Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

0137219779

CHEMISTRY **0971/62**

Paper 6 Alternative to Practical **May/June 2023**

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 **12** pages. Any blank pages are indicated.

1 Hot powdered lead(II) oxide is reduced by methane, a flammable gas. The products are lead, steam and carbon dioxide gas.
Fig. 1.1 shows the apparatus used to reduce lead(II) oxide using excess methane.

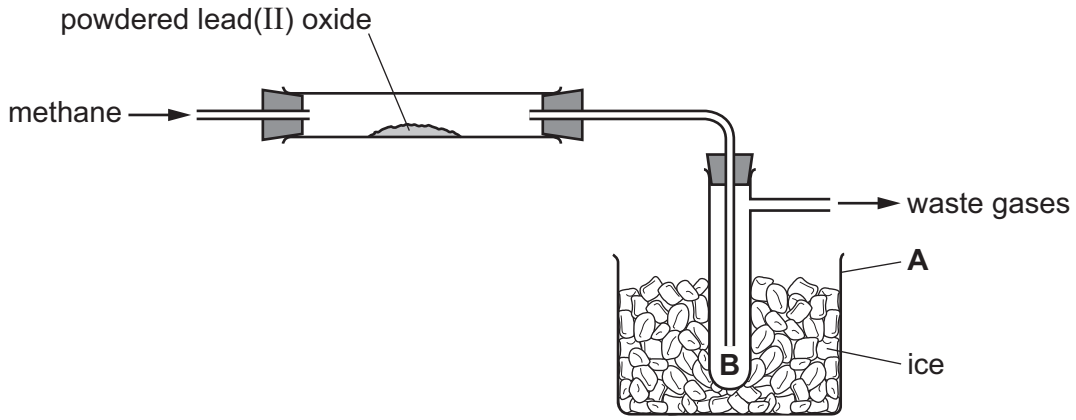


Fig. 1.1

(a) Name the item of apparatus labelled **A**.

..... [1]

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

(c) Explain why powdered lead(II) oxide is used and **not** a large lump of lead(II) oxide.

.....

..... [1]

(d) Explain what happens at the point labelled **B**, on Fig. 1.1.

.....

.....

..... [2]

(e) The waste gases contain methane.

State why the waste gases should **not** be released into the laboratory.

.....

..... [1]

[Total: 6]

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

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

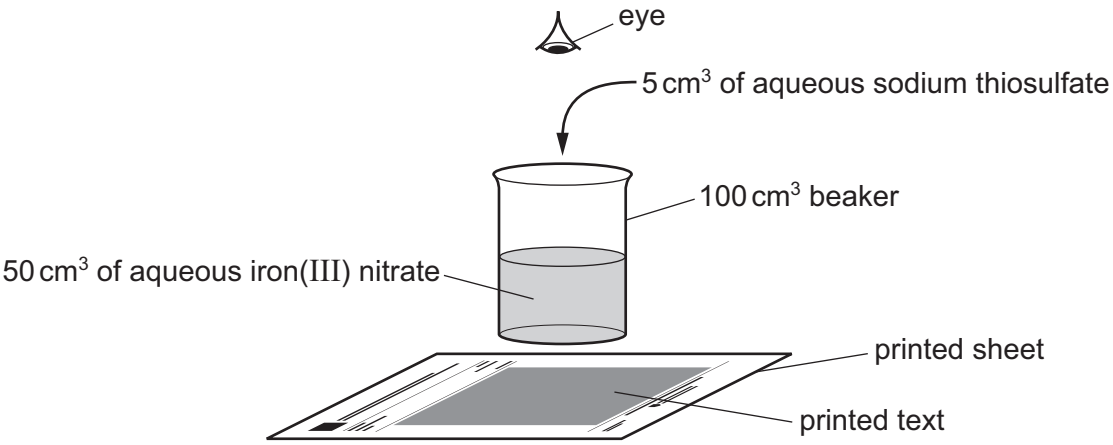


Fig. 2.1

(a) 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 a printed sheet as shown in Fig. 2.1.
- Use a 10 cm^3 measuring cylinder to pour 5 cm^3 of aqueous sodium thiosulfate into the beaker and at the same time start a stop-clock.
- Use a thermometer to stir the contents of the beaker.
- Look down from above the beaker and when the text on the printed sheet becomes visible, stop the stop-clock.
- Use the thermometer to measure the temperature of the solution when the text becomes visible.
- Rinse the beaker and thermometer with water.

Experiment 2

- Use the 50 cm^3 measuring cylinder to pour 50 cm^3 of aqueous iron(III) nitrate into the 100 cm^3 beaker.
- Heat the beaker on a gauze over a Bunsen burner until the temperature of the iron(III) nitrate has increased by about 5 °C.
- Stand the beaker on the printed sheet as shown in Fig. 2.1.
- Use the 10 cm^3 measuring cylinder to pour 5 cm^3 of aqueous sodium thiosulfate into the beaker and at the same time start a stop-clock.
- Use the thermometer to stir the contents of the beaker.
- Look down from above the beaker and when the text on the printed sheet becomes visible, stop the stop-clock.
- Use the thermometer to measure the temperature of the solution when the text becomes visible.
- Rinse the beaker and thermometer with water.

Experiment 3

- Repeat Experiment 2, this time heating the aqueous iron(III) nitrate until the temperature has increased by about 10 °C.

Experiment 4

- Repeat Experiment 2, this time heating the aqueous iron(III) nitrate until the temperature has increased by about 15 °C.

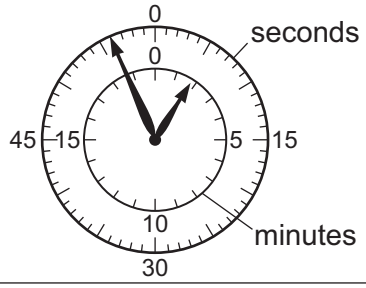
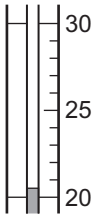
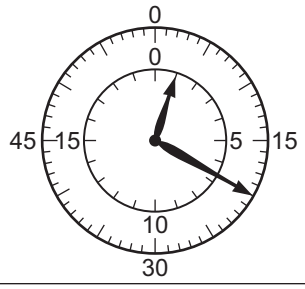
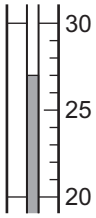
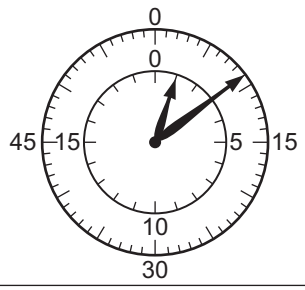
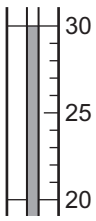
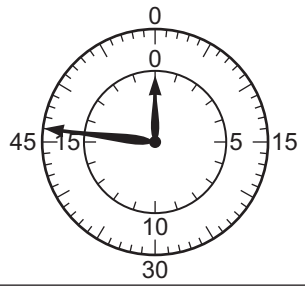
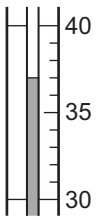
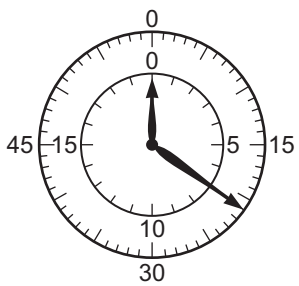
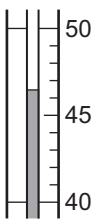
[Turn over

Experiment 5

- Repeat Experiment 2, this time heating the aqueous iron(III) nitrate until the temperature has increased by about 25 °C.

Use the thermometer diagrams and stop-clock diagrams to complete Table 2.1.

Table 2.1

experiment	stop-clock diagram	time taken for the text to become visible / s	thermometer diagram	temperature of the solution when the text becomes visible / °C
1				
2				
3				
4				
5				

[4]

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

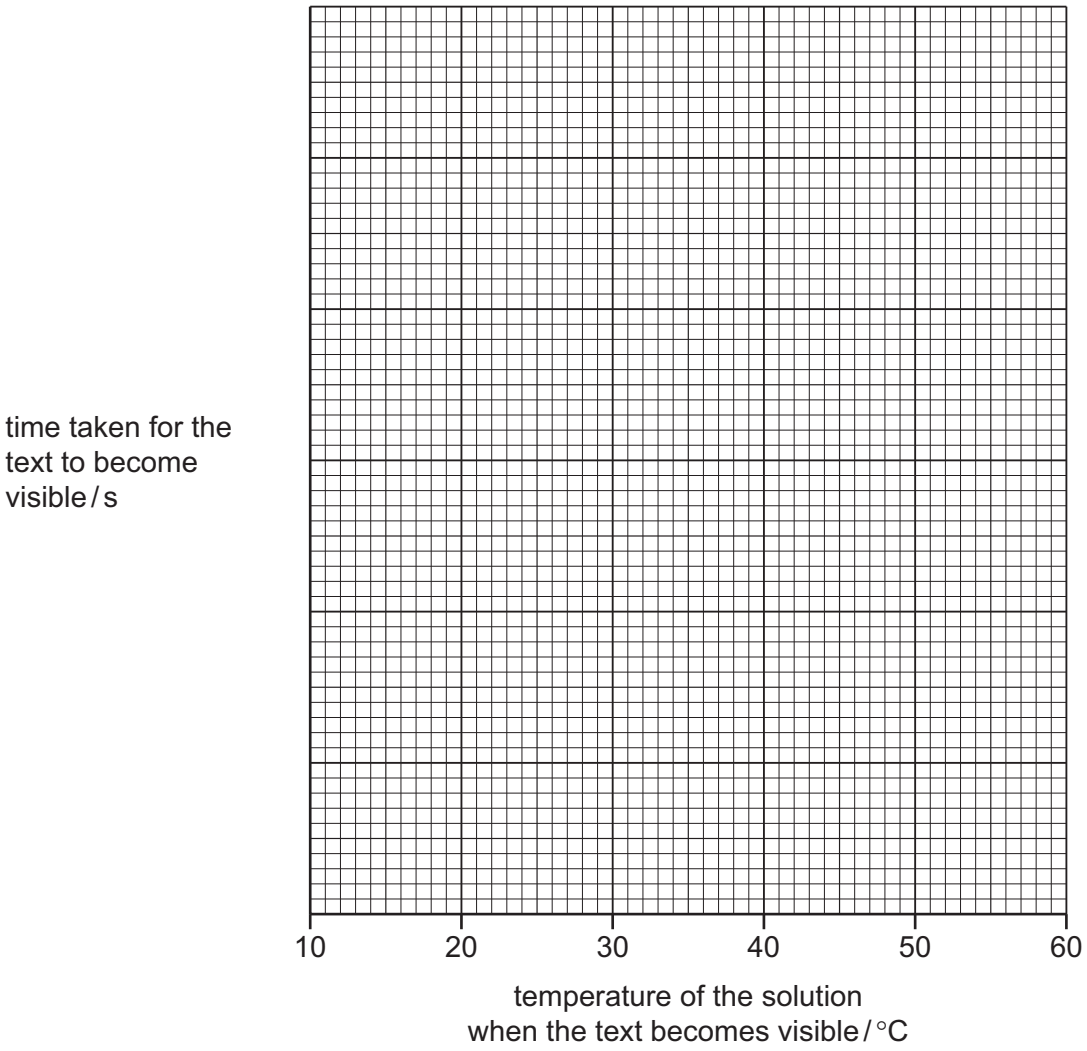


Fig. 2.2

[4]

(c) Deduce the experiment in which the rate of reaction is fastest.

..... [1]

(d) Use your graph to predict the temperature of the solution when the text becomes visible after 55 seconds.
Show your working on Fig. 2.2.

temperature = ... °C [2]

[Turn over

(e) Explain why wrapping the beaker in cotton wool after it has been heated will improve the accuracy of the results obtained.

.....

..... [2]

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

.....

..... [1]

(ii) Suggest why it would **not** be an improvement to add the aqueous sodium thiosulfate using a pipette.

.....

..... [1]

(g) Suggest why the aqueous sodium thiosulfate must be added after the aqueous iron(III) nitrate has been heated and **not** before it is heated.

.....

..... [1]

(h) Describe how the results of the experiment would change when the experiment is repeated using a 250 cm^3 beaker in place of the 100 cm^3 beaker.
Explain your answer.

change in results .....

explanation .....

.....
[2]

[Total: 18]

3 A student tests two substances: solution **F** and solid **G**.

Tests on solution F

Table 3.1 shows the tests and the student's observations for solution **F**. The student divides solution **F** into three portions.

Table 3.1

tests	observations
test 1 Do a flame test on the first portion of solution **F**.	light green colour
test 2 To the second portion of solution **F**, add a 1 cm depth of aqueous sodium hydroxide and a piece of aluminium foil. Warm the mixture gently and test any gas produced.	effervescence was seen; the gas turned damp red litmus paper blue
test 3 To the third portion of solution **F**, add a 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate.	no change

(a) Describe how to do the flame test used in **test 1**.

.....

.....

..... [2]

(b) Identify the gas given off in **test 2**.

..... [1]

(c) Identify solution **F**.

.....

..... [2]

(d) State what would be observed if the student adds dilute sulfuric acid to another portion of solution **F**.

observations .....

..... [1]

[Turn over

Tests on solid G

Solid **G** is iron(II) carbonate.

(e) About 10 cm^3 of dilute sulfuric acid is added to solid **G**.
Any gas given off is tested.

observations .....

.....

..... [2]

(f) To the product from **(e)**, aqueous sodium hydroxide is added dropwise until in excess.

observations adding dropwise .....

observations in excess .....
[2]

[Total: 10]

4 A metal polish is a mixture of four substances.
The properties of these substances are shown in Table 4.1.

Table 4.1

name of substance	solubility in water	reaction with dilute nitric acid
propanol	soluble	dissolves
ethanoic acid	soluble	dissolves
iron(III) oxide	insoluble	reacts when warmed to form a soluble salt
silicon(IV) oxide	insoluble	no reaction

Plan an experiment to find the percentage by mass of silicon(IV) oxide in the mixture. Your plan should include how you will calculate the percentage of silicon(IV) oxide in the mixture.

You are provided with a sample of the metal polish, dilute nitric acid and common laboratory apparatus.

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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