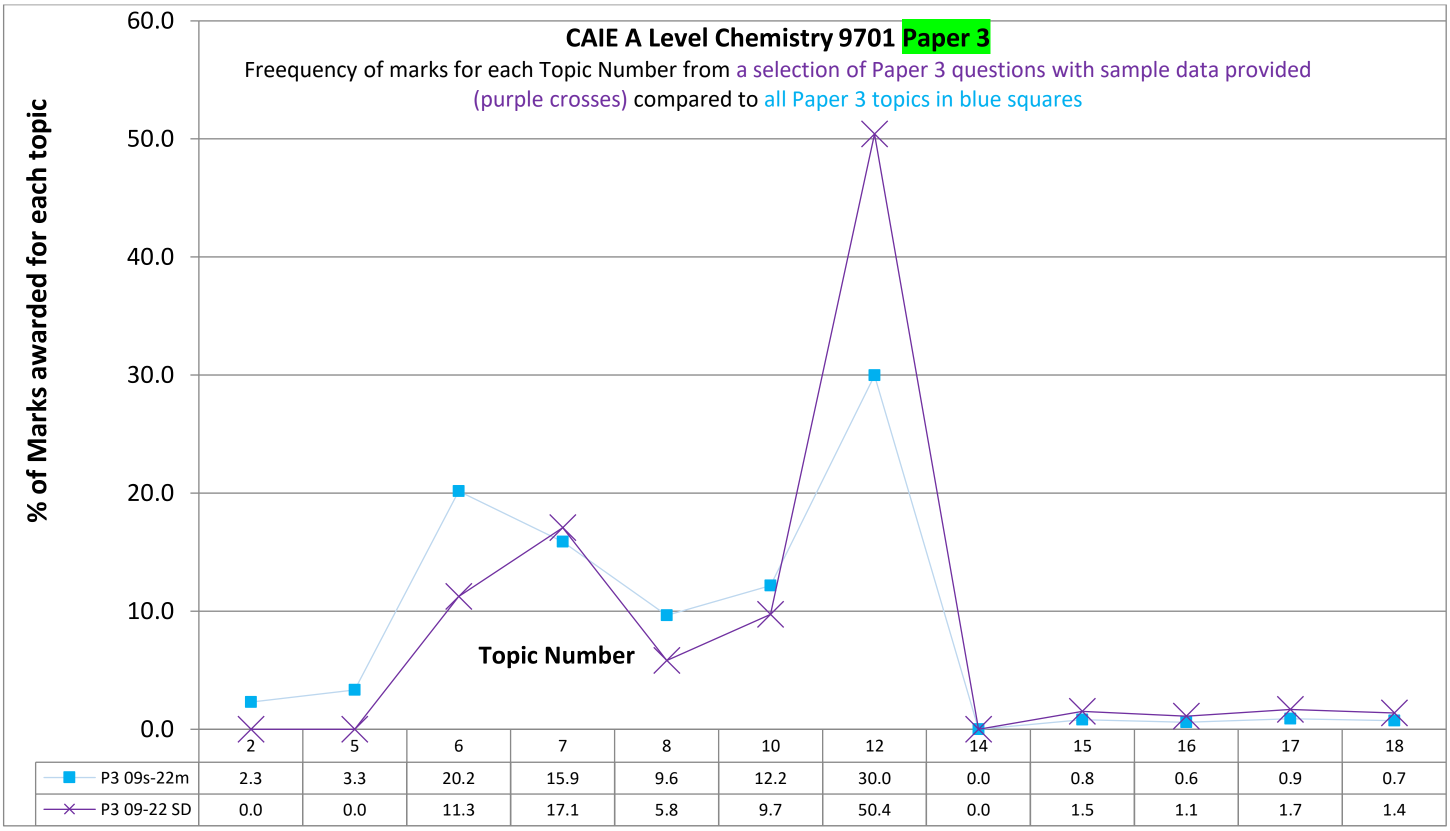
Name: Class: Date:

ALvl Chem 8 EQ P3 22w to 09s Paper 3 SAMPLE DATA Reaction kinetics 42marks

- This **booklet cannot replace lab experience** as the best way to prepare for Paper 3, but it can help with understanding some of the theory aspects.
- This booklet contains 399marks worth of Paper 3 questions with SAMPLE DATA provided which allows you to work on the theory parts of the questions outside of a chemistry lab.
- Not all types of experiment are included (as of May 2024), so **this is only partially complete**. This can be seen best in the graphs comparing experiment types rather than topic numbers.
- It is usually better to revise Paper 3 by looking at specific experiment types, rather than by topic. But these booklets may be helpful when learning each topic for the first time.
- 75 seconds have been budgeted for these theory-based questions (same as Paper 2 questions), which roughly privileges the time allocation to the marks derived directly from practical work. The mean average time per mark is 180 seconds in Paper 3, but there are a lot of different ways that this time allocation could be more carefully worked out.

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.

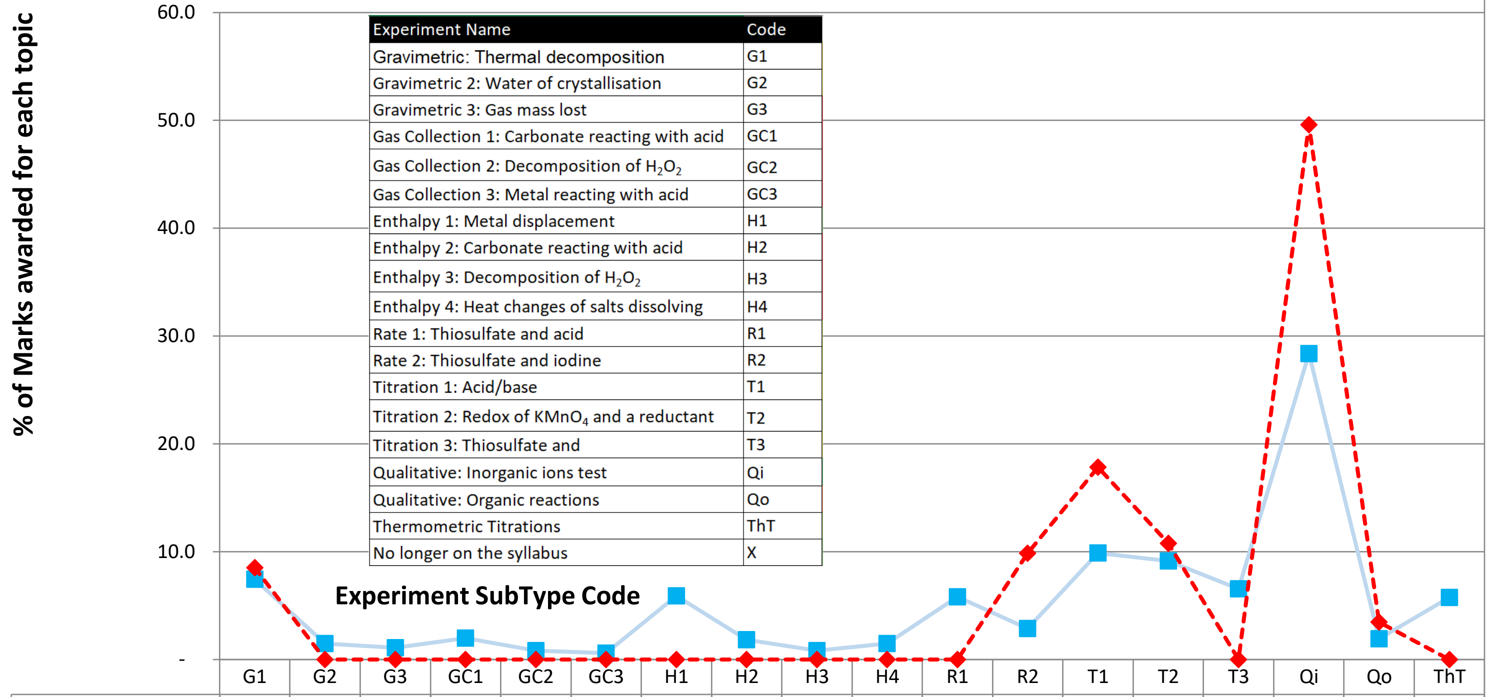
Paper3 Topic 8 **Checklist** Tick each task off as you go along	RANK:	P1 Noob	P1 Novice	P1 Bronze	P1 Silver	P1 Gold	**P1[1] Winner**	**P1 Hero**	**P1 Legend**
		1 Q started	1 Q done	10% of marks	25% of marks	40% of marks	50% of marks	75% of marks	100% of marks
Topic (marks)	42		21	4	11	17	21	32	42
Time @75s/mark (minutes)	53		26	5	13	21	26	39	53



[1] **DO NOT** work on these higher levels of completion in your AS year unless you have also achieved at least a "**Gold**" (40%) in the same topic in both **Paper 1** and **Paper 2**, which is **MOST (77%)** of your **AS grade**

CAIE A Level Chemistry 9701 Paper 3

Freequency of marks for each Experiment SubType from m2022 to m2016 blue squares, compared to SAMPLE DATA Section 1 of this workbook in the red diamonds



Experiment Name	Code
Gravimetric: Thermal decomposition	G1
Gravimetric 2: Water of crystallisation	G2
Gravimetric 3: Gas mass lost	G3
Gas Collection 1: Carbonate reacting with acid	GC1
Gas Collection 2: Decomposition of H_2O_2	GC2
Gas Collection 3: Metal reacting with acid	GC3
Enthalpy 1: Metal displacement	H1
Enthalpy 2: Carbonate reacting with acid	H2
Enthalpy 3: Decomposition of H_2O_2	H3
Enthalpy 4: Heat changes of salts dissolving	H4
Rate 1: Thiosulfate and acid	R1
Rate 2: Thiosulfate and iodine	R2
Titration 1: Acid/base	T1
Titration 2: Redox of $KMnO_4$ and a reductant	T2
Titration 3: Thiosulfate and	T3
Qualitative: Inorganic ions test	Qi
Qualitative: Organic reactions	Qo
Thermometric Titrations	ThT
No longer on the syllabus	X

	G1	G2	G3	GC1	GC2	GC3	H1	H2	H3	H4	R1	R2	T1	T2	T3	Qi	Qo	ThT
P3 09s-22w	7.4	1.5	1.1	2.0	0.8	0.6	5.9	1.8	0.8	1.5	5.8	2.9	9.9	9.1	6.6	28.4	1.9	5.7
SAMPLE Data	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.8	17.8	10.8	0.0	49.6	3.5	0.0

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 10-20 marks, 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.
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.

SAMPLE DATA

	Var	Exp1	Time/s	Exp2	Time/s	Exp3	Time/s	Exp4	Time/s	Exp5	Time/s
2018/m/TZ 3/Q1	TEMP (degrees C)	25 °C	78	55 °C	12	47 °C	20	35 °C	44	30 °C	61
2021/w/TZ 4/Q1	Volume of Sodium thiosulfate	45cm^3	35	20 cm^3	120	25 cm^3	90	30 cm^3	67	35 cm^3	52

Quantitative analysis

Read through the whole method before starting any practical work. Where appropriate, prepare a table for your results in the space provided.

Show your working and appropriate significant figures in the final answer to **each** step of your calculations.

1 The thiosulfate ion, $S_2O_3^{2-}$, is unstable in the presence of acid. The following reaction occurs.

$$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow S(s) + SO_2(aq) + H_2O(l)$$

The rate of this reaction can be measured by timing how long it takes for the solid sulfur that is formed to make the mixture too cloudy to see through.

You will investigate how the concentration of the thiosulfate ions affects the rate of this reaction.

Throughout these experiments care must be taken to avoid inhaling any SO_2 that is produced. It is very important that as soon as each experiment is complete, the contents of the beaker are emptied into the quenching bath and the beaker is rinsed thoroughly.

FB 1 is 0.100 mol dm^{-3} sodium thiosulfate, $Na_2S_2O_3$.
FB 2 is 2.00 mol dm^{-3} hydrochloric acid, HC*l*.
distilled water

(a) Method

Experiment 1

- Label one burette **FB 1** and fill it with **FB 1**.
- Run 45.00 cm^3 of **FB 1** from the burette into the 100 cm^3 beaker.
- Use the 25 cm^3 measuring cylinder to measure 10.0 cm^3 of **FB 2**.
- Add **FB 2** to **FB 1** and start timing **immediately**.
- Stir the mixture once and place the beaker on the printed insert.
- View the print on the insert from above the mixture.
- Stop timing when the print on the insert is no longer visible.
- Record this reaction time to the nearest second.
- Empty the contents of the beaker into the quenching bath.
- Rinse and dry the beaker so it is ready for use in **Experiment 2**.

Experiment 2

- Fill the second burette with distilled water.
- Refill the burette labelled **FB 1** with **FB 1**.
- Run 20.00 cm^3 of **FB 1** into the 100 cm^3 beaker.
- Run 25.00 cm^3 of distilled water into the same beaker.
- Use the 25 cm^3 measuring cylinder to measure 10.0 cm^3 of **FB 2**.
- Add **FB 2** to the beaker and start timing **immediately**.
- Stir the mixture once and place the beaker on the printed insert.
- View the print on the insert from above the mixture.
- Stop timing when the print on the insert is no longer visible.
- Record this reaction time to the nearest second.
- Empty the contents of the beaker into the quenching bath.
- Rinse and dry the beaker so it is ready for use in the next experiment.

Experiments 3–5

- Carry out three further experiments to investigate how the reaction time changes with different volumes of **FB 1**.

The combined volume of **FB 1** and distilled water must always be 45.00 cm^3.
Do not use a volume of **FB 1** that is less than 20.00 cm^3.

Record all your results in a table.
You should include the volume of **FB 1**, the volume of distilled water, the reaction time and the reaction rate for each of your five experiments.
Calculate the rate of reaction using the following formula.

$$\text{rate} = \frac{1000}{\text{reaction time}}$$

I	
II	
III	
IV	
V	
VI	
VII	
VIII	

[8]

(b) On the grid opposite, plot the rate on the *y*-axis against the volume of **FB 1** on the *x*-axis. Identify any anomalous points. Draw a line of best fit.

I	
II	
III	
IV	

[4]

(c) In these experiments, the volume of **FB 1** is related to the concentration of the thiosulfate ions.

Use your graph to suggest the relationship between the rate of reaction and the concentration of the thiosulfate ions.

....

.... [1]

(d) The quenching bath contains an aqueous mixture of sodium carbonate and universal indicator.

(i) How does the quenching bath prevent the further production of SO_2 from the reaction?

....

.... [1]

(ii) Suggest why the mixture contains universal indicator.

....

.... [1]

(e) **(i)** In each experiment the acid is in large excess.

Show, by calculation, that the acid is in large excess in **Experiment 1**.

[2]

(ii) Suggest a reason why the acid used should be in large excess.

....

.... [1]

[Total: 18]

SAMPLE DATA

	Var	Exp1	Time/s	Exp2	Time/s	Exp3	Time/s	Exp4	Time/s	Exp5	Time/s
2018/m/TZ 3/Q1	TEMP (degrees C)	25 °C	78	55 °C	12	47 °C	20	35 °C	44	30 °C	61
2021/w/TZ 4/Q1	Volume of Sodium thiosulfate	45cm^3	35	20 cm^3	120	25 cm^3	90	30 cm^3	67	35 cm^3	52

Quantitative Analysis

Read through the whole method before starting any practical work. Where appropriate, prepare a table for your results in the space provided.

Show your working and appropriate significant figures in the final answer to **each** step of your calculations.

1 You will investigate how increasing temperature affects the rate of a reaction.

Sodium thiosulfate reacts with acid to form a pale yellow precipitate of sulfur.
The ionic equation for the reaction is given.

$$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow S(s) + SO_2(g) + H_2O(l)$$

You will measure the time it takes for the sulfur formed in the reaction to obscure the print on the Insert supplied.

Record your results in a table on page 4. Your table should include the rate of reaction for each experiment.

FA 1 is an 18.1 g dm^{-3} solution of hydrated sodium thiosulfate, $Na_2S_2O_3.5H_2O$.
FA 2 is a 0.050 mol dm^{-3} solution of a strong monoprotic acid, H**Z**.

(a) Method

- Approximately half fill the 250 cm^3 beaker with tap water and place it on the tripod and gauze over the Bunsen burner.
- Heat the water in the beaker to about 55 °C and then switch off the Bunsen burner. This will be your hot water bath.
- Use the 25 cm^3 measuring cylinder to transfer 10 cm^3 of **FA 1** into boiling tube **1**. Place boiling tube **1** into your hot water bath.
- Use the 50 cm^3 measuring cylinder to transfer 20 cm^3 of **FA 2** into boiling tube **2**. Place boiling tube **2** into your hot water bath.
- Leave boiling tubes **1** and **2** in the hot water bath to heat up for use in **Experiment 2**.
- Start **Experiment 1**.

Experiment 1

- Use the 50 cm^3 measuring cylinder to transfer 20 cm^3 of **FA 2** into the 100 cm^3 beaker.
- Measure and record the temperature of **FA 2**.
- Use the 25 cm^3 measuring cylinder to transfer 10 cm^3 of **FA 1** into the same beaker and start timing **immediately**.
- Swirl the beaker once to mix the solutions and place the beaker on the Insert.
- Look down through the beaker and contents onto the Insert.
- Stop timing as soon as the precipitate of sulfur obscures the print on the Insert.
- Record the reaction time to the nearest second.
- Empty the contents of the beaker into the quenching bath.
- Rinse and dry the beaker so it is ready for use in **Experiment 2**.

Experiment 2

- Measure and record the temperature of **FA 2** in boiling tube **2**.
- Carefully transfer the hot contents of boiling tube **2** into the 100 cm^3 beaker.
- Carefully transfer the hot contents of boiling tube **1** into the same beaker and start timing **immediately**.
- Swirl the beaker once to mix the solutions and place the beaker on the Insert.
- Look down through the beaker and contents onto the Insert.
- Stop timing as soon as the precipitate of sulfur obscures the print on the Insert.
- Record the reaction time to the nearest second.
- Empty the contents of the beaker into the quenching bath.
- Rinse and dry the beaker so it is ready for use in **Experiment 3**.

Experiment 3

- Use the 25 cm^3 measuring cylinder to transfer 10 cm^3 of **FA 1** into boiling tube **1**. Place boiling tube **1** into your hot water bath.
- Use the 50 cm^3 measuring cylinder to transfer 20 cm^3 of **FA 2** into boiling tube **2**. Place boiling tube **2** into your hot water bath.
- Place the thermometer in boiling tube **2**. When the temperature of **FA 2** is about 8 °C lower than that for **Experiment 2** record the temperature. Remove the thermometer and transfer the contents of boiling tube **2** into the 100 cm^3 beaker.
- Transfer the contents of boiling tube **1** into the same beaker and start timing **immediately**.
- Swirl the beaker once to mix the solutions and place the beaker on the Insert.
- Look down through the beaker and contents onto the Insert.
- Stop timing as soon as the precipitate of sulfur obscures the print on the Insert.
- Record the reaction time to the nearest second.
- Empty the contents of the beaker into the quenching bath.
- Rinse and dry the beaker so it is ready for use in **Experiments 4 and 5**.

Experiments 4 and 5

- Repeat the method for **Experiment 3** but at **two** different temperatures.
- Keep the temperature of **FA 2** between room temperature and 55 °C. Do **not** exceed 55 °C.

Record all your results in your table on page 4.

Results

The rate of reaction can be calculated as shown.

$$\text{rate} = \frac{1000}{\text{reaction time}}$$

Calculate the rate of reaction for each of your **five** experiments. Record these rates in your table.

I	
II	
III	
IV	
V	
VI	
VII	
VIII	

[8]

(b) On the grid plot a graph of rate of reaction on the *y*-axis, starting at zero, against temperature on the *x*-axis. Select a scale for the *x*-axis which includes a temperature of 15.0 °C. Label your axes and any points you consider anomalous.

Draw a line of best fit and extrapolate it to 15.0 °C.

I	
II	
III	
IV	

[4]

(c) **Use your graph** to calculate the **time** to the nearest second that the reaction would have taken if you had carried it out at 17.5 °C. Show **on the grid** how you obtained your answer.

time = ... s [2]

(d) Explain, by referring to your graph or your table of results, how the rate of reaction is affected by increasing temperature.

....

....

.... [2]

(e) **Calculations**

(i) Calculate the concentration of hydrated sodium thiosulfate, $Na_2S_2O_3.5H_2O$, in **FA 1** in $mol\,dm^{-3}$.

concentration of $Na_2S_2O_3.5H_2O$ in **FA 1** = ... $mol\,dm^{-3}$ [1]

(ii) Calculate the concentration of the strong monoprotic acid, H**Z**, in the solution immediately **after FA 1** was added to **FA 2** in the beaker.

concentration of H**Z** = ... $mol\,dm^{-3}$ [1]

(iii) Use the equation on page 2 to determine which reagent, **FA 1** or **FA 2**, was in excess.

The reagent in excess was .... [2]

(f) **(i)** Calculate the maximum percentage error in measuring the reaction time you recorded for **Experiment 2**. Assume that the maximum error of the timer is ±0.5 s.

maximum percentage error in the reaction time = ... % [1]

(ii) A student suggested that the error in measuring the reaction time in **Experiment 1** was greater than for **Experiment 2**.

Give **one** reason why the student could be correct.

....

.... [1]

(g) Suggest **two** ways to improve the accuracy of the results of these experiments.

1 ....

....

2 ....

....

[2]

[Total: 24]

Q# 16/ AS Chemistry/2021/w/TZ 4/Paper 3/ :o) www.SmashingScience.com

1(a)(i)	**I** Constructs a single 4 × 5 table for results for 5 experiments **AND** at least one experiment attempted	1
	II Correct headings and units for data given. • volume of **FB1 and** in cm^3 or / cm^3 or (cm^3) • volume of water and in cm^3 or / cm^3 or (cm^3) • time and in seconds or / s or (s) • rate and / s^{-1} or (s^{-1})	1
	III All times recorded to the nearest second **AND** all volumes given to nearest 0.05	1
	IV 3 additional volumes chosen with intervals not less than 5.00 cm^3 **AND** all additional volumes of **FB 1** $\ngtr$ 25.00 cm^3 **AND** In all 3 additional experiments water is added to make a total of 45.00 cm^3	1
	V All rates correctly calculated using 1000 / time **AND** all recorded to the same number of dp or same number of sf.	1
	VI All five times increase with decreasing volume of **FB 1**	1
	VII & VIII Compare ratio of time for 20.00 cm^3 of **FB 1** / time for 45.00 cm^3 of **FB 1** to 2 dp. Award **VII** for ratio 2.10 – 2.60 Award **VIII** for ratio 2.20 – 2.50	2
1(b)	**I** Rate on y axis and volume of **FB 1** on the *x* axis With correct labels and units. Do not penalise missing / incorrect unit if penalised in **1(a) II** (ecf)	1
	II Linear scales chosen so that the graph occupies more than half the available length for both axes (7 × 5 big squares)	1
	III All points recorded plotted correctly to within half a small square and in the correct square or on the line if it should be on the line and not on the line if it shouldn't.	1
	IV Draws a line of best fit. This can be a straight line or smooth curve.	1
1(c)	Rate is proportional to concentration of thiosulfate	1
1(d)(i)	(Carbonate/ quenching bath) removes H^+ / neutralises acidic solution (so reaction stops).	1
1(d)(ii)	To know when all the carbonate has been neutralised / no more carbonate (solution) remains / more carbonate needs to be added OR mixture becomes acidic / pH drops below 7 / pH is no longer $\geqslant$ 7	1
1(e)(i)	M1: moles of H^+ = 2(.00) × 10^{-2} **AND** moles of $S_2O_3^{2-}$ = 4.5(0) × 10^{-3} M2: 2(.00) x 10^{-2} > **2** × 4.5(0) × 10^{-3} / 9(.0) × 10^{-3} Other valid methods exist (e.g., comparison of volume of acid required to react and volume used).	2
1(e)(ii)	So acid concentration remains (almost) constant throughout the experiment OR only the conc of thiosulfate affects the rate.	1

1(a)	I Single table to show temperature of FA 2/reactant(s), time and rate for 5 experiments. (*not all experiments need have been done – minimum 2*)	1
	II Headings unambiguous and units correct – displays: (°C), / s, in s^{-1} (*ignore factor of 1000 in rate unit*)	1
	III All temperatures recorded to .0 or .5, all times as integers. (*minimum 4 experiments carried out*)	1
	IV Selects temperatures in experiments 4 and 5 that are ⩾ 4 °C apart from all others and none above 60 °C. (*Paper states 55 °C but T for Expt 2 may be slightly higher.*)	1
	V Rates correctly calculated to 2–4 sf (*minimum 3 results*)	1
	Award VI if candidate for expt 1 is within 10% of supervisor (*If expts have been renumbered by candidate then compare time for the expt carried out at the lowest temperature.*)	1
	Award VII if **all** times decrease with increasing temperature.	1
	Award VIII if all results give an increasing gradient graph (*Allow if 4 out of the 5 points show an increasing gradient line.*) (*Do not award if no graph drawn or fewer than 5 points plotted.*)	1
1(b)	I Axes labelled (*name or unit*) and linear scales chosen so graph occupies more than half the available length for both axes including 15 °C on *x*-axis and 0 on *y*-axis.	1
	II **All** points recorded (*minimum 4 recorded*) accurately plotted *Any point which should be on a line must be on that line.* *Any point not on a line must be in the correct part of the small square.* *If blobs shown then they must be correctly centred and be less than ½ a small square across.*	1
	III Line of best fit drawn (*smooth curve expected but allow suitable straight line*) *Ignore any obviously anomalous points.*	1
	IV Anomalous points indicated and line extrapolated to 15 °C If no points anomalous then smooth line very close to all points	1
1(c)	Both construction lines at 17.5 °C shown *Allow other clear indication linking 17.5 °C with rate*	1
	Correctly calculates time from rate reading (*ignore sf*) Rate must be correctly read from the graph (to within 0.5 s^{-1} of examiner value) If no construction lines are drawn examiner infers rate and checks rate and time given by candidate. *If construction lines / 'point' drawn in wrong place then allow as ecf (i.e. wrong temp selected)*	1
1(d)	Rate of reaction increases with / is proportional to increase in temperature because it / **graph line** curves upwards / has a positive gradient or **figures** from table. Directly proportional is CON	1
	Rate of rate of reaction increases because gradient increases with temperature / rate of reaction increases more / at a greater rate than increase in temperature as gradient increases (or from relevant figures from graph or results table)	1
1(e)(i)	Correctly calculates initial concentration of thio to 2–4 sf. (*Penalise incorrect sf only once in this section.*) $^{18.1}/_{248.2}$ = 0.073 / 0.0729 / 0.07293 mol dm^{-3}	1
1(e)(ii)	Correctly calculates concentration of acid in the mixture to 2–4 sf 0.05 □ $^{2}/_{3}$ = 0.033(3) mol dm^{-3}	1
1(e)(iii)	Shows working to compare concentration of thio in mixture with **(ii)** or moles of thio and of acid in mixture [conc of thio in mixture = 0.073 □ $^{1}/_{3}$ = 0.024(31) mol dm^{-3}] or [moles of thio (in 10 cm^3) = (7.3 / 7.29 / 7.293) □ 10^{-4} mol and moles of acid (in 20 cm^3) = 1(.000) □ 10^{-3} mol]	1
	Comparison using equation moles thio : acid = 1 : 2 ($^{thio}/_{acid}$ = 0.5) and thio / **FA 1** in excess [concentration of $^{thio}/_{acid}$ in mixture = $^{0.024}/_{0.033}$ > 0.5 This may be shown as thio : acid = 0.0243 > 0.0167 or 0.0486 > 0.033] or [moles of $^{thio}/_{acid}$ in mixture = $^{0.00073}/_{0.001}$ > 0.5 This may be shown as thio : acid = 0.00146 > 0.001] *Allow ecf from **(ii)*** (7.29 □ 10^{-2} □ $^{2}/_{3}$ > 3.33 □ 10^{-2} and **FA 1** / thio in excess gains both marks)	1
1(f)(i)	Correct working shown or correct answer to minimum 2 sf ($^{0.5}/$ $_{time\ for\ expt\ 2}$) □ 100 *If '□ 100' not in working allow if answer shows its use.* *(t_2 must match the time recorded for the expt labelled 2 in the results table)*	1
1(f)(ii)	It is more difficult to distinguish exactly when the printing disappears at the lower temperature (in expt 1) *ora*	1

1(g)	One of Take the temperature on initial mixing and the temperature as soon as the printed sheet is obscured (and calculate a mean T). Take the temperature of **FA 1** / both solutions (and calculate (weighted) mean) Use a thermostatically controlled water bath (to prevent temperature fluctuations)	1
	One of Use (graduated) pipette / burette / measuring cylinders calibrated to greater precision / smaller percentage error to measure volumes. Use (graduated) pipette / burette to measure **FA 1** / thio and **FA 2** / acid / (volumes of) solutions / reactants (instead of the measuring cylinders) Use light sensor/colorimeter (to avoid subjective judgement of turbidity) *(Do not allow use a more accurate thermometer)*	1

Apparatus

1 In addition to the fittings ordinarily contained in a chemical laboratory, the apparatus and materials specified below will be necessary.

2 Pipette fillers (or equivalent safety devices), suitable eye protection and disposable gloves should be used where necessary.

3 *For each candidate*

1 x 25 cm^3 measuring cylinder
1 x 50 cm^3 measuring cylinder
1 x 250 cm^3 beaker
1 x 100 cm^3 beaker (beakers for all candidates and the Supervisor **must** be the same)
1 x thermometer (–10 °C to +110 °C at 1 °C graduations)
1 x boiling tube labelled **1**
1 x boiling tube labelled **2**
1 x stop-watch (timer)
8 x test-tube*
2 x boiling tube*
1 x test-tube rack
1 x test-tube holder
2 x teat/dropping pipette
1 x spatula
1 x Bunsen burner
1 x tripod
1 x gauze
1 x heatproof mat
1 x wash bottle containing distilled water
1 x pen (for labelling glassware)
paper towels

*Candidates are expected to rinse and reuse test-tubes and boiling tubes where possible. Additional tubes should be available.

4 *Per five candidates*

A bucket labelled **Quenching bath** must be provided.

The bucket must contain 1 dm^3 of 5% sodium carbonate solution (made up by dissolving 50 g of Na_2CO_3 or 135 g of $Na_2CO_3.10H_2O$ in 1 dm^3 of water) and Universal Indicator.

The Supervisor must monitor the colour of the Universal Indicator in each quenching bath to check that the solution has **not** become acidic. If the solution becomes acidic, the Supervisor must add more 5% sodium carbonate solution to the quenching bath.

9701/33/CI/F/M/18

Chemicals required

1 It is ***especially important*** that great care is taken that the confidential information given below does **not** reach the candidates either directly or indirectly.

2 It should be noted that descriptions of substances given in the Question Paper may **not** correspond with the specifications in these Confidential Instructions.

3 Particular requirements

hazard	label	per candidate	identity	notes (hazards given in this column are for the raw materials)
	FA 1	75 cm^3	0.20 mol dm^{-3} sodium thiosulfate	Dissolve 49.6 g $Na_2S_2O_3.5H_2O$ in each dm^3 of solution.
	FA 2	150 cm^3	0.05 mol dm^{-3} nitric acid	Dilute 25.0 cm^3 of 2.0 mol dm^{-3} HNO_3 **[C]** to 1 dm^3.
[C]	**FA 3**	15 cm^3	2.0 mol dm^{-3} nitric acid	See preparation instructions on page 56 of the current syllabus.
[MH]	**FA 4**	1 g	barium carbonate	Provide approximately 1 g $BaCO_3$ **[MH]** in a stoppered container.
	FA 5	10 cm^3	1.0 mol dm^{-3} magnesium sulfate	Dissolve 246.4 g $MgSO_4.7H_2O$ in each dm^3 of solution.

NOTE: Small amounts of SO_2 **[C]** **[T]**, which can cause respiratory distress in some people, may be produced. **The laboratory must be well ventilated.**