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CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **October/November 2024**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].
- Notes for use in qualitative analysis are provided in the question paper.

This document has **16** pages. Any blank pages are indicated.

IB24 11_0620_62/3RP

1 A teacher uses the apparatus shown in Fig. 1.1 to pass an electric current through molten mercury(II) bromide at a temperature of 300 °C.

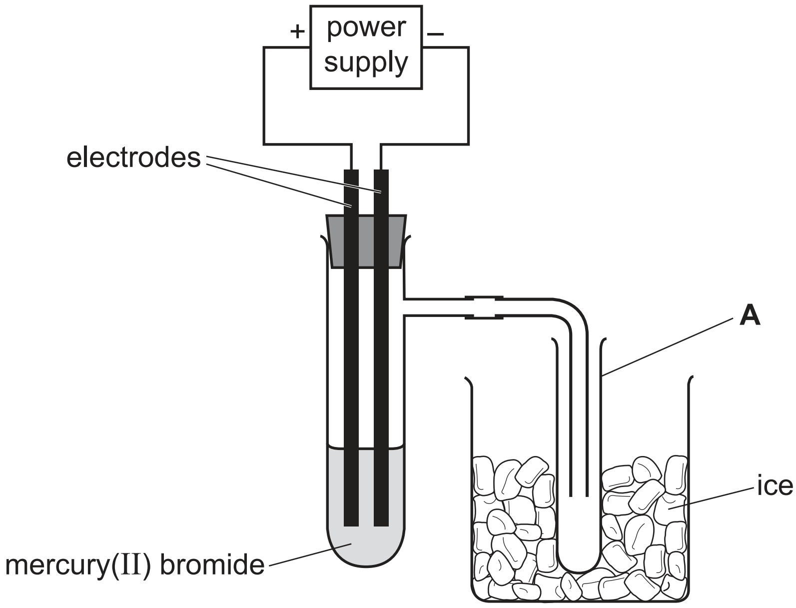

Fig. 1.1

During the process shown in Fig. 1.1, the molten mercury(II) bromide breaks down and forms bromine and mercury.

Table 1.1 shows some information about mercury(II) bromide, bromine and mercury.

Table 1.1

substance	melting point in °C	boiling point in °C	density when liquid in g/cm^3
mercury(II) bromide	236	322	6
bromine	–7	60	3
mercury	–39	357	14

(a) Draw an arrow on Fig. 1.1 to show where the apparatus should be heated. [1]

(b) Name the item of apparatus labelled **A** in Fig. 1.1.

.... [1]

(c) Name the process shown in Fig. 1.1 which breaks down mercury(II) bromide.

.... [1]

(d) The electrodes used in the process shown in Fig. 1.1 are made from platinum.

Give **two** reasons why platinum is a suitable material for the electrodes.

1 ....

2 ....
[2]

(e) On Fig. 1.1, draw an **X** to show where mercury will collect. [1]

(f) Explain why ice is used in the experiment.

....

.... [1]

[Total: 7]

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2 A student investigates the rate of the reaction between aqueous iron(III) nitrate and aqueous sodium thiosulfate.

The student does five experiments using the apparatus shown in Fig. 2.1.

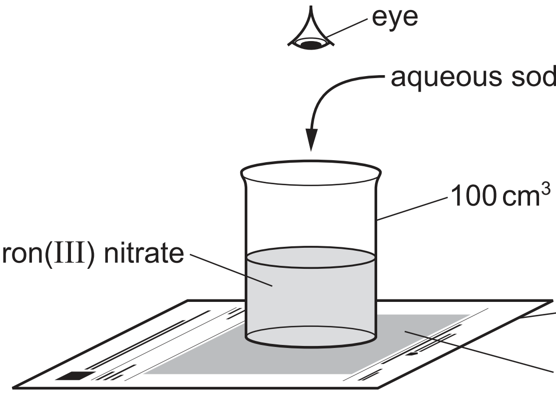


Fig. 2.1

Experiment 1

- Use a 50 cm^3 measuring cylinder to pour 50 cm^3 of aqueous iron(III) nitrate into a 100 cm^3 beaker.
- Stand the beaker on the text of the printed sheet as shown in Fig. 2.1.
- Use a 25 cm^3 measuring cylinder to pour 15.0 cm^3 of aqueous sodium thiosulfate into the beaker. At the same time start a stop-watch.
- Stir the contents of the beaker.
- Look down from above the beaker. When the text on the printed sheet becomes visible, stop the stop-watch and record the time in seconds to the nearest whole number.
- Rinse the beaker with distilled water.

Experiment 2

- Repeat Experiment 1, using 10.0 cm^3 of aqueous sodium thiosulfate instead of 15.0 cm^3.

Experiment 3

- Repeat Experiment 1, using 7.0 cm^3 of aqueous sodium thiosulfate instead of 15.0 cm^3.

Experiment 4

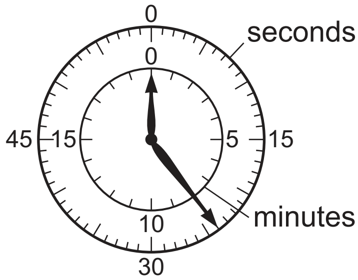
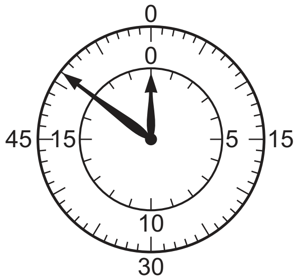
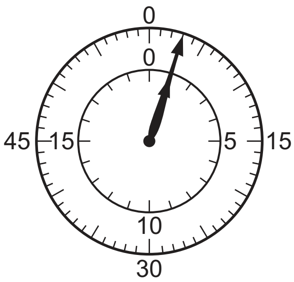
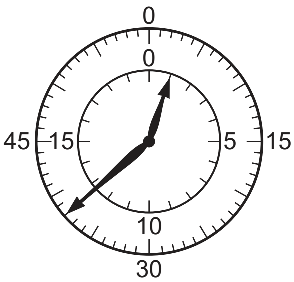
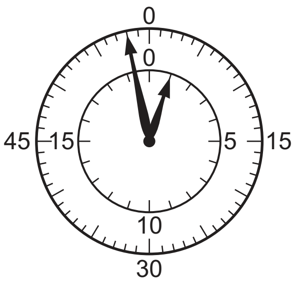
- Repeat Experiment 1, using 6.0 cm^3 of aqueous sodium thiosulfate instead of 15.0 cm^3.

Experiment 5

- Repeat Experiment 1, using 5.0 cm^3 of aqueous sodium thiosulfate instead of 15.0 cm^3.

(a) Use the information in the description of the experiments and the stop-watch diagrams to complete Table 2.1.

Table 2.1

experiment	volume of aqueous sodium thiosulfate / cm^3	stop-watch diagram	time taken for the text to become visible / s
1			
2			
3			
4			
5			

[3]

(b) Write a suitable scale on the *y*-axis and plot the results from Experiments 1 to 5 on Fig. 2.2. Draw a smooth curve of best fit.

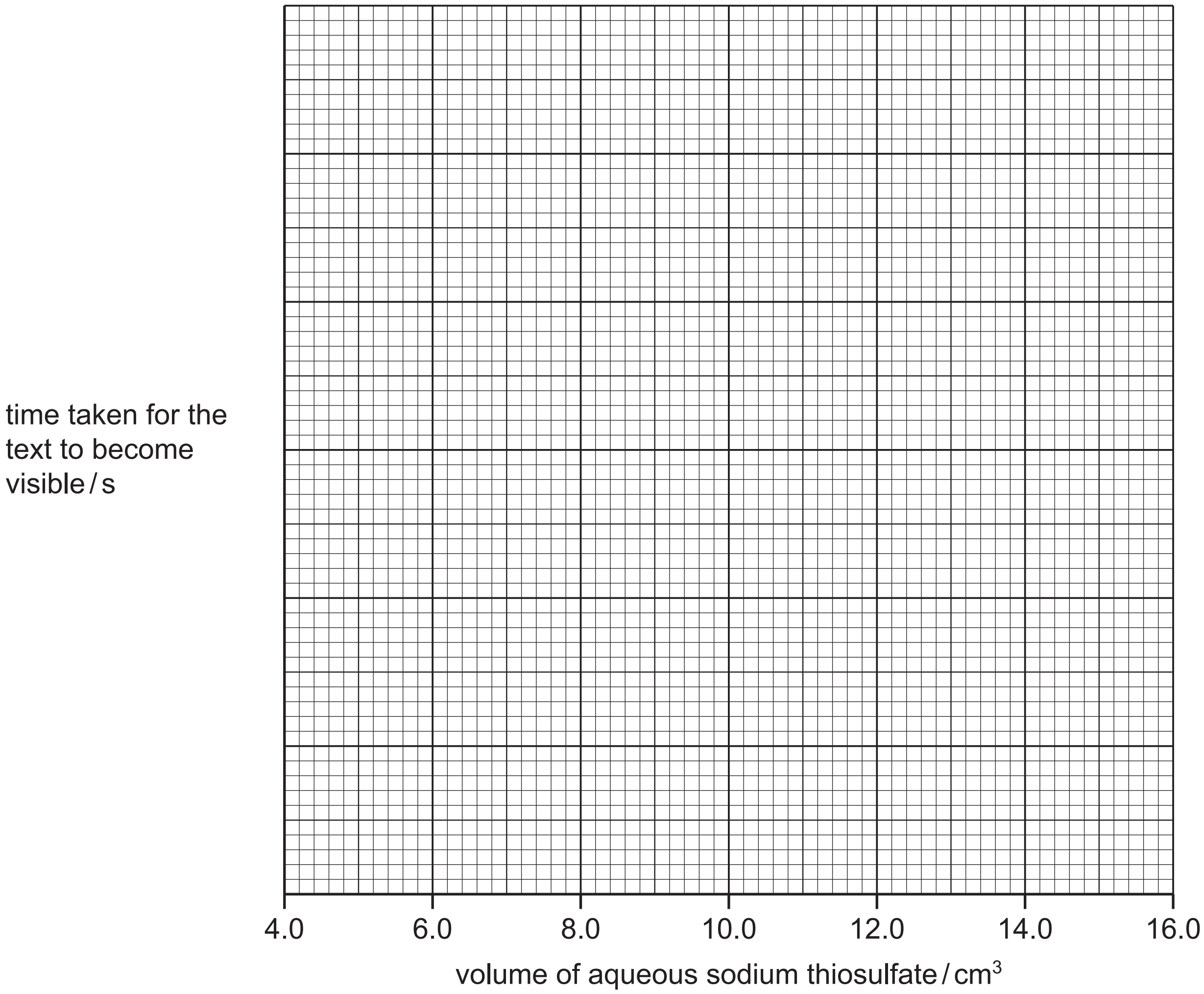


Fig. 2.2

[4]

(c) State why the contents of the beaker are stirred after adding the aqueous sodium thiosulfate to the aqueous iron(III) nitrate.

....

.... [1]

(d) Deduce which experiment has the highest rate of reaction.

.... [1]

(e) Use your graph in Fig. 2.2 to predict the time taken for the text to become visible if the volume of aqueous sodium thiosulfate is 12.5 cm^3.
Show your working on Fig. 2.2.

time = ... [3]

(f) (i) Explain why it would be an improvement to measure the volumes of aqueous iron(III) nitrate in a burette rather than in a measuring cylinder.

....

.... [1]

(ii) Explain why it is **not** possible to use a volumetric pipette to measure the volumes of the aqueous sodium thiosulfate used in the experiments.

....

.... [1]

(iii) Describe how the reliability of the results of this investigation can be checked.

....

.... [1]

(g) Describe how the results of the experiments would change if the experiments are repeated using a narrower and taller beaker.
Explain your answer.

change in results ....

explanation ....

....
[2]

(h) Describe additional measurements that must be taken to determine whether the reaction in this investigation is exothermic or endothermic.

....

.... [1]

[Total: 18]

Question 3 starts on the next page.

3 A student tests two substances: solid **M** and solid **N**.

Tests on solid M

Table 3.1 shows the tests and the student's observations for solid **M**.

Table 3.1

tests	observations
test 1 Do a flame test on solid **M**.	lilac flame colour
test 2 Dissolve the rest of solid **M** in water to form solution **M**. Divide solution **M** into four portions. To the first portion of solution **M**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	a cream precipitate forms
test 3 To the second portion of solution **M**, add aqueous sodium hydroxide dropwise and then in excess.	a green precipitate forms; the precipitate remains when excess aqueous sodium hydroxide is added
test 4 To the third portion of solution **M**, add 1 cm^3 of aqueous sodium hydroxide and a small square of aluminium foil. Warm the mixture and test any gas produced with damp red litmus paper.	litmus paper remains red
test 5 To the fourth portion of solution **M**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.	a white precipitate forms

(a) Explain why a yellow (safety) Bunsen burner flame is **not** suitable for a flame test.

....

.... [1]

(b) Identify the **four** ions in solid **M**.

....

....

....

.... [4]

Tests on solid N

Solid **N** is ammonium carbonate.

Record the expected observations.

(c) The student transfers approximately half of solid **N** to a boiling tube and adds about 10 cm^3 of dilute sulfuric acid to the boiling tube. Any gas produced is tested.

observations ....

.... [2]

The student dissolves the remaining solid **N** in water to form solution **N**.
Solution **N** is divided into two portions.

(d) To the first portion of solution **N**, the student adds about 2 cm^3 of aqueous sodium hydroxide and gently warms the mixture. Any gas produced is tested.

observations ....

.... [1]

(e) To the second portion of solution **N**, the student adds excess aqueous ammonia.

observations ....

.... [1]

[Total: 9]

4 Limes and lemons are citrus fruits which contain aqueous citric acid in their juice. Citric acid reacts with alkalis such as aqueous sodium hydroxide.

Plan an investigation to find which of lime juice and lemon juice contains the most concentrated aqueous citric acid. Assume that citric acid is the only acid present in the juices.

Your plan must include:

- the method to use
- how the results are used to determine which juice contains the most concentrated aqueous citric acid.

You are provided with lime juice, lemon juice, aqueous sodium hydroxide and common laboratory apparatus and chemicals.

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.... [6]

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Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
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 acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green