



NATIONAL JUNIOR COLLEGE
SH 2 Prelim Practical Examination
Higher 2

CANDIDATE
NAME

--

SUBJECT
CLASS

--

REGISTRATION
NUMBER

--

CHEMISTRY

9476/04

Paper 4 Practical

Monday 1 September 2026

You must answer on the question paper.

2 hours 30 minutes

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your identification number and name.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen. Do **not** use correction fluid or tape.
- You may use an approved calculator.
- Qualitative analysis notes are printed in the question paper.
- Write the details of the shift and laboratory in the boxes provided.

INFORMATION

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [].

Shift
Laboratory

For Examiner's use	
1	/ 7
2	/ 8
3	/ 10
4	/ 17
5	/ 8
Total	/ 50

This paper consists of **20** pages. Any blank pages are indicated.

1 Inorganic Qualitative Analysis

FA 1 is a solution which contains two cations and two anions.

Perform the tests described in Table 1.1 and record your observations in the table.
Test and identify any gases evolved.

Table 1.1

	tests	observations
(a)	(i) To a 2 cm depth of FA 1 solution in a test tube, add aqueous sodium hydroxide, slowly with shaking, until 4 cm depth of aqueous sodium hydroxide is added. Gently warm the mixture. Then filter the mixture, collecting the filtrate in a clean test-tube. Leave to stand for several minutes. Keep the filtrate for test (ii) and (iii).	<u>FA 1 is yellow in colour</u> <u>Green ppt insoluble in excess NaOH.</u> (✓) <u>(colourless and pungent) gas turns damp red litmus paper blue.</u> (✓) gas is <u>NH₃</u> (✓) [If no gas, must write "moist litmus paper remain red"] <u>green residue</u> (✓) which turns <u>red-brown on contact with air/ on standing</u> (✓) and <u>colourless/ pale yellow filtrate</u> (✓)
	(ii) To a 1 cm depth of the filtrate from test (i) in a test-tube, add barium nitrate dropwise. Then add dilute hydrochloric acid until there is no further change.	<u>White ppt.</u> (✓) <u>ppt. insoluble in excess dilute hydrochloric acid.</u> (✓) [If no ppt, must write "no ppt"]
	(iii) To a 1 cm depth of the filtrate from test (i) in a test-tube, add 1 cm depth of aqueous silver nitrate. Add aqueous ammonia to the mixture, with shaking until there is no further change.	<u>White ppt.</u> (✓) <u>ppt. soluble in excess NH₃(aq).</u> (✓) [If no ppt, must write "no ppt"]

- (b) By considering the observations made in Table 1.1 and making reference to the *Qualitative Analysis Notes*, identify the cations and the anions present in **FA 1**.

The cations in **FA 1** are Fe^{2+} and NH_4^+

½ m for each correct answer

The anions in **FA 1** are SO_4^{2-} and Cl^-

[2]

[Total: 7]

2 Organic Qualitative Analysis

In this question, you will deduce the structure of an organic compound, **FA 2**. The molecular formula of **FA 2** is $\text{C}_5\text{H}_{10}\text{O}_2$.

Perform the tests described in Table 2.1, and record your observations in the table. Test and identify any gases evolved. Some observations have been recorded.

Some observations have been recorded in part (b).

Do not use Bunsen burner for heating. Use the hot water provided.

Table 2.1

	tests	observations
(a)	(i) Place about 2 cm depth of aqueous sulfuric acid in a test-tube. To this test-tube, add 10 drops of FA 2 , followed by 1 drop of aqueous potassium manganate(VII). Warm the mixture in the hot water bath for two minutes.	<u>Purple KMnO_4 turns colorless.</u>
	(ii) Place about 2 cm depth of aqueous silver nitrate in a test-tube. To this test-tube, add 10 drops of aqueous sodium hydroxide, followed by aqueous ammonia until a clear solution is formed. To this test-tube, add 10 drops of FA 2 . Warm the mixture in the water bath for two minutes.	<u>Brown ppt. dissolves in $\text{NH}_3(\text{aq})$ to give a colourless solution.</u> Not a marking point <u>No silver mirror/ absence of grey ppt</u>
	(iii) Place about 1 cm depth of deionised water in a test-tube. To this test-tube, add 10 drops of FA 2 and add 15 drops of aqueous sodium hydroxide. Now add iodine solution dropwise, until a permanent orange colour is obtained.	<u>Pale yellow ppt. formed.</u>

	Warm the mixture in the water bath for two minutes.	
--	---	--

[3]

- (b) (i) When sodium metal and 2,4-dinitrophenylhydrazine are added to separate samples of **FA 2**, effervescence *extinguishes a lighted splint with a “pop” sound* and an *orange precipitate is observed respectively*.

Use this information and the observations recorded in table 2.1, identify **two** functional groups present in **FA 2**.

Give evidence(s) to support your conclusion.

Functional group: ketone

Evidence: It undergoes condensation with 2,4-dinitrophenylhydrazine / It gives an orange ppt with 2,4-dinitrophenylhydrazine.

AND

It is not oxidised by Tollens' reagent / no silver mirror in test (ii).

[2]

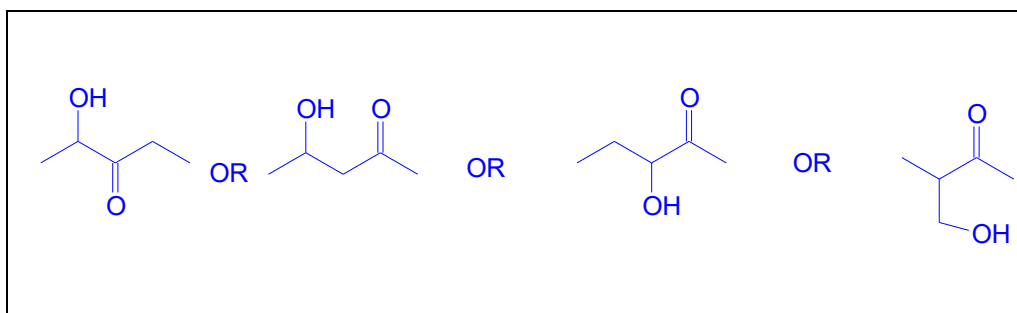
Functional group: 1° or 2° alcohol (award one for either)

Evidence: It is oxidised by purple KMnO_4 / purple KMnO_4 is decolorised in test (i)

It undergoes a redox reaction with Na / it gives H_2 gas with Na.

[2]

- (ii) Suggest a structure of **FA 2** given that it contains a chiral centre.

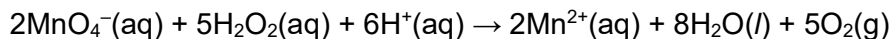


[1]

[Total: 8]

3 Determination of the volume strength of hydrogen peroxide

The concentrations of solutions of hydrogen peroxide are often represented in terms of 'volume strength'. In this experiment you will determine the 'volume strength' of a solution of hydrogen peroxide by titration with acidified potassium manganate(VII).



FA 3 is $0.0300 \text{ mol dm}^{-3}$ potassium manganate(VII), KMnO_4 .

FA 4 is aqueous hydrogen peroxide, H_2O_2 .

FA 5 is 1.0 mol dm^{-3} sulfuric acid, H_2SO_4 .

(a) (i) Dilution of FA 4

- Pipette 25.0 cm^3 of **FA 4** into the 250 cm^3 volumetric flask.
- Make the solution up to the mark using deionised water.
- Label this solution of hydrogen peroxide **FA 6**. This is a solution of hydrogen peroxide suitable for titration.

Keep **FA 5** and **FA 6** for use in Question 4.

Titration of FA 6 against FA 3

1. Fill the burette with **FA 3**.
2. Pipette 25.0 cm^3 of **FA 6** into a conical flask.
3. Use the 50 cm^3 measuring cylinder to add 20.0 cm^3 of **FA 5** into the same conical flask.
4. Run **FA 3** from the burette into the flask. The end-point is reached when the first permanent pink is observed.
5. Record your titration results, to an appropriate level of precision, in the space provided below.
6. Discard the reaction mixture.
7. Repeat steps 2 to 6 until consistent results are obtained.

Titration results

Initial burette reading/ cm^3	1.00	40.70
Final burette reading/ cm^3	21.70	20.00
Volume of FA 3 used/ cm^3	20.70	20.70

1m for correct header and units and data recorded to correct precision

1m for initial burette reading < final burette reading and correct calculation of consistent titre values.

2m for accuracy: within $\pm 0.20 \text{ cm}^3 = 2\text{m}$

within $\pm 0.40 \text{ cm}^3 = 1\text{m}$

[4]

- (ii) From your titrations, obtain a suitable volume of **FA 3** to be used in your calculations.
Show clearly how you obtained this value.

$$\begin{aligned}\text{volume of FA 3 used} &= \frac{1}{2} (20.70 + 20.70) \\ &= \underline{20.70 \text{ cm}^3}\end{aligned}$$

Volume of **FA 3** = [1]

- (b) (i) Calculate the concentration of H_2O_2 in **FA 6**.

$\begin{aligned}\text{No. of moles of KMnO}_4 &= \frac{20.70}{1000} \times 0.0300 \\ &= \underline{6.21 \times 10^{-4} \text{ mol}}\end{aligned}$	$[\text{H}_2\text{O}_2] = \frac{\text{titre}}{1000} \times 0.03 \times \frac{5}{2}$
$\begin{aligned}\text{No. of moles of H}_2\text{O}_2 &= \frac{5}{2} \times 6.21 \times 10^{-4} \\ &= \underline{1.55 \times 10^{-3} \text{ mol}}\end{aligned}$	
$\begin{aligned}\text{Concentration of H}_2\text{O}_2 \text{ in FA 6} &= 1.55 \times 10^{-3} / 0.025 \\ &= \underline{0.0621 \text{ mol dm}^{-3}}\end{aligned}$	

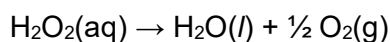
Concentration of H_2O_2 in **FA 6** = [3]

- (ii) Calculate the concentration of H_2O_2 in **FA 4**, in mol dm^{-3} .

$\begin{aligned}\text{Concentration of H}_2\text{O}_2 \text{ in FA 4} &= 0.0659 \times \frac{250}{25} \\ &= \underline{0.621 \text{ mol dm}^{-3}}\end{aligned}$	$[\text{H}_2\text{O}_2]_{(i)} \times 10$
---	--

concentration of H_2O_2 in **FA 4** = mol dm^{-3} [1]

- (iii) When hydrogen peroxide decomposes in the presence of a catalyst, oxygen is produced.



Calculate the volume, in dm^3 , of oxygen produced when 1.00 dm^3 of **FA 4** decomposes. This is the 'volume strength', in vol, of **FA 4**.

(Under room conditions, 1.00 mol of gas occupies a volume of 24.0 dm^3 .)

			Volume of O₂ = 0.621 x ½ x 24 = 7.452 • Volume strength = <u>7.45</u> $[\text{H}_2\text{O}_2]_{(\text{ii})} \times \frac{1}{2} \times 24$ ‘volume strength’ of FA 4 = vol [1]
--	--	--	--

			[Total: 10]
--	--	--	-------------

4 Investigating the kinetics of the reaction between hydrogen peroxide and iodide ions

FA 5 is 1.0 mol dm⁻³ sulfuric acid, H₂SO₄.

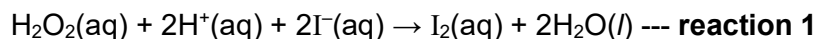
FA 6 is dilute aqueous hydrogen peroxide, H₂O₂, prepared in **Question 3**.

FA 7 is 0.50 mol dm⁻³ potassium iodide, KI.

FA 8 is 0.025 mol dm⁻³ sodium thiosulfate, Na₂S₂O₃.

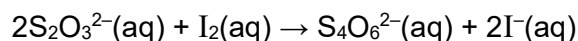
starch indicator

Hydrogen peroxide reacts with iodide ions, I⁻(aq) in acidified medium according to the equation shown.



In this experiment, the rate of reaction is studied by measuring the rate of formation of iodine using a 'clock' method. You will vary the concentration of hydrogen peroxide and measure the time taken for a fixed amount of iodine to be produced. This will be indicated by the formation of a blue-black/ purple color in the presence of starch.

Introducing a small limited amount of sodium thiosulfate reduces the iodine produced back to iodide ions. As a result, the blue-black/ purple colour does not appear immediately.



The end-point of the reaction, characterised by the first appearance of the dark blue starch-iodine complex, is observed when the sodium thiosulfate is fully reacted.

You will conduct a series of five experiments.

For each experiment you will need to ensure that the same total volume of reaction mixture is used, by adding deionised water as required.

For each experiment, you will measure the time, *t*, for the blue-black/ purple colour to appear

(a) Prepare a table in the space provided on page 8 in which to record, to an appropriate degree of precision:

- the volume of **FA 5, FA 6, FA 7, FA 8 and starch** added and deionised water (*V*_{water}) used
- all values of *t* to nearest seconds
- calculated values of $1/t$
- calculated values of $\lg (1/t)$
- calculated values of $\lg (V_{\text{FA 6}})$.

Experiment 1

- Use the same 10 cm³ measuring cylinder to transfer the following volumes into a 100 cm³ conical flask.
 - 10.0 cm³ of **FA 5 H⁺**
 - 10.0 cm³ of **FA 7 KI**
 - 1.0 cm³ of starch indicator
- Use another 10 cm³ measuring cylinder to transfer 10.0 cm³ of **FA 8** thiosulfate into the same 100 cm³ conical flask.
- Use a 25 cm³ measuring cylinder to measure 25.0 cm³ of **FA 6**.
- Add the **FA 6** to the same conical flask, starting the stopwatch during this addition.
- Mix the content thoroughly by swirling the flask several times. Then place the flask on a white tile.
- Stop the stopwatch at the first appearance of a blue-black/ purple colour.
- Record the time taken, to the nearest second, in your table.

Experiment 2 to 5

Repeat experiment 1 four times, adding 20.0 cm³, 17.0 cm³, 13.0 cm³, 10.0 cm³ of **FA 6** respectively in step 3.

In each experiment, you should add appropriate volumes of deionised water in step 3 to ensure the **same total volume** of the reaction mixture is used.

You should alternate the use of the two 100cm³ conical flasks.

Record all volumes, the time taken and the calculated values of $1/t$, $\lg(1/t)$ and $\lg(V_{FA\ 6})$ in your table.

Results

Expt	$V_{FA\ 5}/\text{cm}^3$	$V_{FA\ 7}/\text{cm}^3$	$V_{FA\ 8}/\text{cm}^3$	starch/ cm ³	$V_{FA\ 6}/\text{cm}^3$	Volume of water/ cm ³	t/ s	$1/t/\text{s}^{-1}$	$\lg(1/t)$	$\lg(V_{FA\ 6})$
1	10.0	10.0	10.0	1.0	25.0	0.0	29	0.0345	-1.46	1.40
2	10.0	10.0	10.0	1.0	20.0	5.0	38	0.0263	-1.58	1.30
3	10.0	10.0	10.0	1.0	17.0	8.0	49	0.0204	-1.69	1.23
4	10.0	10.0	10.0	1.0	13.0	12.0	70	0.0143	-1.85	1.11
5	10.0	10.0	10.0	1.0	10.0	15.0	80	0.0125	-1.90	1.00

correct volume of deionised water added

data recorded with correct precision

correct calculation of $1/t$

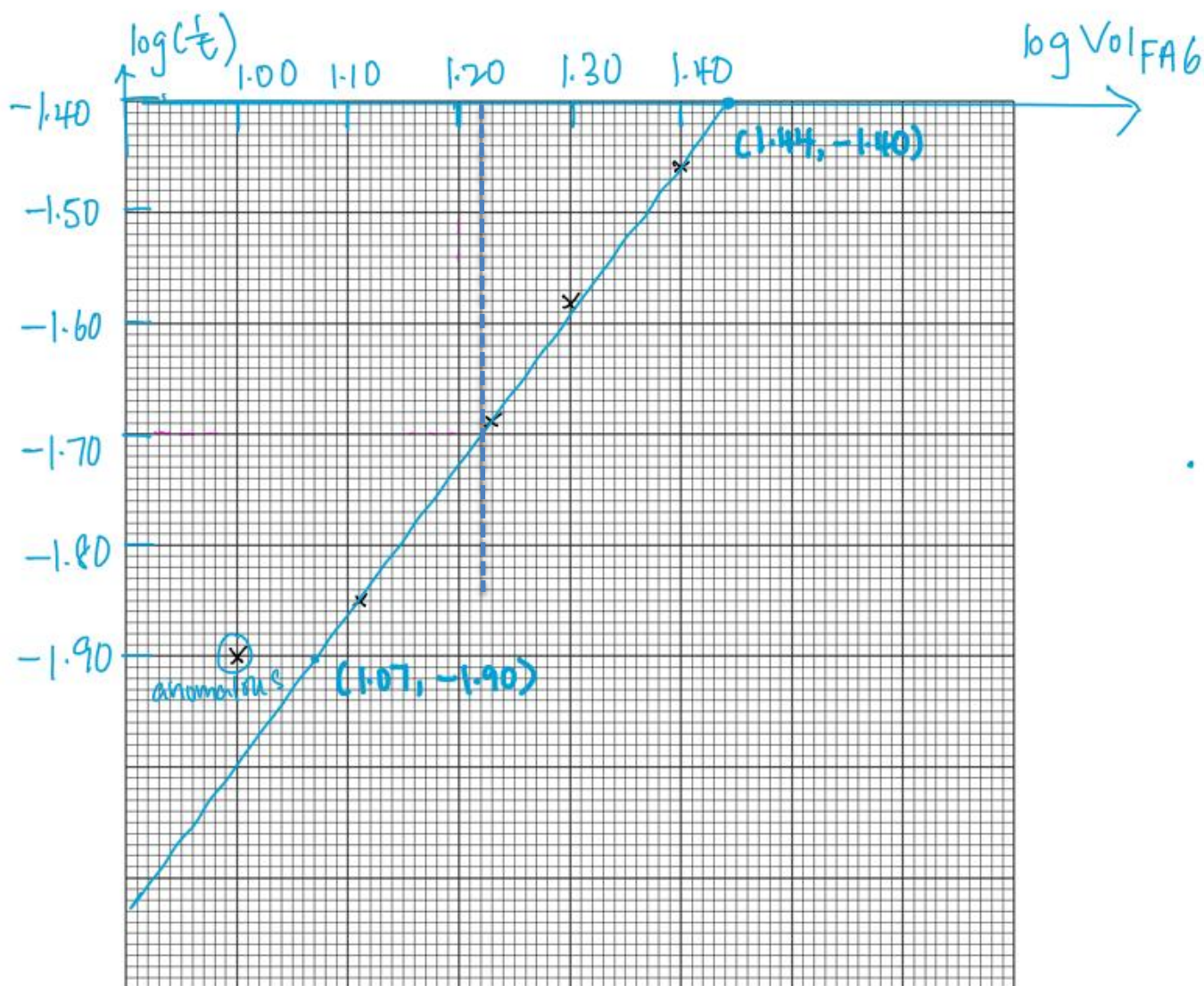
correct calculations of $\lg$ values

correct header and units

} 3sf for processed data

[5]

- (b) (i) Plot a graph of $\lg(1/t)$ on the y axis against $\lg(V_{FA6})$ on the x-axis on the grid in Fig.4.1. Draw a best-fit straight line.



correct scale (graph should cover at least half of the graph space)

correct plot

best-fit straight line

Fig.4.1

[3]

		(ii)	Calculate the gradient of the line to three significant figures, showing your working clearly.
			$\text{Gradient} = \frac{-1.40 + 1.90}{1.44 - 1.07} = 1.35 \text{ (3 s.f)}$
			showing coordinates/ construction lines calculation Gradient:[1]

		(iii)	The gradient of the line gives the order of the reaction with respect to hydrogen peroxide. Using your answer in (ii), calculate the percentage error given that the order with respect to H_2O_2 is one. $\left \frac{1.3514-1}{1} \times 100 \right = 35.1\% \quad (3 \text{ s.f.})$ Percentage error =[1]
		(iv)	Use your graph to determine the time, t, for the experiment if 16.50 cm^3 of FA 6 is added.
			$\lg V_{\text{FA 6}} = \lg 16.50 = 1.22$ From graph, $\lg (1/t) = -1.70$ $t = 50.1 \text{ s} \quad (3 \text{ s.f.})$ Time taken =[1]

(c) Calculate the rate of change of $[\text{S}_2\text{O}_3^{2-}]$ in experiment 1.

Number of moles of $\text{S}_2\text{O}_3^{2-}$ used = $0.025 \times 10.0/1000 = 2.50 \times 10^{-5} \text{ mol}$

Total volume of reacting mixture = 56.0 cm^3

$[\text{S}_2\text{O}_3^{2-}]_{\text{initial}} = (2.50 \times 10^{-5}) / (56.0 \times 10^{-3}) = 4.46 \times 10^{-3} \text{ mol dm}^{-3}$

$[\text{S}_2\text{O}_3^{2-}]_{\text{final}} = 0$ change in $[\text{S}_2\text{O}_3^{2-}]$

Rate of change of $[\text{S}_2\text{O}_3^{2-}] = (0 - 4.46 \times 10^{-3}) / 29$

$= -1.54 \times 10^{-4} \text{ mol dm}^{-3} \text{ s}^{-1}$

[2]

- (d) (i) A student repeated **Experiment 1** but used $0.050 \text{ mol dm}^{-3}$ sodium thiosulfate in place of **FA 8**.

How would this change the percentage error in the recorded time? Explain your answer.

Higher conc. of thiosulfate means more moles of iodine must be formed before
Time taken for blue-black to be observed is longer.
Percentage uncertainty in measurement of time is lowered since greater magnitude is measured.

[1]

- (ii) Another student was unable to complete all five experiments on the same day but had to return to the investigation the following morning. The student noticed that the results were significantly different.

Give one possible reason for these differences and explain how the student could have overcome these problems.

Reason: change of temperature

Use water bath to adjust to same constant temperature as previous experiments

OR

Reason: Decrease in concentration of hydrogen peroxide due to decomposition.

Store $\text{H}_2\text{O}_2(\text{aq})$ at low temperature/ store in opaque bottle/ prepare fresh $\text{H}_2\text{O}_2(\text{aq})$ sample

[2]

- (e) With reference to the graph plotted in (b)(i), suggest a modification to the procedure to increase reliability of results.

- Increase number of experiments carried out and hence MORE data points plotted.
- OR
- Have a greater spread of data points (e.g. V_{FA6} from 25 cm^3 to less than 10 cm^3)

[1]

[Total: 17]

5 Planning

When magnesium sulfate, MgSO_4 is added to water, an exothermic process occurs.



The maximum temperature change occurring during this reaction may be determined graphically.

To increase the reliability of the experimental results, the temperature change should be kept with the range of 5 to 10°C.

The maximum temperature change, ΔT_{max} , obtained from the graph can be used to calculate the heat change, q , for this experiment.

Using q , a value for the molar enthalpy change of solution, ΔH_{sol} , for magnesium sulfate may be determined.

In this question, you are to plan a procedure that would provide sufficient data to allow you to determine an accurate and reliable value for the molar enthalpy change of solution, ΔH_{sol} , for magnesium sulfate.

- (a) Given that when 17.0 g of MgSO_4 solid is dissolved in 50.0 cm³ of water, the temperature change is measured to be 53.0 °C.

Discuss why this experimental result is unreliable. Hence suggest a suitable mass of MgSO_4 that should be used for this experiment.

Temperature change is too high (> 10°C), will result in significant heat exchange with surrounding air, causing smaller ΔT to be measured.

1.7 g ($1.6 < M_{\text{MgSO}_4} < 3.18$) of MgSO_4 should be used so that ΔT becomes 5.3°C.

mass of solid MgSO_4 = g
[1]

- (b) Plan an investigation to determine the maximum temperature change, ΔT_{max} , graphically for the dissolution of magnesium sulfate.

Measurements should be taken:

- before the reaction starts
- during the reaction
- for some time after the reaction is complete.

You may assume that you are provided with:

- 20 g of magnesium sulfate
- deionised water
- the equipment normally found in a school or college laboratory.

In your plan, you should include brief details of

- the apparatus you would use,
- the quantities you would use, so that there is an appropriate temperature change,
- the measurements you would make to allow a suitable temperature–time graph to be drawn,
- how you would ensure that an accurate and reliable value of ΔT_{max} is obtained.

General outline of experiment

1. Using an electronic balance, weigh accurately about 1.7 g (inferred from (a)) of MgSO_4 into a pre-weighed dry weighing bottle.
2. Record the mass of MgSO_4 and the bottle in the table.
3. Using a 100 cm³ measuring cylinder, transfer 50.0 cm³ (inferred from (a)) of water into a dry Styrofoam cup, placed in a 250 cm³ beaker.
4. Use thermometer of 0.2 °C division, stir the water gently.
5. Start the stop-watch and record the initial temperature of the water. Record the temperature of the water every 30s for 2.5 min (any duration above 2 min).
6. At exactly 3 min (30 secs more than duration stated in step 5), add the MgSO_4 in the weighing bottle to the Styrofoam cup. Continue to stir the mixture gently with the thermometer and record the temperature every 30s from 3.5 min until a steady drop in temperature is observed.
7. Reweigh the weighing bottle and record the actual mass of MgSO_4 that dissolved in water.
8. Plot graph of temperature against time
9. Extrapolate the graph to the time when MgSO_4 was added to water to obtain the highest temperature reached

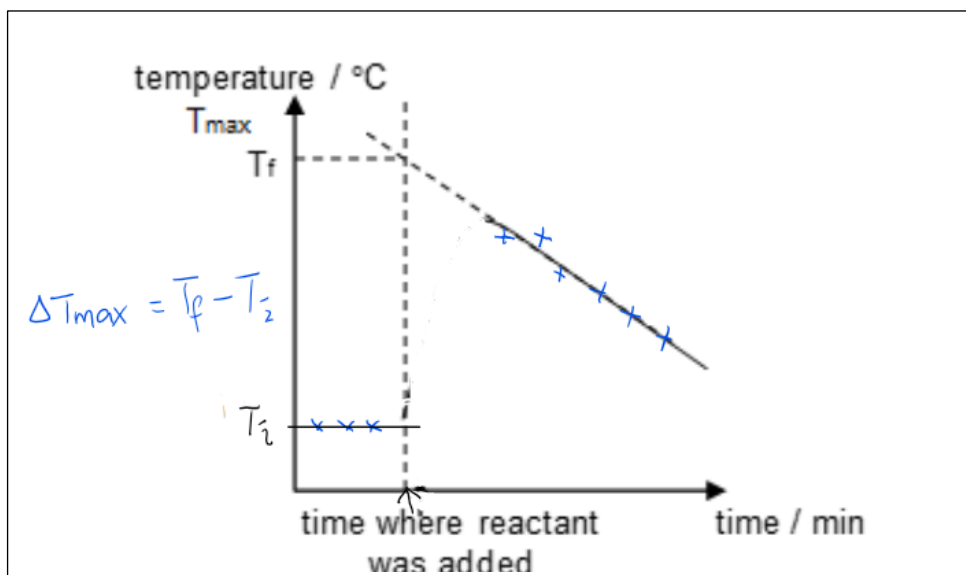
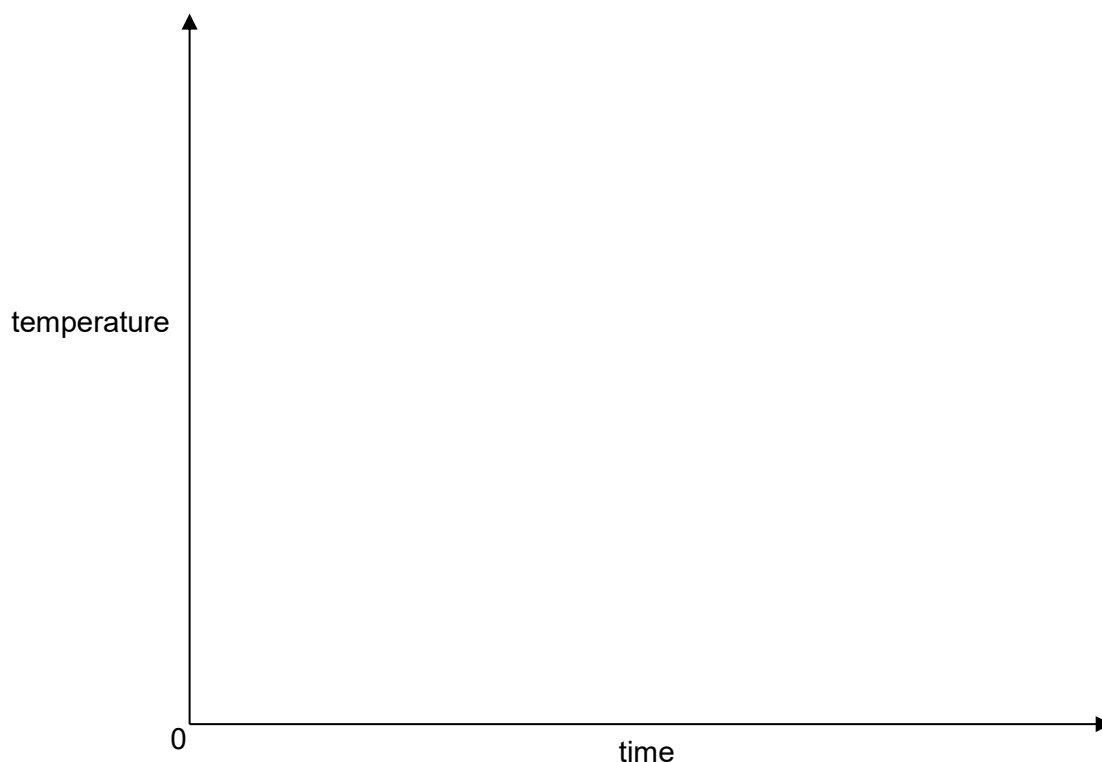
Apparatus	Procedure	Graph	Reliability
1. Electronic/ weighing + balance/ scale/ machine 2. (weighing) bottle (reject: small beaker/ container/ bottle cap) 3. 100/50ml measuring cylinder 4. Styrofoam/ Polystyrene cup (Reject: cup) 5. 0.2 °C div Thermometer Any 4 will do. *capacity not needed	1. Corresponding mass of MgSO_4 used and 50.0 cm^3 of water from (a) (Mass of solid must be $< 20\text{g}$) (If no mass value determined, accept any value $< 50\text{g}$) 2. Starting the stop-watch. 3. Record temperature of water for at least 2 mins BEFORE adding MgSO_4 into the water. 4. Add solid (at $t = ?$) 5. Record temperature of water for a few minutes AFTER adding MgSO_4 into the water until steady decrease in T observed. 6. Reweigh the weighing bottle P = 0 once solid is already in the cup.	1. Plot graph of temperature against time 2. Extrapolate the graph to the third minute (time of addition) when MgSO_4 was added to water to obtain the highest temperature reached. (Both)	1. Dry weighing bottle 2. Stir the water/reaction mixture before/ after adding MgSO_4 until steady drop in Temp is recorded. 3. Styrofoam cup in beaker Any 2.

Annotation A: apparatus, **P:** procedure **R:** Reliability

[5]

- (c) Sketch, on Fig. 5.1, the graph you would expect to obtain using the measurements you planned to make in 5(b).

Show, in your sketch, how the maximum temperature change, $\Delta T_{\max}$, can be determined.



[2]

[Total: 8]

Correct extrapolation of graph

Indicate clearly, minimum temperature, maximum temperature and $\Delta T_{\max}$ on graph

Qualitative Analysis Notes

[ppt. = precipitate]

(a) Reactions of aqueous cations

cation	reaction with	
	NaOH(aq)	NH ₃ (aq)
aluminium, Al ³⁺ (aq)	white ppt. soluble in excess	white ppt. insoluble in excess
ammonium, NH ₄ ⁺ (aq)	ammonia produced on heating	–
barium, Ba ²⁺ (aq)	no ppt. (if reagents are pure)	no ppt.
calcium, Ca ²⁺ (aq)	white ppt. with high [Ca ²⁺ (aq)]	no ppt.
chromium(III), Cr ³⁺ (aq)	grey-green ppt. soluble in excess giving dark green solution	grey-green ppt. insoluble in excess
copper(II), Cu ²⁺ (aq)	pale blue ppt. insoluble in excess	blue ppt. soluble in excess giving dark blue solution
iron(II), Fe ²⁺ (aq)	green ppt., turning brown on contact with air insoluble in excess	green ppt., turning brown on contact with air insoluble in excess
iron(III), Fe ³⁺ (aq)	red-brown ppt. insoluble in excess	red-brown ppt. insoluble in excess
magnesium, Mg ²⁺ (aq)	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese(II), Mn ²⁺ (aq)	off-white ppt., rapidly turning brown on contact with air insoluble in excess	off-white ppt., rapidly turning brown on contact with air insoluble in excess
zinc, Zn ²⁺ (aq)	white ppt. soluble in excess	white ppt. soluble in excess

(b) Reactions of anions

<i>anion</i>	<i>Reaction</i>
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chloride, $\text{Cl}^-(\text{aq})$	gives white ppt. with $\text{Ag}^+(\text{aq})$ (soluble in $\text{NH}_3(\text{aq})$)
bromide, $\text{Br}^-(\text{aq})$	gives pale cream ppt. with $\text{Ag}^+(\text{aq})$ (partially soluble in $\text{NH}_3(\text{aq})$)
iodide, $\text{I}^-(\text{aq})$	gives yellow ppt. with $\text{Ag}^+(\text{aq})$ (insoluble in $\text{NH}_3(\text{aq})$)
nitrate, $\text{NO}_3^-(\text{aq})$	NH_3 liberated on heating with $\text{OH}^-(\text{aq})$ and Al foil
nitrite, $\text{NO}_2^-(\text{aq})$	NH_3 liberated on heating with $\text{OH}^-(\text{aq})$ and Al foil; NO liberated by dilute acids (colourless $\text{NO} \rightarrow$ (pale) brown NO_2 in air)
sulfate, $\text{SO}_4^{2-}(\text{aq})$	gives white ppt. with $\text{Ba}^{2+}(\text{aq})$ (insoluble in excess dilute strong acids)
sulfite, $\text{SO}_3^{2-}(\text{aq})$	SO_2 liberated with dilute acids; gives white ppt. with $\text{Ba}^{2+}(\text{aq})$ (soluble in dilute strong acids)

(c) Tests for gases

<i>Gas</i>	<i>test and test result</i>
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	gives a white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	"pops" with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns aqueous acidified potassium manganate(VII) from purple to colourless

(d) Colour of halogens

<i>halogen</i>	<i>colour of element</i>	<i>colour in aq. solution</i>	<i>colour in hexane</i>
chlorine, Cl_2	greenish yellow gas	pale yellow	pale yellow
bromine, Br_2	reddish brown gas / liquid	orange	orange-red
iodine, I_2	black solid / purple gas	brown	Purple

(e) Test for organic compounds

Organic compounds	reactions
alkene	Decolourises orange Br ₂ (aq)
chloroalkane	Heat with NaOH(aq), White ppt. formed on adding dilute HNO ₃ , followed by Ag ⁺ (aq)
bromoalkane	Heat with NaOH(aq), Pale cream ppt. formed on adding dilute HNO ₃ , followed by Ag ⁺ (aq)
iodoalkane	Heat with NaOH(aq), yellow ppt. formed on adding dilute HNO ₃ , followed by Ag ⁺ (aq)
alcohol	• Forms white fumes with solid PCl₅ • Decolourises purple acidified KMnO₄(aq) on heating (for primary and secondary alcohols) • Gives pale yellow ppt. with alkaline I₂(aq) on warming (for alcohols with CH₃CH(OH)– group)
phenol	Decolourises orange Br ₂ (aq) and forms white ppt.
Carbonyl compounds (aldehydes and ketones)	• Gives orange ppt. with 2,4-dinitrophenylhydrazine • Gives pale yellow ppt. with alkaline I₂(aq) on warming (for carbonyl compounds with CH₃CO– group) • Gives red-brown ppt. with Fehling's solution on warming (for aliphatic aldehyde) • Gives silver mirror with Tollen's reagent on warming (for aldehydes)
Carboxylic acid	• CO₂ liberated by Na₂CO₃(aq) • Gives white fumes with solid PCl₅
phenylamine	Decolourises orange Br ₂ (aq) and forms white ppt.
Primary amide	NH ₃ liberated on heating with NaOH(aq)

BLANK PAGE