

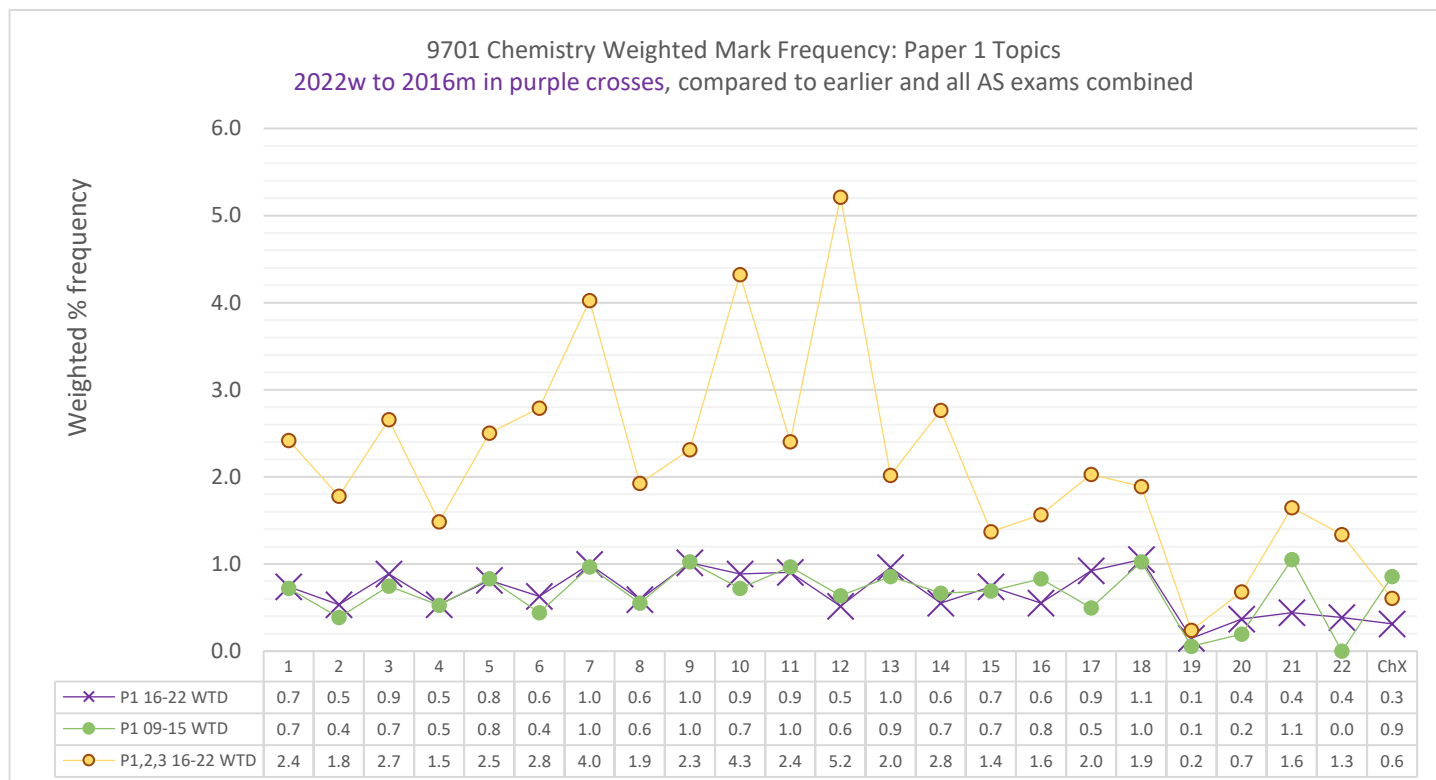
ALyl Chem 9 EQ P1 22w to 09s Paper 1 The Periodic Table: chemical periodicity 90marks

As you start and work through this worksheet you can tick off your progress to show yourself how much you have done, and what you need to do next. The first task is just to read the first question and should take you less than one minutes to complete.

Paper 1 Topic 9

Checklist Tick each task off as you go along

RANK:		P1 Noob	P1 Novice	P1 Bronze	P1 Silver	P1 Gold	P1 ¹ Winner	P1 Hero	P1 Legend
		1 Q started	1 Q done	10% of marks	25% of marks	40% of marks	50% of marks	75% of marks	100% of marks
Topic (marks)	90		1	9	23	36	45	68	90
Time @75s/mark (minutes)	113		1	11	28	45	56	84	113



What the most thoughtful students will get out of their extensive studying will be a capacity to do meaningful brain-based work even under stressful conditions, which is a part of the self-mastery skillset that will continue to deliver value for the whole of their lives. Outstanding grades will also happen, but the most important goal from skillful action in study is being better at any important task, even if circumstances do not feel ideal.

As you are moving through your studies you can learn more about yourself by trying out new ways to manage yourself, and analysing how effective those new techniques were. In this reflective process not only will you get better at working positively and productively to deliver ambitious and successful outcomes, but you will be working towards one aspect of life's highest pursuit, summarised and inscribed on the Temple of Apollo at Delphi: "know thyself".

1. To complete these questions, as important as your answer, is checking your answer against the mark scheme.
2. For each page or group of 10 questions, convert your mark score into a percentage. This will allow you to see (and feel) your progress as you get more experience and understanding with each topic.
3. Multiple choice questions, done carefully where you explain and show yourself your thinking using written notes as you move through each question, can be more useful than just Paper 2 for students aiming for a C or B grade. Paper 2 should be the larger focus for students aiming for A and A* grades, however.

¹ **DO NOT** work on these higher levels of completion in your A2 year unless you have also achieved at least a "Silver" (25%) in the same topic in **Paper 2**, which is **MOST** of your **AS grade**, and Paper 3 which is a smaller part of your year but still important.

4. If you find you get a higher percentage answering short answer questions than multiple choice questions that often means you are NOT using the marking scheme correctly; your correct answer might not be fully complete for all the marks you are awarding. The marks easiest to miss rely on providing the largest amount of detail.

Inorganic chemistry

9 The Periodic Table: chemical periodicity

9.1 Periodicity of physical properties of the elements in Period 3

Learning outcomes

Candidates should be able to:

- 1 describe qualitatively (and indicate the periodicity in) the variations in atomic radius, ionic radius, melting point and electrical conductivity of the elements
- 2 explain the variation in melting point and electrical conductivity in terms of the structure and bonding of the elements

9.2 Periodicity of chemical properties of the elements in Period 3

Learning outcomes

Candidates should be able to:

- 1 describe, and write equations for, the reactions of the elements with oxygen (to give Na_2O , MgO , Al_2O_3 , P_4O_{10} , SO_2), chlorine (to give NaCl , MgCl_2 , AlCl_3 , SiCl_4 , PCl_5) and water (Na and Mg only)
- 2 state and explain the variation in the oxidation number of the oxides (Na_2O , MgO , Al_2O_3 , P_4O_{10} , SO_2 and SO_3 only) and chlorides (NaCl , MgCl_2 , AlCl_3 , SiCl_4 , PCl_5 only) in terms of their outer shell (valence shell) electrons
- 3 describe, and write equations for, the reactions, if any, of the oxides Na_2O , MgO , Al_2O_3 , SiO_2 , P_4O_{10} , SO_2 and SO_3 with water including the likely pHs of the solutions obtained
- 4 describe, explain, and write equations for, the acid/base behaviour of the oxides Na_2O , MgO , Al_2O_3 , P_4O_{10} , SO_2 and SO_3 and the hydroxides NaOH , Mg(OH)_2 , Al(OH)_3 including, where relevant, amphoteric behaviour in reactions with acids and bases (sodium hydroxide only)
- 5 describe, explain, and write equations for, the reactions of the chlorides NaCl , MgCl_2 , AlCl_3 , SiCl_4 , PCl_5 with water including the likely pHs of the solutions obtained
- 6 explain the variations and trends in 9.2.2, 9.2.3, 9.2.4 and 9.2.5 in terms of bonding and electronegativity
- 7 suggest the types of chemical bonding present in the chlorides and oxides from observations of their chemical and physical properties

9.3 Chemical periodicity of other elements

Learning outcomes

Candidates should be able to:

- 1 predict the characteristic properties of an element in a given group by using knowledge of chemical periodicity
- 2 deduce the nature, possible position in the Periodic Table and identity of unknown elements from given information about physical and chemical properties

Q# 497/ AS Chemistry/2022/w/TZ 1/Paper 1/Q# 25//www.SmashingScience.org :o)

25 Separate 1.0g samples of Na_2O , MgO , Al_2O_3 , SiO_2 , NaCl , MgCl_2 , Al_2Cl_6 and SiCl_4 are added to separate beakers containing water and stirred.

The number of beakers containing a white solid is Q.

An excess of NaOH(aq) is then added to each beaker and stirred.

The number of beakers now containing a white solid is R.

Which row is correct?

	Q	R
A	3	2
B	3	3
C	4	3
D	4	4

Q# 498/ AS Chemistry/2022/w/TZ 1/Paper 1/Q# 19//www.SmashingScience.org :o)

19 The oxides BaO , CaO , MgO and SrO all produce alkaline solutions when added to water.

Which oxide produces the saturated solution with the highest pH?

A BaO B CaO C MgO D SrO

Q# 499/ AS Chemistry/2022/w/TZ 1/Paper 1/Q# 18//www.SmashingScience.org :o)

18 Which row describes the relative sizes of the ionic radii of Na^+ , Mg^{2+} and S^{2-} ?

	smallest	→	largest
A	Na^+	Mg^{2+}	S^{2-}
B	Mg^{2+}	Na^+	S^{2-}
C	S^{2-}	Na^+	Mg^{2+}
D	S^{2-}	Mg^{2+}	Na^+

Q# 500/ AS Chemistry/2022/w/TZ 1/Paper 1/Q# 17//www.SmashingScience.org :o)

17 The electrical conductivities of two compounds, Y and Z, are shown.

	for Y	for Z
conductivity of the compound in the liquid state	good	does not conduct
conductivity of the mixture obtained by adding the compound to water	good	good

What are compounds Y and Z?

	Y	Z
A	Al_2O_3	SiCl_4
B	NaCl	Al_2O_3
C	NaCl	SiCl_4
D	SiCl_4	Al_2O_3



6 Which statement about aluminium chloride is correct?

- A Aluminium chloride has a much higher melting point than magnesium chloride due to the small size of the aluminium ion.
- B Anhydrous aluminium chloride reacts vigorously with water to form a solution with a pH greater than 7.
- C Each Al_2Cl_6 molecule found in aluminium chloride vapour contains two coordinate bonds.
- D The bonding between aluminium and chlorine is strongly ionic due to the large difference in electronegativity.

Q# 502/ AS Chemistry/2022/s/TZ 1/Paper 1/Q# 23//www.SmashingScience.org :o)

23 Silicon is heated in an excess of chlorine, producing compound J.

An excess of water is added to the sample of J produced.

Which row is correct?

	structure of J	Is HCl produced when water is added to J?
A	giant molecular	no
B	giant molecular	yes
C	simple molecular	no
D	simple molecular	yes

Q# 503/ AS Chemistry/2022/s/TZ 1/Paper 1/Q# 19//www.SmashingScience.org :o)

19 A student reacts 0.100 mol of each of sodium, magnesium and phosphorus atoms separately with an excess of oxygen.

Which rows are correct?

	oxide	mass of oxide formed / g
1	sodium	3.10
2	magnesium	4.03
3	phosphorus	7.10

- A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 and 3 only

Q# 504/ AS Chemistry/2022/s/TZ 1/Paper 1/Q# 18//www.SmashingScience.org :o)

18 Which statement for the element in Period 3 and Group 13 of the Periodic Table is correct?

- A It has the highest melting point of the elements in its period.
- B It has exactly one electron in its shell with principal quantum number 3.
- C It forms an oxide that reacts with aqueous sodium hydroxide.
- D It forms a chloride that dissolves in water to give a neutral solution.

19 The table shows the melting points of SiO_2 and P_4O_6 .

oxide	SiO_2	P_4O_6
melting point/ K	1883	297

Which statement explains the difference between the melting points of SiO_2 and P_4O_6 ?

- A The bonding of the oxides changes from ionic to covalent.
- B The metallic character of the elements decreases across Period 3.
- C The oxidation number of the element increases from Si to P.
- D The structure changes from giant molecular to simple molecular.

Q# 506/ AS Chemistry/2022/m/TZ 2/Paper 1/Q# 18//www.SmashingScience.org :o)

18 The elements in Period 3 and their compounds show trends across the period from sodium to chlorine.

Which row is correct?

	electronegativity of the elements	acid/base behaviour of the oxides of the elements
A	decreases	basic $\rightarrow$ amphoteric $\rightarrow$ acidic
B	decreases	acidic $\rightarrow$ amphoteric $\rightarrow$ basic
C	increases	basic $\rightarrow$ amphoteric $\rightarrow$ acidic
D	increases	acidic $\rightarrow$ amphoteric $\rightarrow$ basic

Q# 507/ AS Chemistry/2022/m/TZ 2/Paper 1/Q# 17//www.SmashingScience.org :o)

17 A student investigated the chloride of a Period 3 element. This is what the student wrote down as a record.

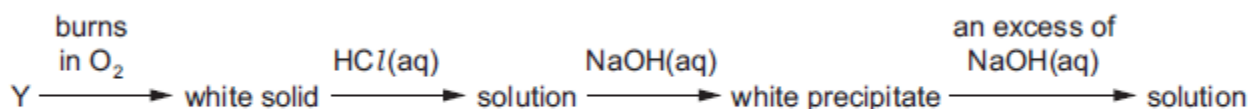
The compound was a white crystalline solid. It dissolved easily in water to give a solution of pH 12. When placed in a test-tube and heated in a roaring Bunsen flame, the compound melted after several minutes heating.

What can be deduced from this record?

- A At least one of the recorded observations is incorrect.
- B The compound was magnesium chloride, MgCl_2 .
- C The compound was phosphorus pentachloride, PCl_5 .
- D The compound was sodium chloride, NaCl .



13 An element, Y, reacts according to the following sequence.



What could be element Y?

- A Na B Mg C Al D P

12 Which element requires the least number of moles of oxygen for the complete combustion of 1 mol of its atoms?

- A aluminium
B magnesium
C phosphorus
D sodium

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which statements are correct going across Period 3 from sodium to chlorine?

- The charge on the nucleus increases, pulling the electrons closer to it.
- The radius of the most common ion of each element decreases.
- The shielding caused by inner electrons decreases, so the outer electrons are pulled closer to the nucleus.

19 R is an oxide of Period 3 element T. 5.00 g of R contains 2.50 g of T.

What is T?

- A magnesium
B aluminium
C silicon
D sulfur

12 Element X is in Period 3. Element X forms a solid oxide Y.

Y reacts with hot concentrated hydrochloric acid. Y reacts with hot aqueous sodium hydroxide to form a compound in which X is part of an anion.

How many p electrons does one atom of X have in its outer shell?

- A 0 B 1 C 2 D 3



The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 A sample containing x mol of Al_2Cl_6 is dissolved in water to give solution W.

In order to precipitate all of the aluminium as its hydroxide, y mol of sodium hydroxide are required.

More of the alkali is added to re-dissolve the precipitate, giving solution Z.

Which statements are correct?

- 1 the initial pH of solution W is below 7
- 2 $y = 3x$
- 3 Z contains x mol of aluminium

Q# 514/ AS Chemistry/2021/m/TZ 2/Paper 1/Q# 13//www.SmashingScience.org :o)

13 Which row is correct?

	statement	reason
A	The first ionisation energy of phosphorus is greater than that of magnesium.	electron is lost from a 3p orbital in both cases
B	The melting point of phosphorus is greater than that of magnesium.	phosphorus has more valence electrons than magnesium
C	The atomic radius of phosphorus is smaller than that of magnesium.	phosphorus has greater nuclear charge than magnesium
D	The electrical conductivity of phosphorus is smaller than that of magnesium.	bonding changes from ionic in magnesium to covalent in phosphorus

Q# 515/ AS Chemistry/2021/m/TZ 2/Paper 1/Q# 12//www.SmashingScience.org :o)

12 Which observations are made when a sample of silicon chloride, $SiCl_4$, is added to a beaker of water?

- A No visible change is observed.
- B Steamy fumes and a precipitate are both observed.
- C The appearance of a precipitate is the only observation.
- D The appearance of steamy fumes is the only observation.



The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Three test-tubes, X, Y and Z, each contain water.

- A small amount of NaCl is added to test-tube X.
- A small amount of SiCl_4 is added to test-tube Y.
- A small amount of AlCl_3 is added to test-tube Z.

After a short time, two drops of universal indicator solution are added to each test-tube.

Which statements can be correct?

- 1 The pH in test-tube X is 7.
- 2 The pH in test-tube Y is 2.
- 3 The pH in test-tube Z is 2.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which rows correctly show the relative electrical conductivities of the sets of three Period 3 elements?

	greatest conductivity	→	least conductivity
1	sodium	silicon	chlorine
2	aluminium	magnesium	phosphorus
3	sulfur	silicon	phosphorus

12 X and Y are two elements in Period 3 of the Periodic Table. They combine to form compound Z.

X forms a soluble acidic oxide. The oxidation number of X in this oxide is +4.

Y forms an amphoteric oxide.

What is the formula of compound Z?

- A** AlP **B** Al_2S_3 **C** Si_2P_5 **D** SiS_2



16 Sodium, aluminium and silicon are three elements in Period 3. Each element forms an oxide.

Which row has three correct properties of these oxides?

	sodium oxide	aluminium oxide	silicon dioxide
A	basic	basic	amphoteric
B	giant ionic	giant ionic	simple molecular
C	high melting point	low melting point	high melting point
D	reacts with water	no reaction with water	no reaction with water

15 Element Z has a giant structure.

The chloride of Z reacts with water to give a solution with a pH less than 5.

Which pair shows two elements which could be Z?

- A** aluminium, magnesium
- B** aluminium, silicon
- C** phosphorus, magnesium
- D** phosphorus, silicon

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 Which statements are correct?

- 1** Aluminium chloride dissolves in water to give an acidic solution.
- 2** Magnesium chloride dissolves in water to give a solution of pH close to 7.
- 3** Sodium chloride dissolves in water to give an alkaline solution.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



31 Carbon and nitrogen are adjacent in the Periodic Table.

Which properties do they both have?

- 1 There is an empty 2p orbital in each atom of the element.
- 2 The principal quantum number of the highest occupied orbital is 2.
- 3 They can form compounds in which their atoms form four bonds.

Q# 523/ AS Chemistry/2020/m/TZ 2/Paper 1/Q# 16//www.SmashingScience.org :o)

16 Sodium, magnesium and aluminium are three elements in Period 3 of the Periodic Table. Each element forms an oxide.

Which row is correct?

	sodium oxide	magnesium oxide	aluminium oxide
A	basic	amphoteric	amphoteric
B	giant ionic	giant ionic	simple molecular
C	high melting point	high melting point	low melting point
D	readily reacts with water	slight reaction with water	no reaction with water

Q# 524/ AS Chemistry/2020/m/TZ 2/Paper 1/Q# 12//www.SmashingScience.org :o)

12 X and Y are oxides of different Period 3 elements.

If one mole of X is added to water, the solution formed is neutralised by exactly one mole of Y.

What could be the identities of X and Y?

	X	Y
A	P_4O_{10}	Al_2O_3
B	SO_3	Al_2O_3
C	P_4O_{10}	Na_2O
D	SO_3	Na_2O

Q# 525/ AS Chemistry/2019/w/TZ 1/Paper 1/Q# 13//www.SmashingScience.org :o)

13 X, Y and Z are consecutive elements in Period 3 of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point of these three elements.

What are the identities of X, Y and Z?

	X	Y	Z
A	Na	Mg	Al
B	Mg	Al	Si
C	Al	Si	P
D	Si	P	S

Q# 526/ AS Chemistry/2019/w/TZ 1/Paper 1/Q# 12//www.SmashingScience.org :o)

12 Which oxide will cause an increase in pH when added to water?

- A MgO B Al_2O_3 C SiO_2 D SO_2

Q# 527/ AS Chemistry/2019/s/TZ 1/Paper 1/Q# 35//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which oxides, when placed in cold water for one day, will react with the water?

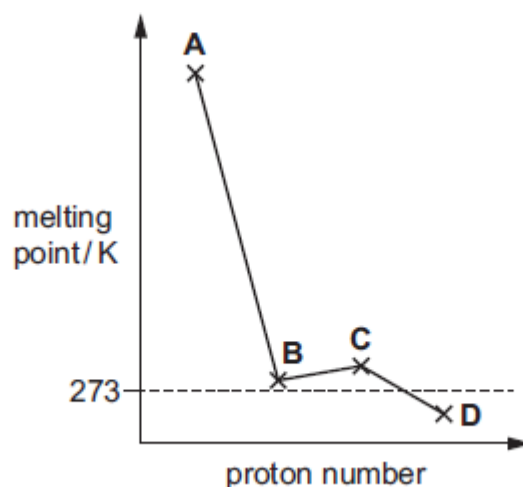
- 1 MgO
2 Al_2O_3
3 SiO_2

Q# 528/ AS Chemistry/2019/s/TZ 1/Paper 1/Q# 13//www.SmashingScience.org :o)

13 The relative melting points of four consecutive elements in the Periodic Table are shown in the graph.

The elements all have proton numbers less than 20.

Which element is in Group 16?



Q# 529/ AS Chemistry/2019/m/TZ 2/Paper 1/Q# 13//www.SmashingScience.org :o)

13 A solid Period 3 element, Q, is reacted with oxygen gas. Compound R is formed.

When R is added to water the pH decreases.

What could be the empirical formula of R?

- A Q_2O_4 B Q_2O_5 C Q_4O_{10} D Q_5O_2



12 X, Y and Z are elements in Period 3 of the Periodic Table. The results of some experiments carried out with compounds of these elements are shown.

element	result of adding the oxide of the element to $\text{H}_2\text{O}(\text{l})$	result of adding the chloride of the element to $\text{H}_2\text{O}(\text{l})$	result of adding the oxide of the element to $\text{HCl}(\text{aq})$
X	no reaction	hydrolyses	forms chloride salt
Y	forms hydroxide	dissolves	forms chloride salt
Z	forms acid	hydrolyses	hydrolyses

Which statement could be correct?

- A X is Al and Y is Mg.
- B X is Si and Y is Na.
- C Y is Al and Z is P.
- D Y is Na and Z is Al.

14 Which row describes the structure and bonding of SiO_2 and SiCl_4 ?

	SiO_2		SiCl_4	
	bonding	structure	bonding	structure
A	covalent	giant	covalent	giant
B	covalent	giant	covalent	simple
C	ionic	giant	covalent	giant
D	ionic	giant	covalent	simple

13 X and Y are elements in Period 3 of the Periodic Table.

- The oxide of X is a solid at room temperature. This oxide has a giant structure.
- The chloride of X does not react with water.
- Argon is the only element in Period 3 with a lower melting point than Y.

What could be the formula of a compound formed between elements X and Y?

- A Al_2S_3
- B MgS
- C NaCl
- D PCl_5



12 Sodium and sulfur are burned separately in oxygen.

Each reaction has a distinctive coloured flame.

Which row is correct?

	Na + O ₂	S + O ₂
A	white	blue
B	white	yellow
C	yellow	blue
D	yellow	yellow

13 Which element has the **second** smallest atomic radius in its group and the **third** lowest first ionisation energy in its period?

- A boron
- B calcium
- C magnesium
- D sodium

12 Silicon is heated in an excess of chlorine, producing compound J.

Excess water is added to the sample of J produced.

Which row is correct?

	structure of J	Is HCl produced when water is added to J?
A	giant molecular	no
B	giant molecular	yes
C	simple molecular	no
D	simple molecular	yes

14 X, Y and Z are three elements in the third period.

- X reacts with chlorine to give a liquid product.
- Y reacts with chlorine to give a solid product that dissolves in water to give a solution of pH 7.
- Z reacts with chlorine to give a solid product that dissolves in water to give a solution of pH 6.

Which elements are good conductors of electricity?

- A X and Y
- B Y and Z
- C Y only
- D Z only

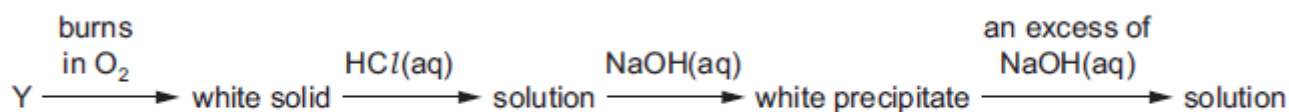


13 Which oxide is insoluble in aqueous sodium hydroxide?

- A MgO B Al_2O_3 C P_4O_{10} D SO_2

Q# 538/ AS Chemistry/2017/w/TZ 1/Paper 1/Q# 13//

13 An element Y reacts according to the following sequence.



What could be element Y?

- A Al B Ca C Mg D P

Q# 539/ AS Chemistry/2017/w/TZ 1/Paper 1/Q# 12//

12 The elements Cl, Mg, Si and S are all in Period 3.

What is the correct sequence of the melting points of these elements, from lowest to highest?

	lowest melting point	→	highest melting point	
A	Cl	S	Mg	Si
B	Cl	S	Si	Mg
C	Mg	Si	S	Cl
D	Si	Mg	S	Cl

Q# 540/ AS Chemistry/2017/s/TZ 1/Paper 1/Q# 35//www.SmashingScience.org :o)

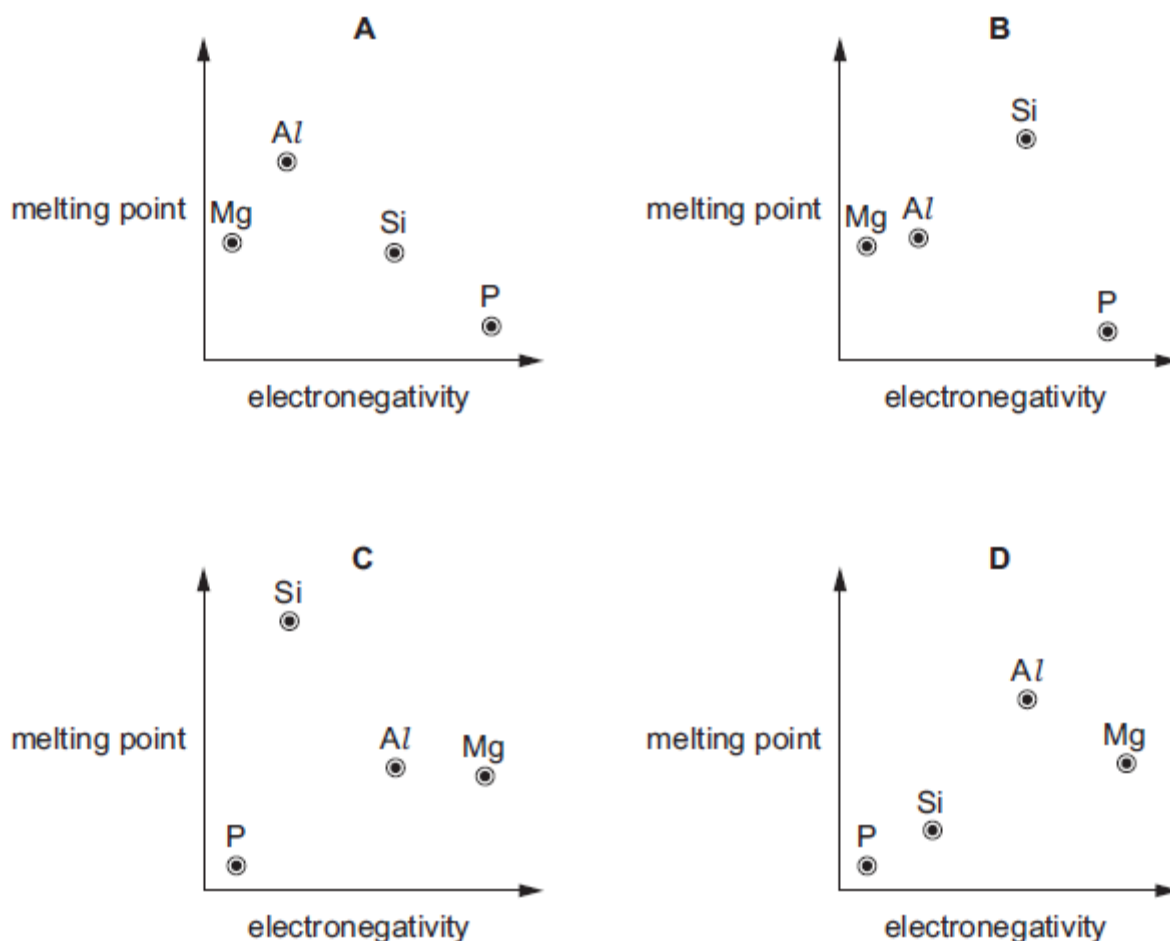
The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which statements describe a trend in Period 3 between **every pair** of adjacent elements from sodium to chlorine?

- The atomic radius decreases.
- The 1st ionisation energy decreases.
- The melting point decreases.

13 Which graph correctly shows the relative melting points of the elements Mg, Al, Si and P plotted against their relative electronegativities?



The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Three test-tubes, X, Y, and Z, each contain a small amount of water.

- A small amount of NaCl is added to test-tube X.
- A small amount of SiCl_4 is added to test-tube Y.
- A small amount of AlCl_3 is added to test-tube Z.

After a short time, two drops of Universal Indicator solution are added to each test-tube.

Which observations are made?

- 1 The indicator added to test-tube X stays green.
- 2 The indicator added to test-tube Y turns red.
- 3 The indicator added to test-tube Z turns red.



The responses **A** to **D** should be selected on the basis of

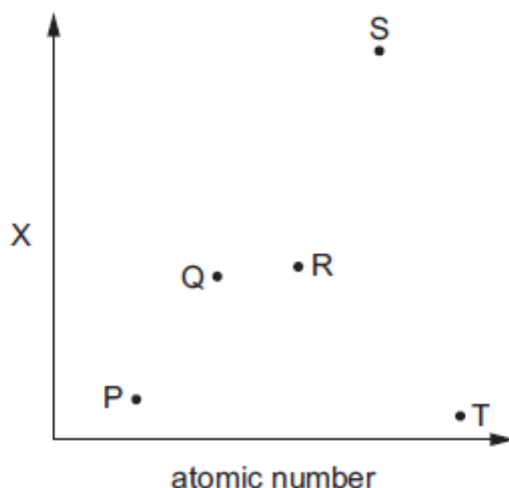
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

- 31 Nitrogen and phosphorus are both in Group 15 of the Periodic Table. Phosphorus forms a chloride with the formula PCl_5 but nitrogen does not form NCl_5 .

Which statements help to explain this?

- 1 Nitrogen's outer shell cannot contain more than eight electrons.
- 2 Nitrogen cannot have an oxidation state of +5.
- 3 Nitrogen is less electronegative than phosphorus.

- 15 The magnitude of property X of five elements from the third period of the Periodic Table, P, Q, R, S and T is shown. P, Q, R, S and T have consecutive atomic numbers. The letters do not represent the symbols of the elements.



Which row correctly identifies property X and element R?

	property X	element R
A	electrical conductivity	Al
B	electronegativity	Si
C	melting point	Al
D	melting point	Si

12 The electrical conductivities of two compounds, Y and Z, are shown in the table.

	Y	Z
conductivity of the compound in the liquid state	good	does not conduct
conductivity of the mixture obtained by adding the compound to water	good	good

What could compounds Y and Z be?

	Y	Z
A	Al_2O_3	$SiCl_4$
B	NaF	Al_2O_3
C	NaF	$SiCl_4$
D	$SiCl_4$	Al_2O_3

Q# 546/ AS Chemistry/2016/w/TZ 1/Paper 1/Q# 35//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Water is added to anhydrous aluminium chloride to make a 0.1 mol dm^{-3} solution.

Which observations are correct?

- 1 The reaction is endothermic.
- 2 The solution is acidic.
- 3 The solution contains the ion $[Al(H_2O)_6]^{3+}$.

Q# 547/ AS Chemistry/2016/s/TZ 1/Paper 1/Q# 34//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

34 A little water is added to each of the following compounds and the mixture warmed.

For which compounds will an acidic gas be evolved?

- 1 aluminium chloride
- 2 silicon tetrachloride
- 3 phosphorous pentachloride



Q# 548/ AS Chemistry/2016/s/TZ 1/Paper 1/Q# 13//www.SmashingScience.org :o)

- 13 Elements D and E are both in Period 3. Element D has the smallest atomic radius in Period 3. There are only two elements in Period 3 which have a lower melting point than element E. Elements D and E react together to form compound L.

Which compound could be L?

- A MgCl_2 B MgS C Na_2S D PCl_3

Q# 549/ AS Chemistry/2016/s/TZ 1/Paper 1/Q# 12//www.SmashingScience.org :o)

- 12 Why is the ionic radius of a chloride ion larger than the ionic radius of a sodium ion?

- A A chloride ion has one more occupied electron shell than a sodium ion.
B Chlorine has a higher proton number than sodium.
C Ionic radius increases regularly across the third period.
D Sodium is a metal, chlorine is a non-metal.

Q# 550/ AS Chemistry/2016/m/TZ 2/Paper 1/Q# 13//www.SmashingScience.org :o)

- 13 When dealing with a spillage of metallic sodium it is important that no toxic or flammable products are formed.

Which material should be used if there is a spillage of metallic sodium?

- A dilute hydrochloric acid
B ethanol
C sand
D water spray

Q# 551/ AS Chemistry/2016/m/TZ 2/Paper 1/Q# 12//www.SmashingScience.org :o)

- 12 Consecutive elements X, Y and Z are in Period 3 of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point of these three elements.

What are the identities of X, Y and Z?

- A sodium, magnesium, aluminium
B magnesium, aluminium, silicon
C aluminium, silicon, phosphorus
D silicon, phosphorus, sulfur

Q# 552/ AS Chemistry/2015/w/TZ 1/Paper 1/Q# 32//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



- 32 The Group IV elements carbon, silicon and germanium can all exist in the giant molecular structure which is also found in diamond. The bond lengths in these structures are given below.

element X	C	Si	Ge
bond length X–X / nm	0.154	0.234	0.244

Why does the bond length increase down the group?

- 1 Orbital overlap decreases down the group.
- 2 Atomic radius increases down the group.
- 3 Nuclear charge increases down the group.

Q# 553/ AS Chemistry/2015/w/TZ 1/Paper 1/Q# 16//www.SmashingScience.org :o)

- 16 X is the oxide of a Period 3 element. X reacts with water to give an acidic solution.

A solution is prepared by reacting 0.100 g of X with excess water. This solution was neutralised by exactly 25.0 cm³ of 0.100 mol dm⁻³ sodium hydroxide solution.

What could be the identity of X?

- A Al₂O₃ B MgO C P₄O₁₀ D SO₃

Q# 554/ AS Chemistry/2015/w/TZ 1/Paper 1/Q# 15//www.SmashingScience.org :o)

- 15 The melting points of the Period 3 elements sodium to aluminium are shown in the table.

element	Na	Mg	Al
mp/K	371	923	932

Which factor explains the increase in melting points from sodium to aluminium?

- A the changes in first ionisation energy from sodium to aluminium
B the increase in electronegativity from sodium to aluminium
C the increase in the A_r of the elements from sodium to aluminium
D the increase in the number of outer electrons in each atom from sodium to aluminium

Q# 555/ AS Chemistry/2015/w/TZ 1/Paper 1/Q# 14//www.SmashingScience.org :o)

- 14 Use of the Data Booklet is relevant to this question.

Which of the elements sodium, magnesium, aluminium, silicon, phosphorus, sulfur and chlorine

- has a lower first ionisation energy than the preceding element in the Periodic Table,
- conducts electricity and
- has a lower atomic radius than the preceding element in the Periodic Table?

- A aluminium
B magnesium
C phosphorus
D sulfur

3 Use of the Data Booklet is relevant to this question.

1.00 g of carbon is combusted in a limited supply of pure oxygen. 0.50g of the carbon combusts to form CO_2 and 0.50g of the carbon combusts to form CO .

The resultant mixture of CO_2 and CO is passed through excess NaOH(aq) and the remaining gas is then dried and collected.

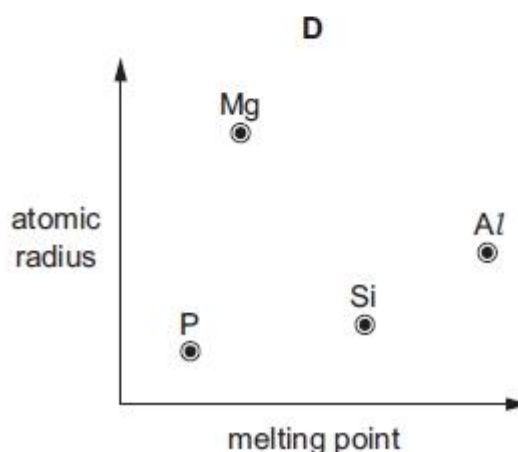
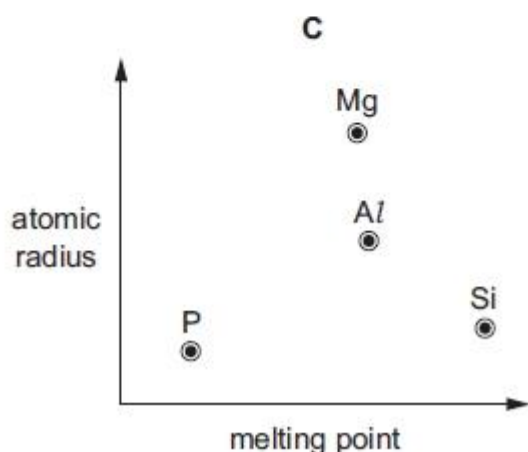
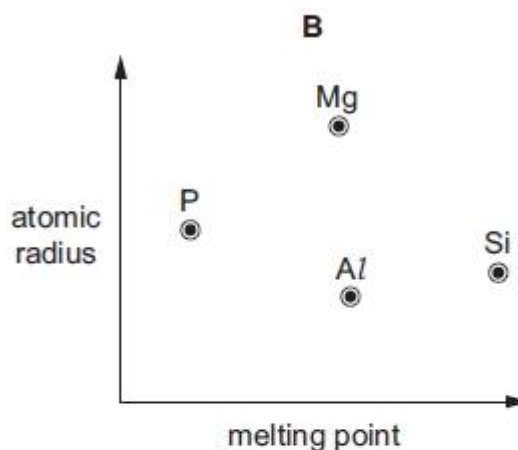
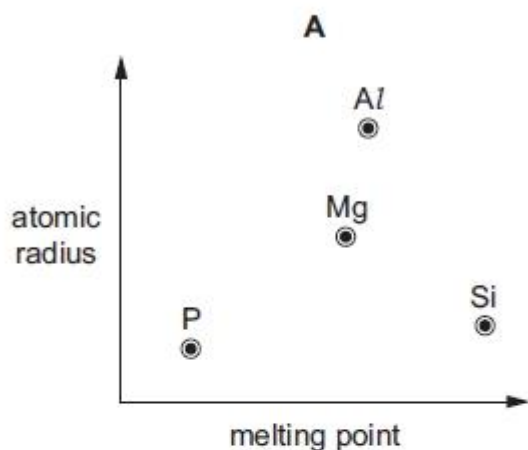
What is the volume of the remaining gas? (All gas volumes are measured at 25°C and 1 atmosphere pressure.)

- A 1 dm^3 B 1.5 dm^3 C 2 dm^3 D 3 dm^3

Q# 557/ AS Chemistry/2015/s/TZ 1/Paper 1/Q# 15//www.SmashingScience.org :o)

15 Use of the Data Booklet is relevant to this question.

Which diagram correctly shows the atomic radii of the elements Mg, Al, Si and P plotted against their melting points?



Q# 558/ AS Chemistry/2015/s/TZ 1/Paper 1/Q# 14//www.SmashingScience.org :o)

14 Which observations are made when a sample of silicon chloride, SiCl_4 , is added to a beaker of water?

- A No visible changes are observed.
- B Steamy fumes and a white precipitate are both observed.
- C The appearance of a white precipitate is the only observation.
- D The appearance of steamy fumes is the only observation.

Q# 559/ AS Chemistry/2014/w/TZ 1/Paper 1/Q# 19//www.SmashingScience.org :o)

19 Which oxide does **not** react with cold dilute sodium hydroxide to produce a salt?

- A Al_2O_3 B P_4O_{10} C SO_2 D SiO_2

Q# 560/ AS Chemistry/2014/w/TZ 1/Paper 1/Q# 18//www.SmashingScience.org :o)

18 Total removal of the pollutant sulfur dioxide, SO_2 , is difficult. The quantities emitted from furnace chimneys can be lowered by using desulfurisation plants. The gases are reacted with calcium hydroxide to remove the SO_2 .

What is the main product formed **initially**?

- A $\text{Ca}(\text{HSO}_4)_2$ B CaS C CaSO_3 D CaSO_4

Q# 561/ AS Chemistry/2014/w/TZ 1/Paper 1/Q# 14//www.SmashingScience.org :o)

14 *Use of the Data Booklet is relevant to this question.*

Sir Humphrey Davy discovered boron, calcium, magnesium and sodium.

Which of these elements has the **second** smallest atomic radius in its group and the **third** lowest first ionisation energy in its period?

- A boron
- B calcium
- C magnesium
- D sodium

Q# 562/ AS Chemistry/2014/w/TZ 1/Paper 1/Q# 13//www.SmashingScience.org :o)

13 Which property is **not** associated with the element sodium?

- A It can react with cold water to form hydrogen.
- B It forms a basic oxide.
- C It forms a neutral chloride.
- D It is an oxidising agent.

Q# 563/ AS Chemistry/2014/w/TZ 1/Paper 1/Q# 12//www.SmashingScience.org :o)

12 Element X, in Period 3, has the following properties.

- Its oxide has a giant structure.
- It forms covalent bonds with chlorine.
- Its oxide will neutralise $\text{HCl}(\text{aq})$.

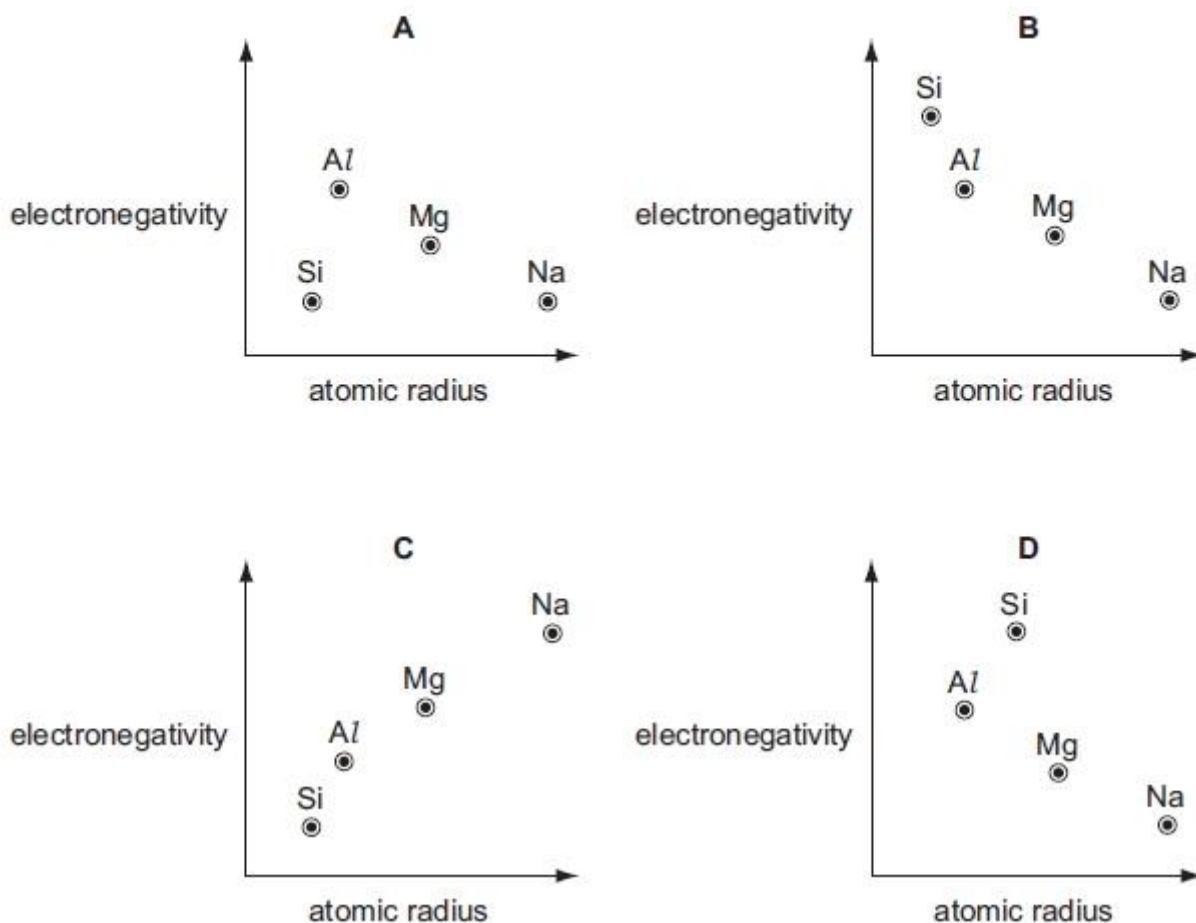
What is element X?

- A Mg B Al C Si D P



19 Use of the Data Booklet is relevant to this question.

Which graph correctly shows relative electronegativity plotted against relative atomic radius for the elements Na, Mg, Al and Si?



16 Which description of the bonding and acid / base nature of aluminium oxide is correct?

	bonding	acid / base nature
A	covalent	amphoteric
B	covalent	basic
C	ionic	amphoteric
D	ionic	basic

15 When calcium is burnt in oxygen, what colour is the flame?

- A green
- B red
- C white
- D yellow



Q# 567/ AS Chemistry/2013/w/TZ 1/Paper 1/Q# 19//www.SmashingScience.org :o)

- 19 Consecutive elements **X**, **Y** and **Z** are in the third period of the Periodic Table. Element **Y** has the highest first ionisation energy and the lowest melting point of these three elements.

What could be the identities of **X**, **Y** and **Z**?

- A sodium, magnesium, aluminium
- B magnesium, aluminium, silicon
- C aluminium, silicon, phosphorus
- D silicon, phosphorus, sulfur

Q# 568/ AS Chemistry/2013/s/TZ 1/Paper 1/Q# 4//www.SmashingScience.org :o)

- 4 Use of the Data Booklet is relevant to this question.

The elements radon (Rn), francium (Fr) and radium (Ra) have proton numbers 86, 87 and 88 respectively.

What is the order of their first ionisation energies?

	least endothermic	→	most endothermic
A	Fr	Ra	Rn
B	Fr	Rn	Ra
C	Ra	Fr	Rn
D	Rn	Ra	Fr

Q# 569/ AS Chemistry/2013/s/TZ 1/Paper 1/Q# 34//www.SmashingScience.org :o)

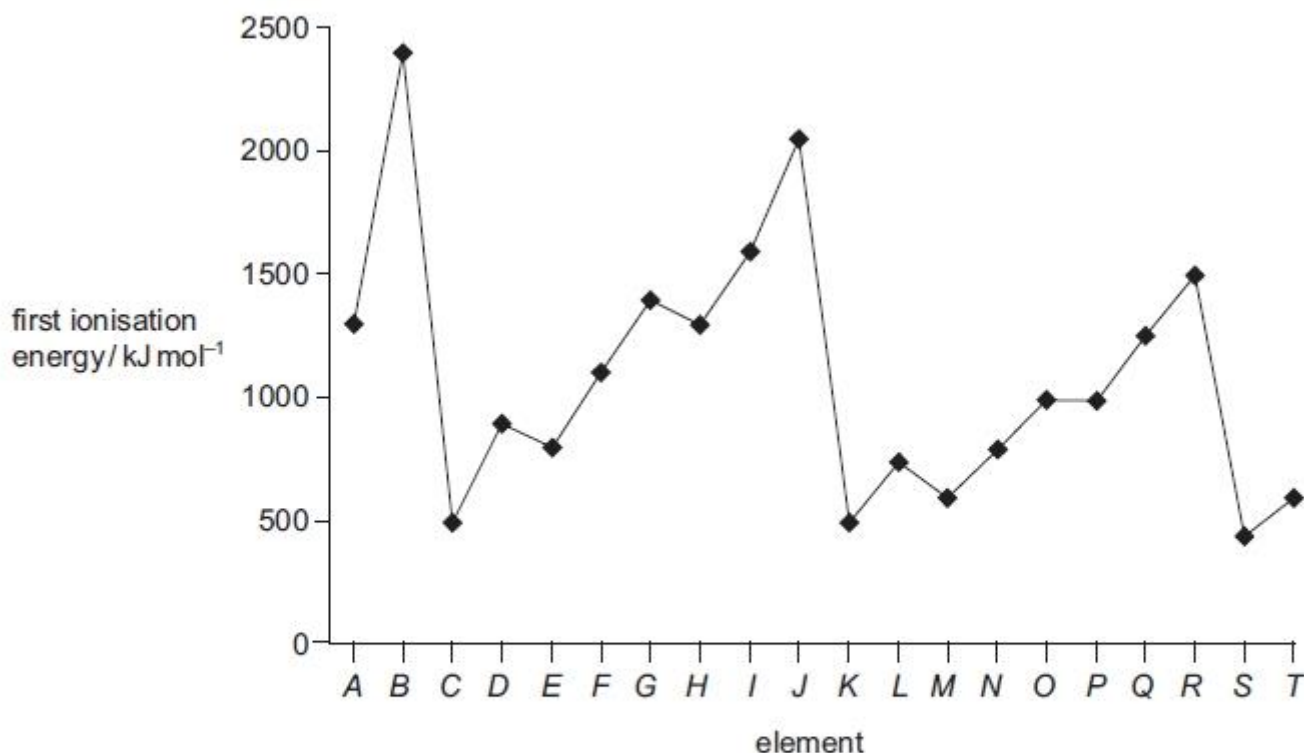
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



- 34 The first ionisation energies of twenty successive elements in the Periodic Table are represented in the graph.

The letters given are not the normal symbols for these elements.



Which statements about this graph are correct?

- 1 Elements B, J and R are in Group 0 of the Periodic Table.
- 2 Atoms of elements D and L contain two electrons in their outer shells.
- 3 Atoms of elements G and O contain a half-filled p subshell.

Q# 570/ AS Chemistry/2013/s/TZ 1/Paper 1/Q# 2//www.SmashingScience.org :o)

- 2 A mixture of 10 cm^3 of methane and 10 cm^3 of ethane was sparked with an excess of oxygen. After cooling to room temperature, the residual gas was passed through aqueous potassium hydroxide.

All gas volumes were measured at the same temperature and pressure.

What volume of gas was absorbed by the alkali?

- A 15 cm^3 B 20 cm^3 C 30 cm^3 D 40 cm^3

Q# 571/ AS Chemistry/2012/w/TZ 1/Paper 1/Q# 36//www.SmashingScience.org :o)

The responses A to D should be selected on the basis of

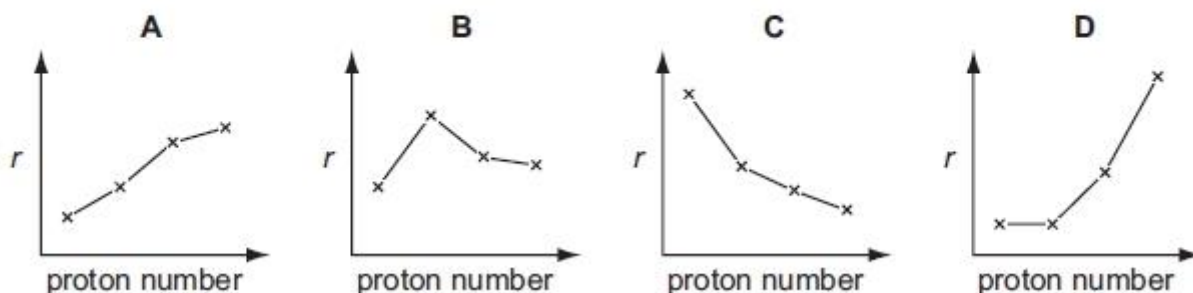
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

36 When added to water, which oxides will **not** cause a change in pH?

- 1 Al_2O_3
- 2 SiO_2
- 3 P_4O_{10}

Q# 572/ AS Chemistry/2012/w/TZ 1/Paper 1/Q# 19//www.SmashingScience.org :o)

19 Which diagram shows the variation of the metallic radius r of the Group I elements, Li, Na, K and Rb, with increasing proton (atomic) number?



Q# 573/ AS Chemistry/2012/w/TZ 1/Paper 1/Q# 18//www.SmashingScience.org :o)

18 Elements X and Y are both in period three.

When the chloride of X is added to water, it reacts and a solution of pH 2 is produced.

When the chloride of Y is added to water, it dissolves and a solution of pH 7 is produced.

Which statement explains these observations?

- A Both chlorides hydrolyse in water.
- B X is phosphorus and Y is aluminium.
- C X is silicon and Y is sodium.
- D X is sodium and Y is phosphorus.

Q# 574/ AS Chemistry/2012/s/TZ 1/Paper 1/Q# 15//www.SmashingScience.org :o)

15 The oxides BaO, CaO, MgO and SrO all produce alkaline solutions when added to water.

Which oxide produces the saturated solution with the highest pH?

- A BaO(aq)
- B CaO(aq)
- C MgO(aq)
- D SrO(aq)

Q# 575/ AS Chemistry/2011/w/TZ 1/Paper 1/Q# 18//www.SmashingScience.org :o)

18 Total removal of the pollutant sulfur dioxide, SO_2 , is difficult, both for economic and technical reasons. The quantities emitted from furnace chimneys can be lowered by using desulfurisation plants. The gases are scrubbed (washed) with calcium hydroxide to remove the SO_2 .

What is the main product formed initially?

- A $\text{Ca}(\text{HSO}_4)_2$
- B CaS
- C CaSO_3
- D CaSO_4



1 Three elements, X, Y and Z, have the physical properties shown in the table.

element	melting point /°C	boiling point /°C	density /g cm ⁻³
X	-7	59	3.12
Y	98	883	0.97
Z	649	1107	1.74

What could be the identities of X, Y and Z?

	X	Y	Z
A	Br ₂	Al	Si
B	Br ₂	Na	Mg
C	I ₂	Mg	Na
D	I ₂	Si	K

5 Which factor helps to explain why the first ionisation energies of the Group I elements decrease from lithium to sodium to potassium to rubidium?

- A The nuclear charge of the elements increases.
- B The outer electron is in an 's' subshell.
- C The repulsion between spin-paired electrons increases.
- D The shielding effect of the inner shells increases.

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

35 Which oxides react with water to give a solution of pH 10 or higher?

- 1 CaO
- 2 Na₂O
- 3 SrO

The responses A to D should be selected on the basis of

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct



34 Which statements are correct?

- 1 Aluminium chloride dissolves in water to give an acidic solution.
- 2 Magnesium chloride dissolves in water to give a slightly acidic solution.
- 3 Sodium chloride dissolves in water to give an alkaline solution.

Q# 580/ AS Chemistry/2011/s/TZ 1/Paper 1/Q# 13//www.SmashingScience.org :o)

- 13 0.02 mol of aluminium is burned in oxygen and the product is reacted with 2.00 mol dm^{-3} hydrochloric acid.

What minimum volume of acid will be required for complete reaction?

- A 15 cm^3 B 20 cm^3 C 30 cm^3 D 60 cm^3

Q# 581/ AS Chemistry/2010/w/TZ 1/Paper 1/Q# 13//www.SmashingScience.org :o)

- 13 Why is the first ionisation energy of phosphorus greater than the first ionisation energy of silicon?

- A A phosphorus atom has one more proton in its nucleus.
- B The atomic radius of a phosphorus atom is greater.
- C The outer electron in a phosphorus atom is more shielded.

Q# 582/ AS Chemistry/2010/s/TZ 1/Paper 1/Q# 2//www.SmashingScience.org :o)

- 2 Use of the Data Booklet is relevant to this question.

The elements radon (Rn), francium (Fr) and radium (Ra) have consecutive proton numbers in the Periodic Table.

What is the order of their first ionisation energies?

	least endothermic	—————→	most endothermic
A	Fr	Ra	Rn
B	Fr	Rn	Ra
C	Ra	Fr	Rn
D	Rn	Ra	Fr

Q# 583/ AS Chemistry/2010/s/TZ 1/Paper 1/Q# 19//www.SmashingScience.org :o)

- 19 Two properties of non-metallic elements and their atoms are as follows.

property 1 has an oxide that can form a strong acid in water

property 2 has **no** paired 3p electrons

Which properties do phosphorus and sulfur have?

	phosphorus	sulfur
A	1 and 2	1 only
B	1 only	1 and 2
C	1 and 2	1 and 2
D	2 only	1 only

Q# 584/ AS Chemistry/2010/s/TZ 1/Paper 1/Q# 18//www.SmashingScience.org :o)

18 Which element of the third period requires the least number of moles of oxygen for the complete combustion of 1 mol of the element?

- A aluminium
- B magnesium
- C phosphorus
- D sodium

Q# 585/ AS Chemistry/2010/s/TZ 1/Paper 1/Q# 16//www.SmashingScience.org :o)

16 Consecutive elements X, Y, Z are in the third period of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point.

What could be the identities of X, Y and Z?

- A aluminium, silicon, phosphorus
- B magnesium, aluminium, silicon
- C silicon, phosphorus, sulfur
- D sodium, magnesium, aluminium

Q# 586/ AS Chemistry/2009/w/TZ 1/Paper 1/Q# 14//www.SmashingScience.org :o)

14 The oxide and chloride of an element X are separately mixed with water. The two resulting solutions have the same effect on litmus.

What is element X?

- A sodium
- B magnesium
- C aluminium
- D phosphorus

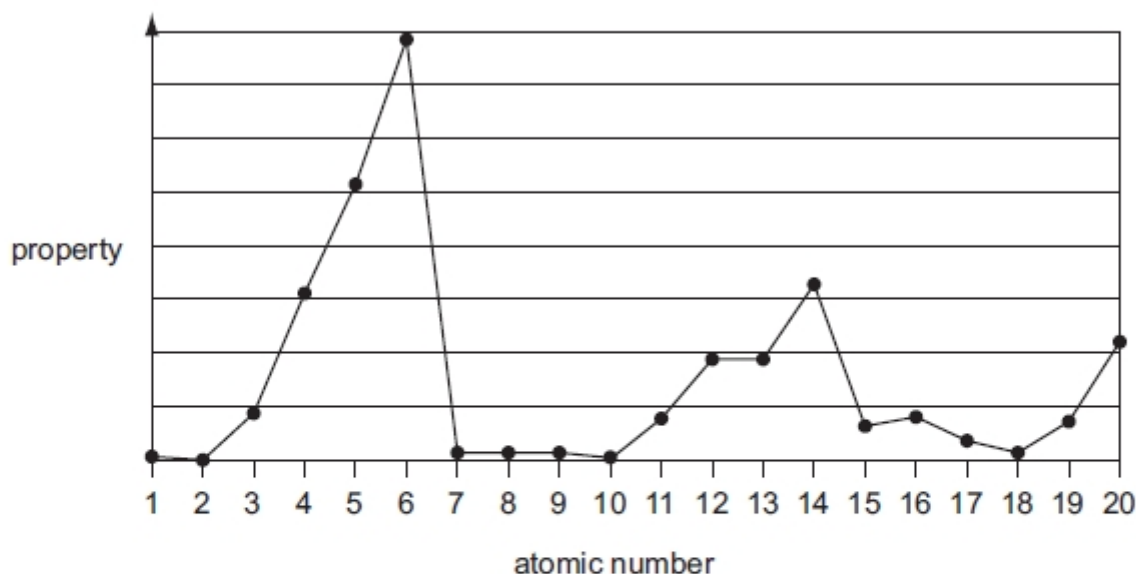
Q# 587/ AS Chemistry/2009/w/TZ 1/Paper 1/Q# 13//www.SmashingScience.org :o)

13 Which statement correctly describes what happens when silicon tetrachloride is added to water?

- A The SiCl_4 dissolves to give a neutral solution only.
- B The SiCl_4 reacts to give an acidic solution only.
- C The SiCl_4 reacts to give a precipitate and an acidic solution.
- D The SiCl_4 reacts to give a precipitate and a neutral solution.



12 The following graph shows the variation of a property of the first 20 elements in the Periodic Table with the atomic number of the element.



What is the property?

- A atomic radius
- B first ionisation energy
- C ionic radius
- D melting point

Mark Scheme ALyI Chem 9 EQ P1 22w to 09s Paper 1 The Periodic Table: chemical periodicity 90marks

Q# 497/ AS Chemistry/2022/w/TZ 1/Paper 1/Q# 25//www.SmashingScience.org :o)

25 | D

Q# 498/ AS Chemistry/2022/w/TZ 1/Paper 1/Q# 19//www.SmashingScience.org :o)

19 | A

Q# 499/ AS Chemistry/2022/w/TZ 1/Paper 1/Q# 18//www.SmashingScience.org :o)

18 | B

Q# 500/ AS Chemistry/2022/w/TZ 1/Paper 1/Q# 17//www.SmashingScience.org :o)

17 | C

Q# 501/ AS Chemistry/2022/s/TZ 1/Paper 1/Q# 6//www.SmashingScience.org :o)

6 | C

Q# 502/ AS Chemistry/2022/s/TZ 1/Paper 1/Q# 23//www.SmashingScience.org :o)

23 | D

Q# 503/ AS Chemistry/2022/s/TZ 1/Paper 1/Q# 19//www.SmashingScience.org :o)

19 | A

Q# 504/ AS Chemistry/2022/s/TZ 1/Paper 1/Q# 18//www.SmashingScience.org :o)

18 | C

Q# 505/ AS Chemistry/2022/m/TZ 2/Paper 1/Q# 19//www.SmashingScience.org :o)

19 | D

Q# 506/ AS Chemistry/2022/m/TZ 2/Paper 1/Q# 18//www.SmashingScience.org :o)

18 | C

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17 | A



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13 | C

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12 | D

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35 | D

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19 | D

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12 | B

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35 | D

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13 | C

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12 | B

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36 | A

Q# 517/ AS Chemistry/2020/w/TZ 1/Paper 1/Q#
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35 | B

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12 | B

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16 | D

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15 | B

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36 | B

Q# 522/ AS Chemistry/2020/m/TZ 2/Paper 1/Q#
31//www.SmashingScience.org :o)

31 | C

Q# 523/ AS Chemistry/2020/m/TZ 2/Paper 1/Q#
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16 | D

Q# 524/ AS Chemistry/2020/m/TZ 2/Paper 1/Q#
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12 | D

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13 | D

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12 | A

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35 | D

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13 | C

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13 | B

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12 | A

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14 | B

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13 | C

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12 | C

Q# 534/ AS Chemistry/2018/s/TZ 1/Paper 1/Q#
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13 | C

Q# 535/ AS Chemistry/2018/s/TZ 1/Paper 1/Q#
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12 | D

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14 | B

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13 | A

Q# 538/ AS Chemistry/2017/w/TZ 1/Paper 1/Q# 13//

13 | A

Q# 539/ AS Chemistry/2017/w/TZ 1/Paper 1/Q# 12//

12 | A

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35 | D



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13 | B

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35 | A

Q# 543/ AS Chemistry/2017/m/TZ 2/Paper 1/Q#
31//www.SmashingScience.org :o)

31 | D

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15 | C

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12 | C

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35 C

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34 A

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13 C

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12 D

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32 B

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16 D

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15//www.SmashingScience.org :o)

15 D

Q# 555/ AS Chemistry/2015/w/TZ 1/Paper 1/Q#
14//www.SmashingScience.org :o)

14 A

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3//www.SmashingScience.org :o)

3 A

Q# 557/ AS Chemistry/2015/s/TZ 1/Paper 1/Q#
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15 C

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14 B

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19//www.SmashingScience.org :o)

19 D

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18//www.SmashingScience.org :o)

18 C

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14 C

Q# 562/ AS Chemistry/2014/w/TZ 1/Paper 1/Q#
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13 D

Q# 563/ AS Chemistry/2014/w/TZ 1/Paper 1/Q#
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12 B

Q# 564/ AS Chemistry/2014/s/TZ 1/Paper 1/Q#
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19 B

Q# 565/ AS Chemistry/2014/s/TZ 1/Paper 1/Q#
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16 C

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15 B

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19 D

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4 A

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34 A

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2 C

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36 B

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19//www.SmashingScience.org :o)

19 A

Q# 573/ AS Chemistry/2012/w/TZ 1/Paper 1/Q#
18//www.SmashingScience.org :o)

18 C



Q# 574/ AS Chemistry/2012/s/TZ 1/Paper 1/Q#
15//www.SmashingScience.org :o)

15 **A**

Q# 575/ AS Chemistry/2011/w/TZ 1/Paper 1/Q#
18//www.SmashingScience.org :o)

18 **C**

Q# 576/ AS Chemistry/2011/w/TZ 1/Paper 1/Q#
1//www.SmashingScience.org :o)

1 **B**

Q# 577/ AS Chemistry/2011/s/TZ 1/Paper 1/Q#
5//www.SmashingScience.org :o)

5 **D**

Q# 578/ AS Chemistry/2011/s/TZ 1/Paper 1/Q#
35//www.SmashingScience.org :o)

35 **A**

Q# 579/ AS Chemistry/2011/s/TZ 1/Paper 1/Q#
34//www.SmashingScience.org :o)

34 **B**

Q# 580/ AS Chemistry/2011/s/TZ 1/Paper 1/Q#
13//www.SmashingScience.org :o)

13 **C**

Q# 581/ AS Chemistry/2010/w/TZ 1/Paper 1/Q#
13//www.SmashingScience.org :o)

13 **A**

Q# 582/ AS Chemistry/2010/s/TZ 1/Paper 1/Q#
2//www.SmashingScience.org :o)

2 **A**

Q# 583/ AS Chemistry/2010/s/TZ 1/Paper 1/Q#
19//www.SmashingScience.org :o)

19 **A**

Q# 584/ AS Chemistry/2010/s/TZ 1/Paper 1/Q#
18//www.SmashingScience.org :o)

18 **D**

Q# 585/ AS Chemistry/2010/s/TZ 1/Paper 1/Q#
16//www.SmashingScience.org :o)

16 **C**

Q# 586/ AS Chemistry/2009/w/TZ 1/Paper 1/Q#
14//www.SmashingScience.org :o)

14 **D**

Q# 587/ AS Chemistry/2009/w/TZ 1/Paper 1/Q#
13//www.SmashingScience.org :o)

13 **C**

Q# 588/ AS Chemistry/2009/w/TZ 1/Paper 1/Q#
12//www.SmashingScience.org :o)

12 **D**

