Cambridge Assessment International Education

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CHEMISTRY **0620/63**

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.

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1 When crystals of hydrated calcium ethanedioate, $CaC_2O_4 \cdot H_2O$, are heated they decompose to form solid calcium carbonate, steam and carbon monoxide gas.

$$CaC_2O_4 \cdot H_2O(s) \rightarrow CaCO_3(s) + H_2O(g) + CO(g)$$

A student suggests using the apparatus shown in Fig. 1.1 to decompose hydrated calcium ethanedioate and obtain the products.

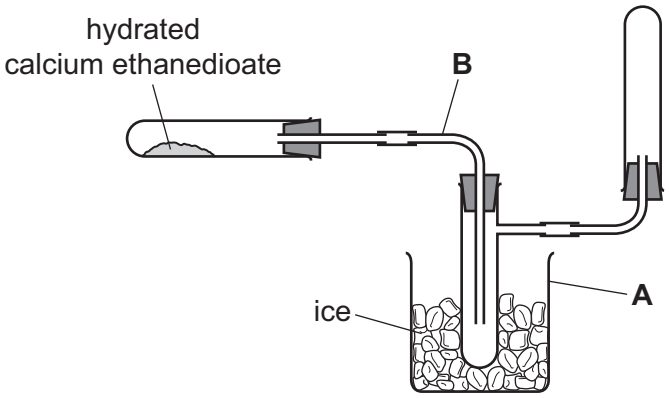

Fig. 1.1

Table 1.1 shows some information about carbon monoxide.

Table 1.1

	melting point / °C	boiling point / °C	density compared to air	solubility in water	safety warning
carbon monoxide	–205	–192	about the same	insoluble	toxic

(a) Name the items of apparatus labelled **A** and **B** in Fig. 1.1.

View solution

A .....

B .....

[2]

(b) The apparatus shown in Fig. 1.1 will **not** work because there is an error in how the gas is collected. This error makes it dangerous to use the apparatus.

Identify the error and explain why this error makes it dangerous to use the apparatus.

View solution

error .....

.....

explanation .....

.....

[2]

(c) Complete Fig. 1.2 to show how the gas could be collected safely.

View solution

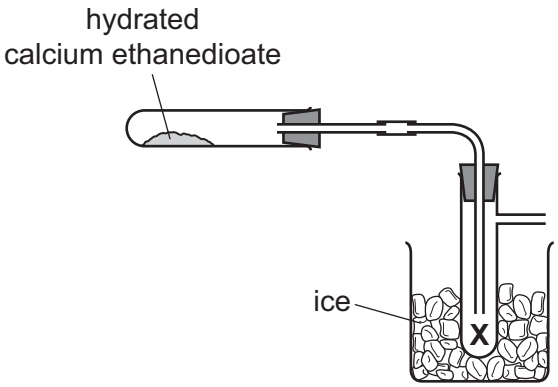

Fig. 1.2

[1]

(d) Add **one** arrow to Fig. 1.2 to show where the apparatus should be heated. [1]

View solution

(e) Identify the substance that collects at the point marked **X** on Fig. 1.2.

View solution

..... [1]

(f) Suggest why this experiment should be carried out in a fume cupboard.

View solution

.....

..... [1]

[Total: 8]

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2 A student investigates the temperature change when solid **P** dissolves in water.

The student does two experiments.

Experiment 1

- Use a 25 cm^3 measuring cylinder to pour 20 cm^3 of distilled water into a boiling tube.
- Use a thermometer to measure the temperature of the distilled water. This is the temperature at time = 0 seconds.
- Add a 5 g sample of solid **P** to the distilled water in the boiling tube. At the same time start a stop-watch.
- Continually stir the contents of the boiling tube using the thermometer.
- Measure the temperature of the mixture in the boiling tube every 20 seconds for 120 seconds.
- Rinse the boiling tube with distilled water.

Experiment 2

- Repeat Experiment 1 using 10 cm^3 of distilled water instead of the 20 cm^3 of distilled water.

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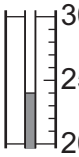
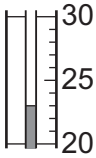
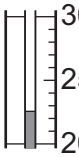
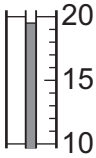
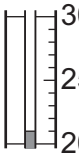
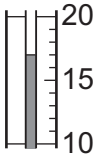
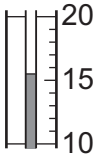
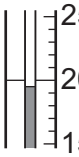
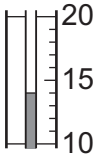
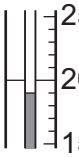
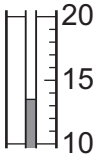
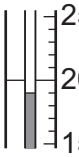
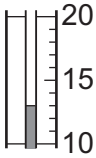
(a) Complete Table 2.1 by using the thermometer diagrams and calculating the temperature decreases from the temperature at 0 seconds.

View solution

For example, at 60 seconds:

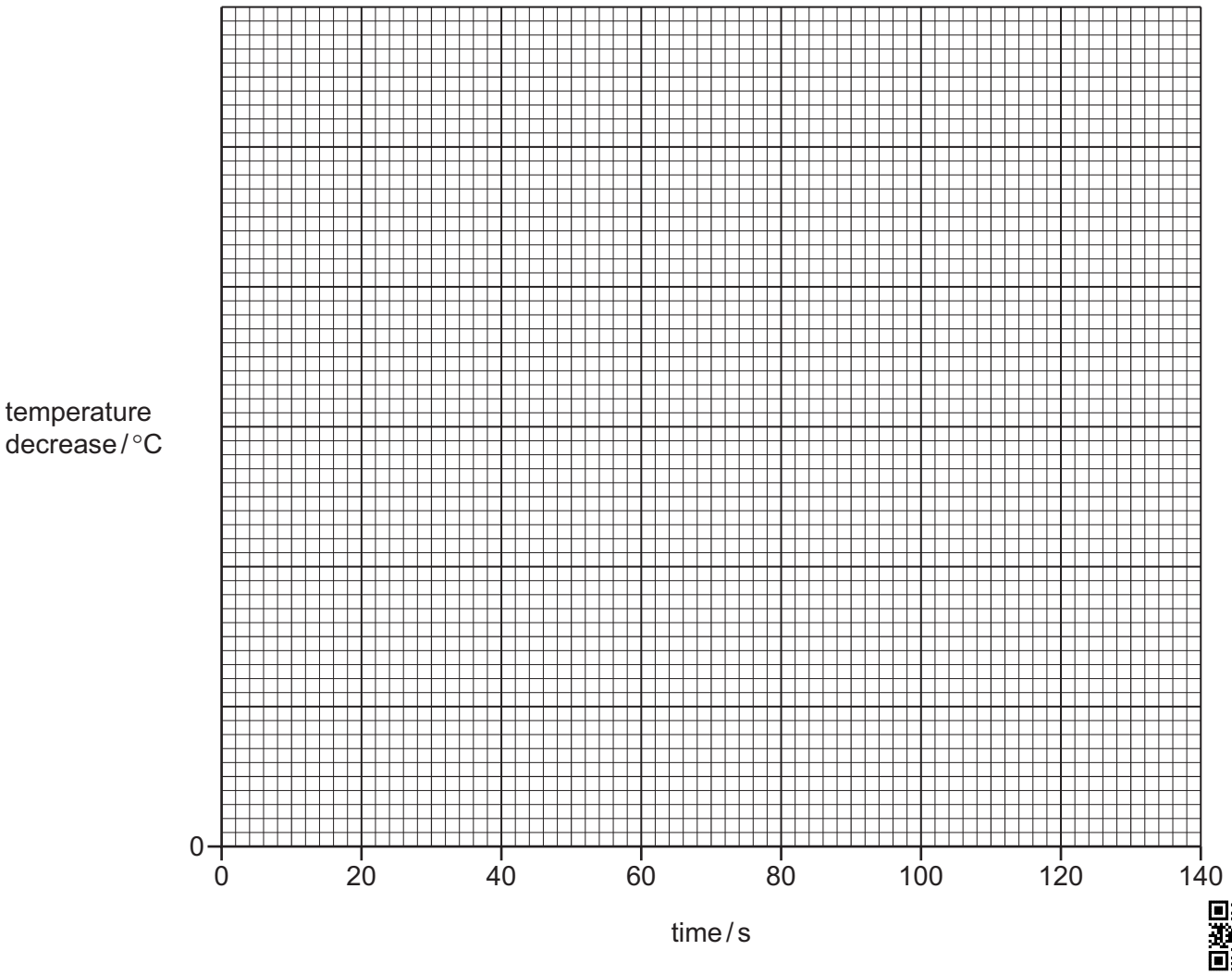
temperature decrease = temperature at 0 s – temperature at 60 s

Table 2.1

	Experiment 1			Experiment 2		
time / s	thermometer diagram	temperature / °C	temperature decrease / °C	thermometer diagram	temperature / °C	temperature decrease / °C
0		24.0	0.0		23.0	0.0
20						
40						
60						
80						
100						
120						

[5]

(b) Complete a suitable scale on the *y*-axis and plot the results from Experiment 1 and Experiment 2 on Fig. 2.1.
Draw **two** lines of best fit. Both of your lines of best fit **must** go to (0,0). Label both lines.



View solution

Fig. 2.1

[4]

View solution

(c) State whether the energy change in Experiment 1 is exothermic or endothermic.
Explain your answer.

.....

..... [1]

(d) Compare the maximum temperature decrease in Experiment 1 with the maximum temperature decrease in Experiment 2.

.....

.....

..... [2]

(e) **From your graph in Fig. 2.1**, deduce the temperature decrease in Experiment 2 after 45 seconds.
Show clearly **on Fig. 2.1** how you worked out your answer.

View solution

temperature decrease = ... °C [2]

(f) The average rate of temperature decrease in each experiment can be calculated using the equation shown.

View solution

$$\text{average rate of temperature decrease} = \frac{\text{temperature decrease}}{\text{time}}$$

Calculate the average rate of temperature decrease in Experiment 1 for 120 seconds.
Give units for the average rate you have calculated.

average rate of temperature decrease = ...

units = ...
[2]

(g) State **two** possible sources of error in these experiments.
For each source of error, suggest an improvement which reduces the error.

View solution

source of error 1 .....

improvement 1 .....

.....

source of error 2 .....

improvement 2 .....

.....
[4]

[Total: 20]

Question 3 starts on the next page.

3 A student tests two substances: solid **R** and solid **S**.

Tests on solid R

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

Table 3.1

tests	observations
test 1 Gently heat about half of solid **R** in a boiling tube.	the white solid forms a colourless liquid steam comes out from the boiling tube and condensation forms at the top of the boiling tube
test 2 The remaining solid **R** is dissolved in distilled water to form solution **R**. Solution **R** is divided into four portions. To the first portion of solution **R**, add aqueous sodium hydroxide dropwise and then in excess.	white precipitate forms the white precipitate dissolves in excess aqueous sodium hydroxide
test 3 To the second portion of solution **R**, add aqueous ammonia dropwise and then in excess.	white precipitate forms the white precipitate remains in excess aqueous ammonia
test 4 To the third portion of solution **R**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.	no change
test 5 To the fourth portion of solution **R**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	cream precipitate forms

View solution

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(a) State the conclusion that can be made from the observations in **test 1**.

..... [1]

(b) Identify solid **R**.

View solution

.....

..... [2]

Tests on solid S

Solid **S** is sodium sulfite.

Record the expected observations.

(c) The student carries out a flame test on solid **S**.

View solution

observations ..... [1]

The student dissolves the remaining solid **S** in distilled water to form solution **S**.
The student divides solution **S** into two portions.

(d) To the first portion of solution **S**, the student adds about 2 cm^3 of aqueous sodium hydroxide.

observations ..... [1]

(e) To the second portion of solution **S**, the student adds a few drops of acidified aqueous potassium manganate(VII).

observations ..... [1]

[Total: 6]

View solution

4 A mixture contains three solid compounds:

- aluminium oxide
- calcium carbonate
- calcium chloride.

View solution

Table 4.1 gives some information about the three compounds in the mixture.

Table 4.1

name of compound	solubility in water	effect of adding aqueous sodium hydroxide
aluminium oxide	insoluble	reacts to form a soluble compound
calcium carbonate	insoluble	no effect
calcium chloride	soluble	reacts to form an insoluble compound

Plan an experiment to find the percentage by mass of calcium carbonate in the mixture. Your plan must include how you will calculate the percentage by mass of calcium carbonate in the mixture.

You are provided with a sample of the mixture, distilled water, aqueous sodium hydroxide 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

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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

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