Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

6968103562

CHEMISTRY **9701/52**

Paper 5 Planning, Analysis and Evaluation **February/March 2019**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Use of a Data Booklet is unnecessary.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **9** printed pages and **3** blank pages.

IB19 03_9701_52/3RP

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1 The reaction between hydrogen peroxide, H_2O_2(aq), and iodide ions, I^-(aq), takes place in acidic conditions.

$$H_2O_2(aq) + 2I^-(aq) + 2H^+(aq) \rightarrow I_2(aq) + 2H_2O(l) \quad \textbf{reaction 1}$$

The rate of this reaction can be found by measuring the time taken for a given amount of iodine, I_2(aq), to form.

This is done by adding a known amount of thiosulfate ions, $S_2O_3^{2-}$(aq), and allowing the I_2(aq) formed in **reaction 1** to react with the $S_2O_3^{2-}$(aq).

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq) \quad \textbf{reaction 2}$$

After the $S_2O_3^{2-}$(aq) ions have all reacted in **reaction 2**, any further I_2(aq) formed in **reaction 1** can be detected using an indicator.

A student carried out a series of experiments to determine the order of reaction with respect to the concentration of I^-(aq) ions in **reaction 1**.

The student prepared the following solutions.

solution **A** 0.100 mol dm^{-3} KI(aq)

solution **B** 0.0500 mol dm^{-3} $Na_2S_2O_3$(aq)

The student also had access to the following chemicals.

solution **C** 0.100 mol dm^{-3} H_2O_2(aq)
0.2 mol dm^{-3} H_2SO_4(aq)
distilled water
a suitable indicator

(a) The student prepared solution **A** in a 250 cm^3 volumetric flask.

(i) The student used a balance accurate to two decimal places and a weighing boat. A weighing boat is a small container used to hold solid samples when they are weighed.

Determine the mass, in g, of KI needed to prepare 250.0 cm^3 of solution **A**.
[A_r: K, 39.1; I, 126.9]

mass = ... g [2]

(ii) The student weighed the empty weighing boat. The student then added solid KI to the weighing boat until the mass of KI calculated in **(i)** was reached. The student transferred all of the KI from the weighing boat into a 100 cm^3 beaker.

Describe how the student could check that the mass of KI transferred into the 100 cm^3 beaker was exactly the same as the mass calculated in **(i)**.

....

.... [1]

(iii) The student dissolved the KI in the 100 cm^3 beaker in distilled water and transferred the solution formed into a 250 cm^3 volumetric flask. Distilled water was added to the volumetric flask until the volume of the solution was exactly 250 cm^3. Care was taken to avoid parallax errors.

Describe:

- how the student should transfer all the KI solution from the beaker into the 250 cm^3 volumetric flask
- how the student should fill the volumetric flask exactly up to the 250 cm^3 mark.

....

....

....

.... [2]

(b) The student rinsed a burette with solution **A** before filling it with solution **A**.

Explain why this improves the accuracy of the results.

....

.... [1]

(c) The student was given a solution of 0.400 $mol\,dm^{-3}$ $Na_2S_2O_3(aq)$.

Determine the volume, in cm^3, of this solution that should be added to a 100 cm^3 volumetric flask to prepare 100.0 cm^3 of solution **B**. Give your answer to **two** decimal places.

volume = ... cm^3 [1]

(d) Experiment 1 was carried out using a series of steps.

step 1 The student used a measuring cylinder to measure 25 cm^3 of 0.2 mol dm^{-3} H_2SO_4(aq). This was transferred to a conical flask.

step 2 The student added 20.00 cm^3 of distilled water from a burette to the conical flask.

step 3 The student added 5.00 cm^3 of solution **A** from a burette to the conical flask.

step 4 The student added 5.00 cm^3 of solution **B** from a burette to the conical flask.

step 5 The student added 1.0 cm^3 of indicator from a teat pipette to the conical flask.

step 6 The student used a burette to add 10.00 cm^3 of solution **C** to a small beaker. The contents of the beaker were added to the conical flask and a stopclock was started immediately. The stopclock was stopped when the I_2 formed caused the indicator to change colour.

In Experiments 2–6 the student repeated **steps 1–6** but using the volumes of distilled water and solution **A** given in the table.

The student carried out two trials of each experiment.

experiment	volume of H_2SO_4(aq) / cm^3	volume of distilled water / cm^3	volume of solution **A**, *v* / cm^3	volume of solution **B** / cm^3	volume of indicator / cm^3	time for the indicator to change colour, *t* / s	
						trial 1	trial 2
1	25.0	20.00	5.00	5.00	1.0	218	220
2	25.0	15.00	10.00	5.00	1.0	112	113
3	25.0	12.50	12.50	5.00	1.0	100	
4	25.0	10.00	15.00	5.00	1.0	77	76
5	25.0	5.00	20.00	5.00	1.0	59	59
6	25.0	0.00	25.00	5.00	1.0	47	49

(i) In Experiment 3, trial 2, the indicator changed colour as soon as the student added solution **C** to the conical flask. No results were recorded for Experiment 3, trial 2.

Suggest which step the student did **not** carry out in Experiment 3, trial 2.

.... [1]

(ii) Suggest why the results shown in the table could be considered reliable.

....

.... [1]

(iii) What was the percentage error in the burette reading for measuring the volume of solution **A** in Experiment 5?

percentage error = ... % [1]

(iv) Suggest why a measuring cylinder was used to measure the volume of H_2SO_4(aq) rather than a more accurate piece of apparatus, such as a burette.

.... [1]

(v) For Experiments 1–6, state:

- the independent variable ....
- the dependent variable. ....

[2]

(e) The rate equation can be written as rate = k$[I^-]^n$ where $[I^-]$ is proportional to the volume of solution **A** and *n* is the order of reaction with respect to I^-.

(i) Use only the results of Experiments 1–6 given in **(d)** to complete the table where:

- *v* is the volume of solution **A** used in cm^3
- t_{av} is the average time taken in trial 1 and trial 2 in s.

Give all values to **three** significant figures.

experiment	v / cm^3	log *v*	t_{av} / s	$(1/t_{av}) / s^{-1}$	$\log(1/t_{av})$
1	5.00				
2	10.00				
3	12.50		100	0.0100	
4	15.00				
5	20.00				
6	25.00				

[2]

(ii) Rate can be expressed as $(1/t_{av})$.
The rate equation can be expressed as shown.

$$\log(1/t_{av}) = n\log v + c$$

where:

- c is a constant
- *v* is proportional to $[I^-]$.

On the grid:

- Plot a graph of $\log(1/t_{av})$ against log *v*. Use a cross (×) to plot each data point.
- Draw a line of best fit.

[2]

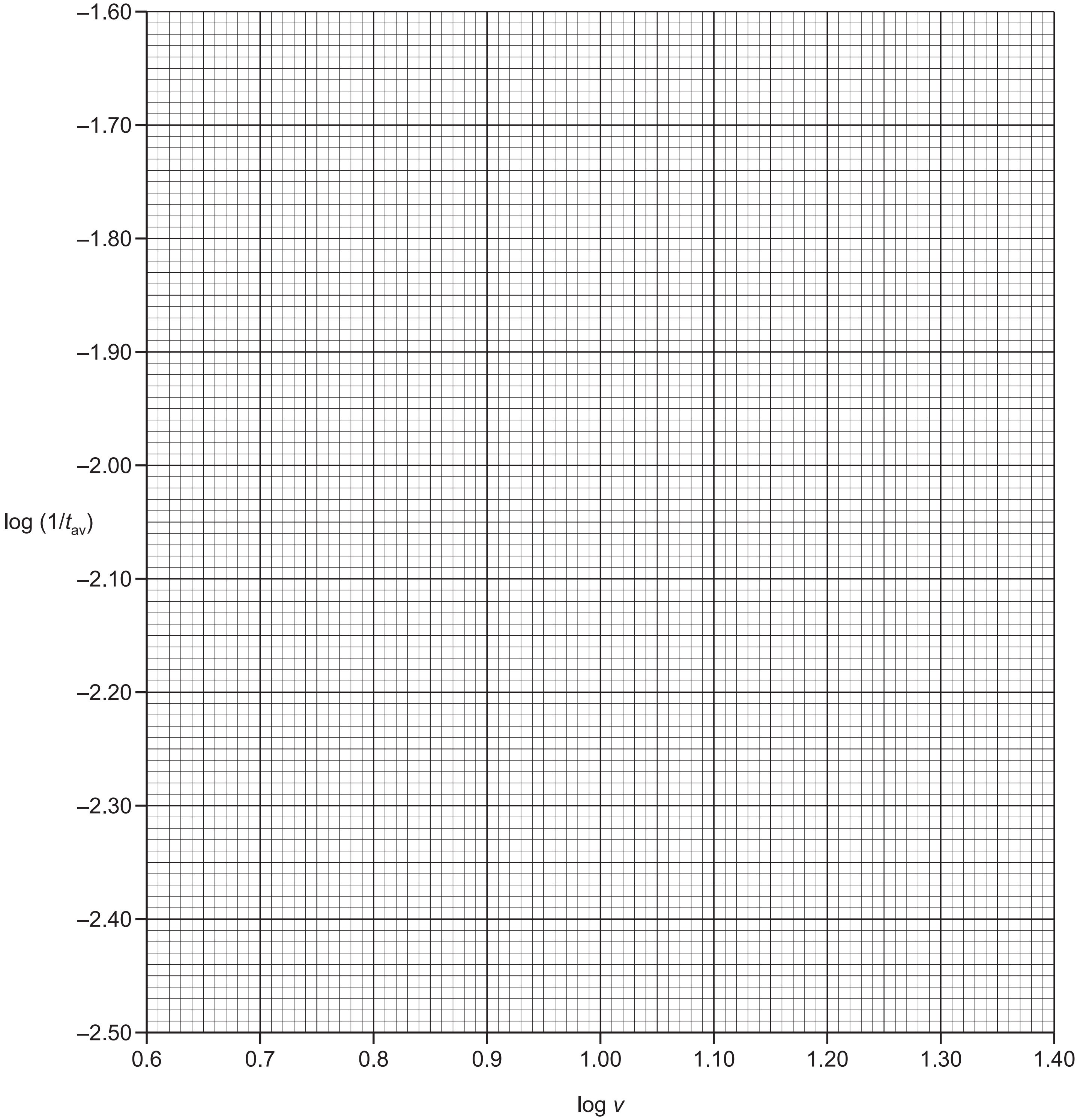
(iii) Use your graph to determine the gradient of the line of best fit. State the coordinates of both points you used in your calculation. Give the gradient to **three** significant figures.
Determine the order of reaction with respect to I^-(aq).

co-ordinates 1 .... co-ordinates 2 ....

gradient = ...

order of reaction with respect to I^-(aq) = ...

[3]



log (1/t_{av})
–1.60
–1.70
–1.80
–1.90
–2.00
–2.10
–2.20
–2.30
–2.40
–2.50
0.6
0.7
0.8
0.9
1.00
1.10
1.20
1.30
1.40
log v

[Total: 20]

2 A student was given a sample of an unknown Group 2 chloride. The student dissolved 3.172 g of the unknown Group 2 chloride in distilled water in a beaker and added an excess of aqueous silver nitrate, $AgNO_3(aq)$, to the beaker.

A white precipitate of silver chloride formed.

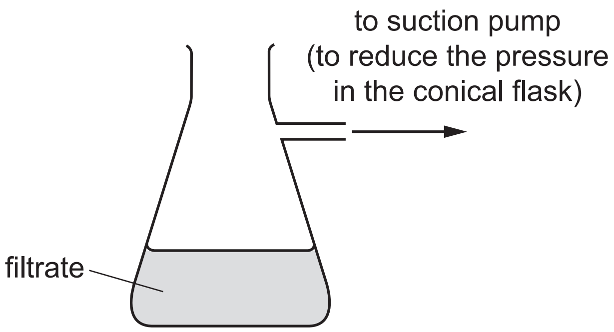
(a) Write the ionic equation, including state symbols, for the reaction occurring.

.... [1]

(b) To separate the filtrate from the residue, filtration can be carried out using gravity or by using reduced pressure.

The student decided to filter the mixture under reduced pressure.

(i) Complete the labelled diagram to suggest how the student could filter the mixture under reduced pressure.



[2]

(ii) Suggest **one** major advantage of filtering the mixture under reduced pressure compared with filtering using gravity.

.... [1]

(c) The student rinsed the residue, transferred it to a crucible and placed it in a warm oven to dry it.

(i) What should the student do to ensure that the drying process is complete?

.... [1]

(ii) The student recorded the masses shown in the table.

Complete the table to calculate the mass of dry silver chloride formed. Use this value to determine the number of moles of silver chloride formed.
[A_r: C*l*, 35.5; Ag, 107.9]

mass of crucible + dry silver chloride / g	24.898
mass of empty crucible / g	19.162
mass of dry silver chloride / g	

moles of silver chloride formed = ... mol [1]

(iii) Use your answer to **(ii)** to calculate the mass of **one** mole of the Group 2 chloride and hence identify the Group 2 metal present in the chloride.

If you were unable to calculate an answer in **(ii)**, assume that 0.0304 mol of silver chloride formed. This is **not** the correct value.
[A_r: Be, 9.0; Mg, 24.3; Ca, 40.1; Sr, 87.6; Ba, 137.3]

mass of **one** mole of the Group 2 chloride = ... g

identity of the Group 2 metal = ...
[3]

(iv) State and explain how the number of moles of silver chloride formed in **(ii)** would change if the student used tap water instead of distilled water to dissolve the Group 2 chloride.

....

.... [1]

[Total: 10]

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