen?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

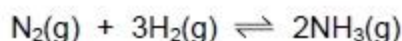
16 The reaction used to manufacture ammonia from nitrogen and hydrogen is reversible.

An equilibrium can be established between ammonia, nitrogen and hydrogen.

Which statement describes the equilibrium?

- A** Both the forward reaction and the backward reaction have the same rate.
- B** The rate of the backward reaction is greater than the rate of the forward reaction.
- C** The rate of the forward reaction is greater than the rate of the backward reaction.
- D** The forward and backward reactions have both stopped.

16 Nitrogen, hydrogen and ammonia gases are placed inside a container. The container is then sealed. After some time, an equilibrium forms.



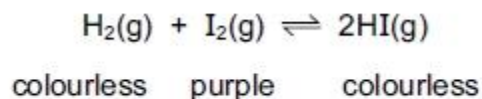
Which statement describes the equilibrium in this container?

- A** The amount of ammonia remains constant from the moment the container is sealed.
- B** The amounts of ammonia, nitrogen and hydrogen in the container are always equal.
- C** The rate of formation of ammonia is equal to the rate of decomposition of ammonia.
- D** The rate of formation of ammonia is faster than the rate of decomposition of ammonia.



- 16 The equation for the reversible reaction between hydrogen and iodine to form hydrogen iodide is shown.

The colours of the reactants and products are shown.



The forward reaction is exothermic.

Which statement is correct?

- A An increase in pressure has no effect on the equilibrium position.
- B The purple colour fades when the reaction mixture is heated.
- C When equilibrium is reached, both forward and reverse reactions stop.
- D When more hydrogen gas is added, the purple colour increases.



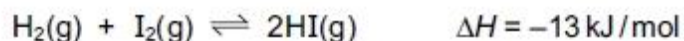
16 Chlorine can be manufactured by the following reaction. The reaction is exothermic.



Which change increases the yield of chlorine at equilibrium?

- A adding more HCl(g)
- B adding more $\text{H}_2\text{O(g)}$
- C decreasing the pressure
- D increasing the temperature

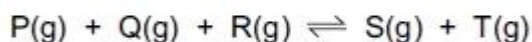
16 At 400°C the reaction between hydrogen and iodine reaches an equilibrium. The reaction is exothermic.



Which change in conditions would increase the percentage of hydrogen iodide in the equilibrium mixture?

- A a decrease in pressure
- B a decrease in temperature
- C an increase in pressure
- D an increase in temperature

16 The following reversible reaction takes place in a closed vessel at constant temperature.



When the system has reached equilibrium, more T is added.

After the addition of T, which substances increase in concentration?

- A P, Q, R and S
- B P and Q only
- C P, Q and R only
- D S only

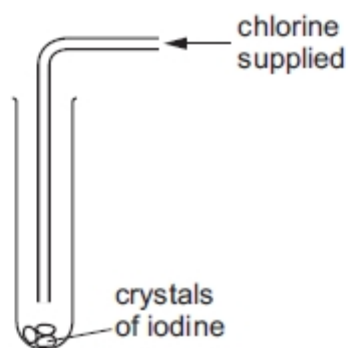


14.13 ESSENTIAL Assessed Activity 3 Topic 7.3 15 marks

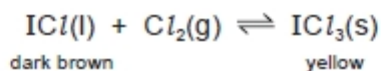
Chem 7.3

Q# 1/

(c) Iodine reacts with chlorine to form a dark brown liquid, iodine monochloride.



When more chlorine is added and the tube is sealed, a reversible reaction occurs and the reaction comes to equilibrium.



(i) Give another example of a reversible reaction.

..... [1]

(ii) Explain the term *equilibrium*.

..... [2]

(d) Chlorine is removed from the tube and a new equilibrium is formed.

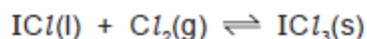
Explain why there is less of the yellow solid and more dark brown liquid in the new equilibrium mixture.

..... [2]



- (e) A sealed tube containing the equilibrium mixture is placed in ice-cold water. There is an increase in the amount of yellow solid in the equilibrium mixture.

What can you deduce about the forward reaction in this equilibrium?



Explain your deduction.

.....

.....

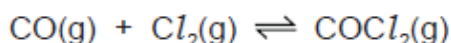
.....

..... [3]

Chem 7.3 Q# 2/

- 5 Carbonyl chloride, COCl_2 , is widely used in industry to make polymers, dyes and pharmaceuticals.

- (b) Carbonyl chloride is now made by the reversible reaction given below.



The forward reaction is exothermic.

The reaction is catalysed by carbon within a temperature range of 50 to 150 °C.

- (i) Predict the effect on the yield of carbonyl chloride of increasing the pressure.
Explain your answer.

.....

..... [2]

- (ii) If the temperature is allowed to increase to above 200 °C, very little carbonyl chloride is formed. Explain why.

.....

..... [2]

- (iii) Explain why a catalyst is used.

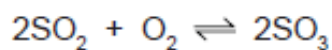
..... [1]

Chem 7.3 Q# 3/

- 4 Vanadium is a transition element. It has more than one oxidation state.
The element and its compounds are often used as catalysts.



- (c) Vanadium(V) oxide is used to catalyse the exothermic reaction between sulfur dioxide and oxygen in the Contact Process.



The rate of this reaction can be increased either by using a catalyst or by increasing the temperature. Explain why a catalyst is used and not a higher temperature.

.....

.....

..... [2]

- 14.14 EXTENSION Mind Map For Topics 7.3 Reversible Reactions, 11.3 Nitrogen & Fertilisers & 12 Sulfur (Equilibria)



14.15 ESSENTIAL End of Topic Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

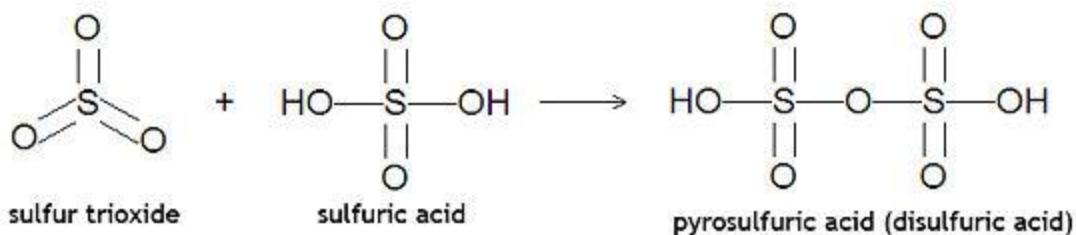
1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?



14.16 Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus



14.16.1 EXCEPTIONAL Active Learning Activity Can you think of why these molecules look wrong?

What rules do they break that you have learnt at iGCSE?

Try to find as many reasons these molecules should not exist as possible and explain why in the space below.

.....

.....

.....

.....

.....

.....

.....

.....

.....

Now go online to try to find out why they exist, and if there are any additional problems that these chemical structures ignore or get wrong

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....



14.17 Exceptional Extra Credit Science in Context

May have saved more lives than any other person in human history, but his contribution to society did not only save lives, he also helped develop and introduce a variety of weapons that many feel have made the world a less safe place. Using the internet, and the resources that are available in this section of my website (under Topic 11):

<https://www.smashingsciencecn.org/igcse-chem-additional-resources>

Find out about the man and create a short presentation about one aspect of his life or his contribution to society.

You can find out more about how to make a lasting impression with your presentation here:

https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_c85f76e6275141b1b2b98fc6530a5753.pptx?dn=Basics%20to%20a%20good%20presentation.pptx

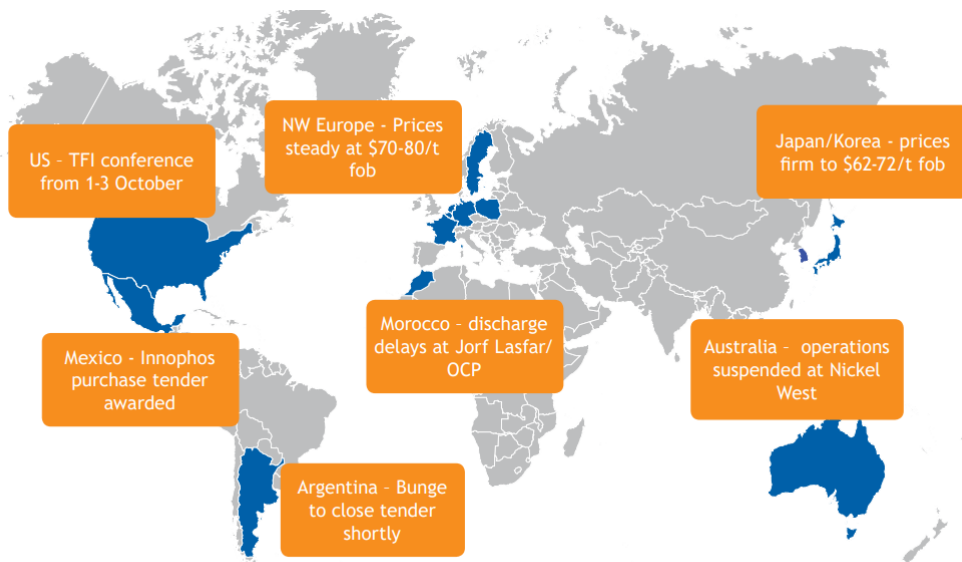
And what kinds of things that matter in the best presentations here:

https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_9a753109001c4ad5a6b630adb8e64ccc.pdf?index=true



Alternatively, you could look at the Contact Process.

Why do you think it is included in the syllabus? About 30 years ago it used to be suggested that the more sulfuric acid a country uses the more developed it is. Is this still true? If not, why not? Why is this chemical so important to society?



Disclaimer: Argus depicts geo-political borders as defined by the United Nations Geospatial Information Section.
For more information visit <http://www.un.org/Depts/Cartographic/map/profile/world.pdf>

https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_9038cccb606643c889dc09c257e5dbb4.pdf?index=true

To find out more, you could buy this book, which is just \$5,000 US (or about 36,000RMB); maybe writing these kinds of books might make for an interesting career?: <https://www.researchandmarkets.com/reports/4793190/global-sulfuric-acid-market-by-raw-material-by>

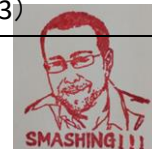


15 APPENDIX

15.1 EXTENSION Keywords

You do not need to understand these words to score a good A, or even a low A* but if you are aiming for a good or high A* then understanding words like these here will be helpful.

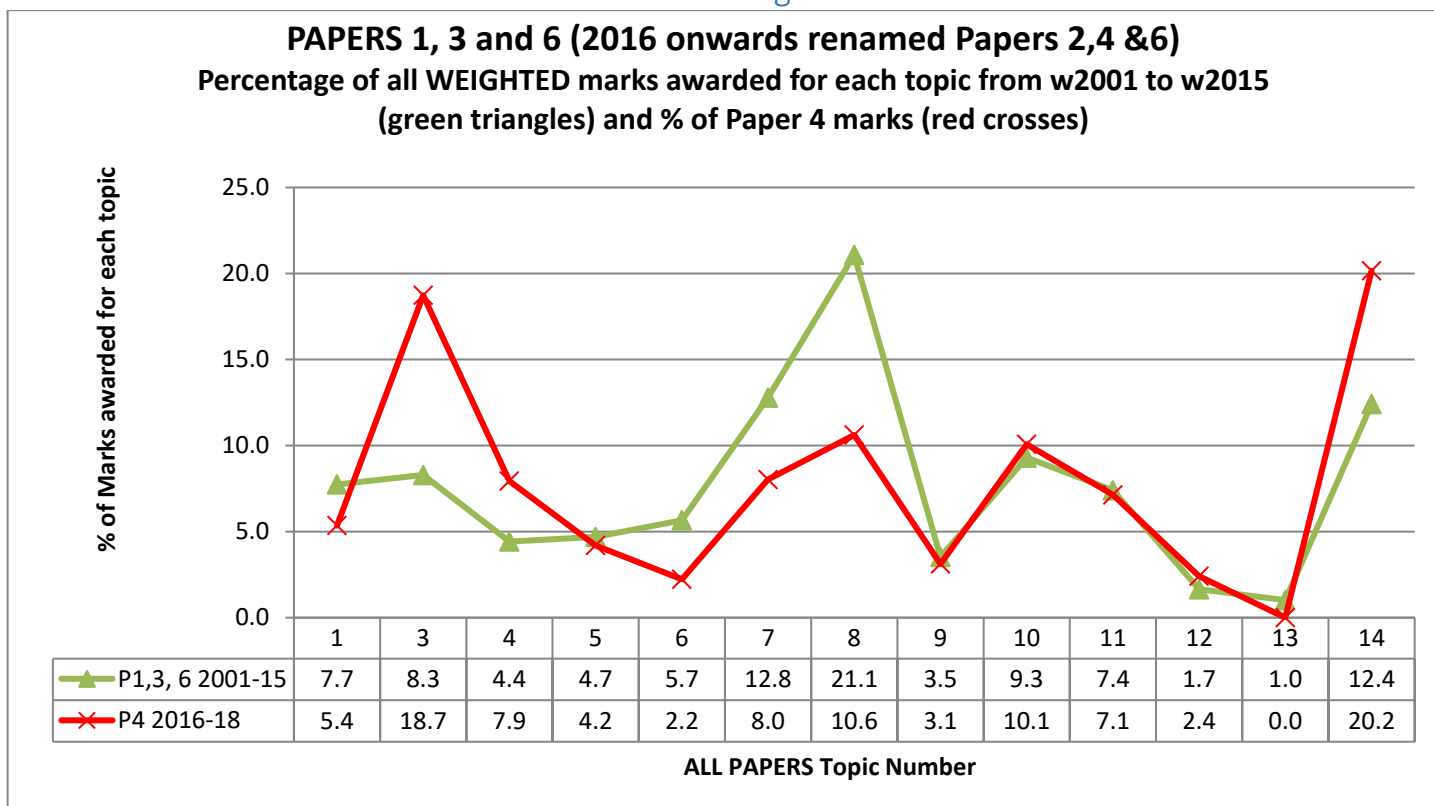
Topic #	English	Chinese
x1	absolute temperature a temperature measured with respect to absolute zero on the Kelvin scale – absolute zero is the lowest possible temperature that can be achieved	绝对温度相对于开氏温标上的绝对零测量的温度–绝对零是可以达到的最低温度
x1	atmospheric pressure the pressure exerted by the atmosphere on the surface of the Earth due to the weight of the atmosphere	大气压力由于大气层的重量，大气层在地球表面施加的压力
x1	centrifugation the separation of an insoluble solid from a liquid by rapid spinning during which the solid collects at the bottom of the sample tubes – the liquid can then be decanted off carefully	离心通过快速旋转从液体中分离出不溶性固体，在此期间固体收集在样品管的底部，然后可以小心地倾析出液体
x1	distillate the liquid distilling over during distillation	蒸馏过程中蒸馏出的液体
x1	immiscible if two liquids form two layers when they are mixed together, they are said to be immiscible	如果两种液体混合在一起时形成两层，则称它们是不溶混的
x1	miscible if two liquids form a completely uniform mixture when added together, they are said to be this.	如果将两种液体加在一起形成完全均匀的混合物，则可以混溶。
x1	solubility curve a graph showing how the solubility of a substance in a solvent changes with temperature	溶解度曲线表示物质在溶剂中的溶解度如何随温度变化的曲线图
x3	ceramics materials such as pottery made from inorganic chemicals, like clay, by high-temperature processing	陶瓷材料，例如由粘土等无机化学物质通过高温加工制成的陶瓷
x3	ductile a word used to describe the property that metals can be drawn out and stretched into wires	延性这个词用来描述金属可以被拉出并拉成金属丝的特性
x3	half-life the time taken for half of the radioactive atoms in a sample of a radio isotope to decay	半衰期放射性同位素样品中一半放射性原子衰变所需的时间
x3	mass spectrometer an instrument in which atoms or molecules are ionised and then accelerated; the ions are then separated according to their mass	质谱仪一种将原子或分子离子化然后加速的仪器；然后根据它们的质量分离离子
x3	volatile term that describes a liquid that which evaporates easily; it is a liquid with a low boiling point having only weak intermolecular forces between the molecules in the liquid	挥发性术语，描述易于蒸发的液体；它是一种低沸点的液体，液体中分子之间的分子间力很弱
x3	volatility the property of how easily a liquid can become a gas	挥发性液体容易变成气体的特性
x4	Avogadro constant another name for a mole	Avogadro常数痣的另一个名字
x4	mass concentration the measure of the concentration of a solution in terms of the mass of the solute, in grams, dissolved per cubic decimetre of solution (g/dm ³)	质量浓度，以每立方分米溶液中溶解的溶质质量（克）为单位的溶液浓度的量度（g / dm ³ ）



Topic #	English	Chinese
x4	relative atomic mass (Ar) the average mass of an atom of an element, taking account of the isotopes of the element, on a scale where a carbon-12 atom has a mass of exactly 12	相对原子质量 (Ar) 元素的原子平均质量，考虑到元素的同位素，碳12原子的质量恰好为12
x5	non-electrolytes liquids or solutions that do not take part in electrolysis: they do not contain ions	不参与电解的非电解质液体或溶液：它们不含离子
x6	heat of neutralisation the heat change which takes place when one mole of hydrogen ions is completely neutralised	中和热当一摩尔氢离子完全被中和时发生的热变化
x7	spontaneous (reaction) a reaction that can take place simply by mixing the reactants	通过混合反应物即可发生的自发反应
x8	antacid compound used medically to treat indigestion by neutralising excess stomach acid	用于中和过量胃酸的消化不良的抗酸药



15.2 APPENDIX EXCEPTIONAL Statistics Relating to the Course



	Paper 2	Paper 4	Paper 6	Totals	Average
Relative value %	30	50	20	100	
Number of marks	40	80	40	160	
Value of each mark/% of iGCSE	0.75	0.63	0.50		0.63
Time/min	45	75	60	180	60
Time per mark/sec	68	56	60		61
Portion of syllabus examined	C & S	C & S	Core		
	C = Core	S = Supplement			

15.3 Topics in Rank Order

Topic	14	3	10	7	8	11	4	5	9	1	12	6	13
Rank ALL Papers	2	4	5	3	1	6	9	8	11	7	12	10	13
Rank P3: A* Focus	1	2	3	4	5	6	7	8	9	10	10	12	13
All Syllabus Word Count RANK	1	2	5	3	6	4	9	7	10	8	12	11	13

Greener = Better; "Words per %..." refers to the words in the syllabus versus weighted marks awarded since w2001

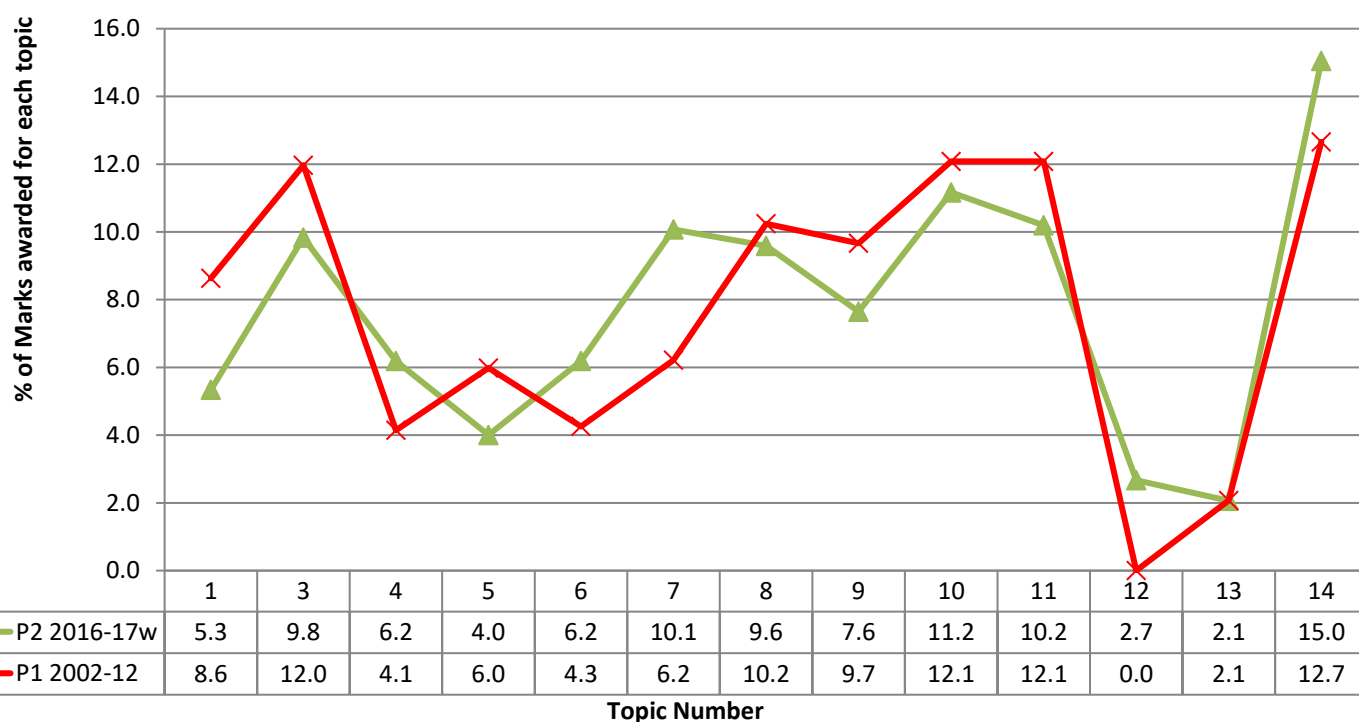


15.4 Key Points about these graphs and data

- **To do well, you must learn T8 (40 and 10.5% of P6 & P3) but to get an A* T14 is essential (20.2% of P3).**
- Paper 3 (after 2016 renamed Paper 4) is easily the most important paper, it has gotten more challenging over the last 5 years with the same questions being asked, but with less help with the answer that is required (so more 5 or 6 marks questions), also the same questions are being asked but have fewer marks attached meaning that you not only need to know the answer, but you need to better understand the priority (e.g. many sources of sulfur, but the main source, from petroleum, is the only acceptable answer).
- **However, these changes only make it harder for the less well prepared student, if you have not only answered these questions before, and checked your answers, but also looked at how some questions change with time (ANALYSED the trends) then it is in fact easier than ever before. There are fewer new questions than ever before!**
- These are just averages, so for instance T13 is not often examined, so appears less relevant, but when it is in a paper (P3) it will be on average 5 marks, and because it is all supplement material, these will be a lot of the higher marks. This data should hopefully allow you to prioritise topics in your revision.
- T4 is the most efficient topic to learn (least to learn per mark awarded), provided you are good at maths (predicted to get at least a B grade), otherwise it is by far the least worthwhile topic (which these numbers don't show but has been my experience in teaching) if you struggle with maths. You can still get an A* without this topic, but you'll not be able to drop many marks in any other topic.
- If there was a fire and you had to leave one topic behind, T5 would be the one taking a hit for the team.
- Most important topics to your grades are 14, 8, 3, 10, 7 and 11, in that order.

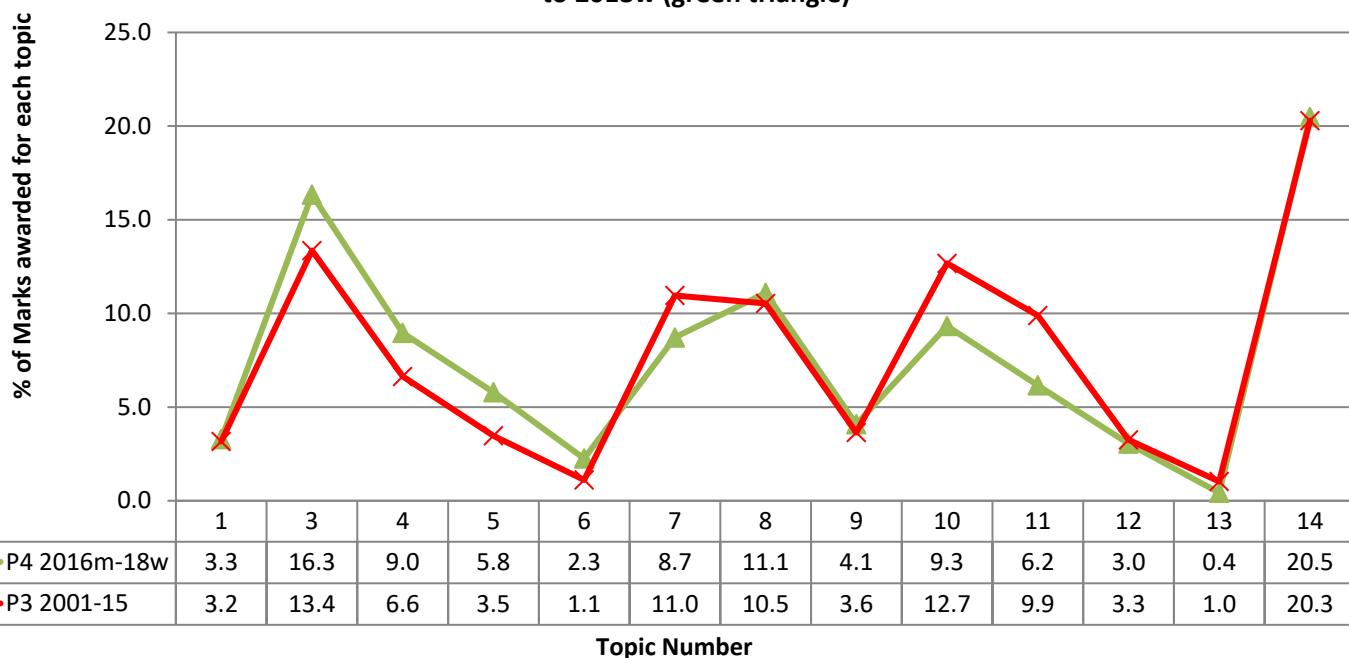
Multiple Choice Paper (B4 2016=P1, after=P2)

Percentage of all marks awarded for each topic from s2002-w12 and marks per topic for the new P2 (green triangle) s16 to s19



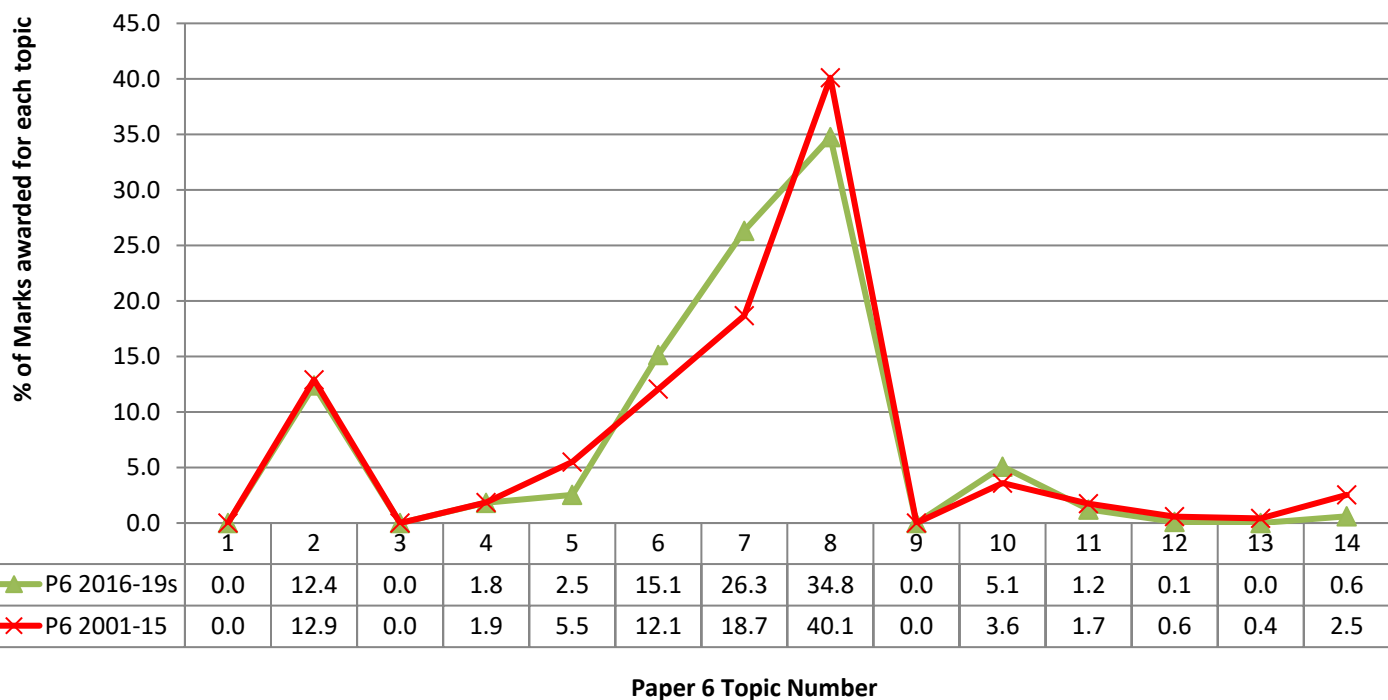
0620 PAPER 4 (pre2016 called Paper 3)

Percentage of all marks awarded for each topic from s2013 to w2015 (red cross) and for 2016m to 2018w (green triangle)



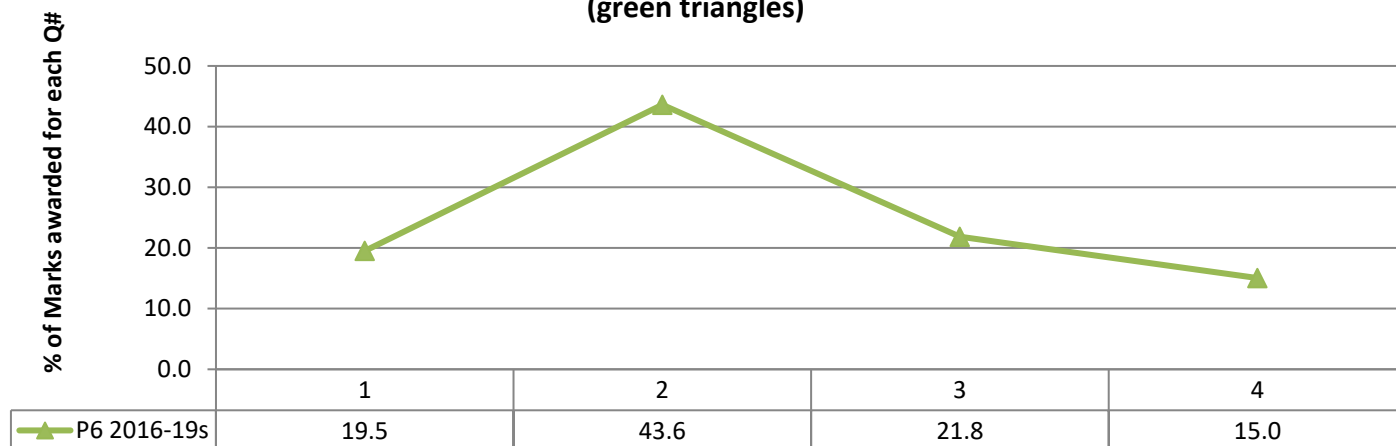
PAPER 6

Percentage of all marks awarded for each topic from w2001 to w2015 (red crosses) and from m2016 to s2019 (green triangles)



PAPER 6

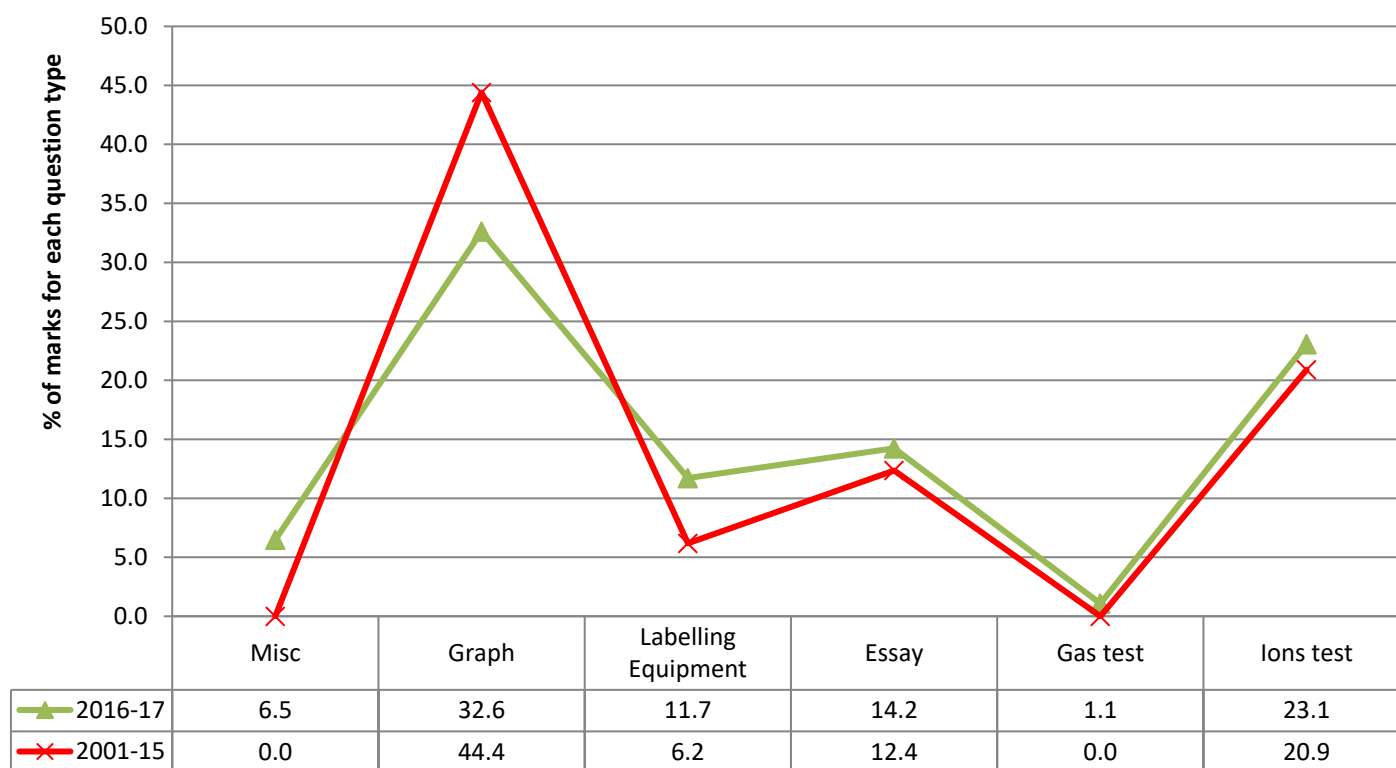
Percentage of all marks awarded for each question number from m2016 to w2019
(green triangles)



Paper 6 Question Number

PAPER 6 - Question types

Percentage of all marks awarded for each question type from w2001 to w2015 (red crosses) and from m2016 to w2017 (green triangles)



Paper 6 Question type

Above are the main experiments and the main question types in Paper 6. Word files broken down by these categories are available on my website (e.g.

s



15.4.1 Raw Data Info Used to Make the Graphs

		Topic													Averages
		1	3	4	5	6	7	8	9	10	11	12	13	14	
P1	% of Marks	8.6	12.0	4.1	6.0	4.3	6.2	10.2	9.7	12.1	12.1	0.0	2.1	12.7	7.7
P1	# of Questions	27.0	44.0	25.0	28.0	27.0	32.0	45.0	36.0	41.0	39.0	0.0	16.0	39.0	30.7
P1	Average marks per Q	2.8	2.4	1.4	1.9	1.4	1.7	2.0	2.3	2.6	2.7	0.0	1.1	2.8	1.9
P3	% of Marks	3.3	13.2	6.6	5.6	1.1	10.8	10.5	3.6	11.2	9.6	3.3	1.0	20.2	7.7
P3	# of Questions	20.0	58.0	39.0	25.0	6.0	46.0	53.0	19.0	54.0	46.0	14.0	5.0	79.0	35.7
P3	Average marks per Q	3.8	5.3	4.0	5.2	4.3	5.5	4.6	4.5	4.8	4.9	5.4	4.8	6.0	4.9
P6	% of Marks	12.9	0.0	1.9	5.5	12.1	18.7	40.1	0.0	3.6	1.7	0.6	0.4	2.5	7.7
P6	# of Questions	40.0	0.0	4.0	17.0	17.0	32.0	93.0	0.0	7.0	6.0	2.0	2.0	10.0	17.7
P6	Average marks per Q	6.1	0.0	8.8	6.1	13.4	11.0	8.2	0.0	9.7	5.5	5.5	4.0	4.8	6.4
ALL	% of Marks (Weighted)	6.8	9.9	4.9	5.7	4.4	11.5	17.2	4.2	9.6	8.4	1.9	1.1	14.4	7.7
ALL	# of Questions	87.0	102.0	68.0	70.0	50.0	110.0	191.0	55.0	102.0	91.0	16.0	23.0	128.0	84.1
ALL	Average marks per Q	2.1	2.7	2.0	2.2	2.4	2.9	2.5	2.1	2.6	2.5	3.2	1.4	3.1	2.4
Rank Order		7	4	9	8	10	3	1	11	5	6	12	13	2	

15.4.2

Comments

Yellow indicates the paper range for P1 is not the same as for the other papers, this is because P1 is changing, and taking apart that paper is particularly soul destroying, I can't justify the hours of mind-numbing tedium if the information is going to be increasingly irrelevant.

Blue indicates the substantial difference in the total number of marks I should be able to account for (Total Marks All Papers) and the ones that have gone into the topic calculations. This is hopefully the result of a RANDOM error where some questions have had parts duplicated and I have not filtered these duplications out. Realistically, though it isn't. When I started to break this paper down by topic I was not systematic in my process; my intentions were disorganised and I wasn't thinking about being able to account for every mark, just for every question. So some topics were duplicated

15.5 Words per topic statistics from the syllabus

Core Syllabus Word Count	218	344	131	130	58	183	273	209	241	287	44	56	363	2537		
Suppliment Syllabus Word Count	82	141	122	191	73	245	68	41	134	124	29	2	352	1604		
All Syllbus Word Count	300	485	253	321	131	428	341	250	375	411	73	58	715	4141		
Core Syllabus Word Count %	5.3	8.3	3.2	3.1	1.4	4.4	6.6	5.0	5.8	6.9	1.1	1.4	8.8			
Suppliment Syllabus Word Count %	2.0	3.4	2.9	4.6	1.8	5.9	1.6	1.0	3.2	3.0	0.7	0.0	8.5			
All Syllbus Word Count %	7.2	11.7	6.1	7.8	3.2	10.3	8.2	6.0	9.1	9.9	1.8	1.4	17.3			
All Syllabus Word Count RANK	8	2	9	7	11	3	6	10	5	4	12	13	1			
% Total ALL Papers	6.8	9.9	4.9	5.7	4.4	11.5	17.2	4.2	9.6	8.4	1.9	1.1	14.4			
% Total P3: A* Focus	3.3	13.2	6.6	5.6	1.1	10.8	10.5	3.6	11.2	9.6	3.3	1.0	20.2			
Words per % ALL Papers	44	49	51	57	30	37	20	59	39	49	39	51	49.8			
Words per % P3	25	11	18	34	66	23	6.5	11	12	13	9	2	17.4			

Although this is only one course so there is very little data at present to go on, a possible generalisation which might be of value when studying for other CIE subjects is that the more words there are in the syllabus, the more important that topic is to the exam. So to get an idea, count the words (can be done electronically: 1. Mark for redaction all of the section of the syllabus for supplement 2. Redact 3. Copy and past all of it to word 4. Do the same for supplement 5. Highlight the topic and word will give you the number of words). The actual results of this will not probably be too surprising, but outcome of this exercise and why it will help is it will force you to think objectively about the syllabus. Instead of thinking about the things that you didn't like or you didn't think you were good at, you will have the opportunity to get a different perspective on the subject. And hopefully, instead of thinking of the subject as a whole, you will start to break it down into more manageable chunks and begin the process of prioritisation, which when done well, is perhaps the most important principle in thought.

[Looking back on this project to count the words in the syllabus, which I did about 5 years ago, I cannot say it produced anything really interesting or useful. But it was super boring to do! Would not recommend doing it]

[illegible]Patrick Brannac www.SmashingScience.org & for China www.SmashingScienceCN.org Page 584 of 585

DATA SHEET

The Periodic Table of the Elements

Group

I	II											III	IV	V	VI	VII	0
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	98 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
87 Fr Francium	88 Ra Radium	226 Ac Actinium	†														
58-71 Lanthanoid series																	
90-103 Actinoid series																	
a X b a = relative atomic mass X = atomic symbol b = proton (atomic) number																	
140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71	 www.SmashingScienceCN.Org		102 No Nobelium 102	103 Lr Lawrencium 103	

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).