Cambridge Assessment International Education

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CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **May/June 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.

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1 A student carries out a titration to find the concentration of a sample of dilute hydrochloric acid.

The student:

- adds 25.0 cm^3 of aqueous potassium hydroxide to the apparatus labelled **A** in Fig. 1.1

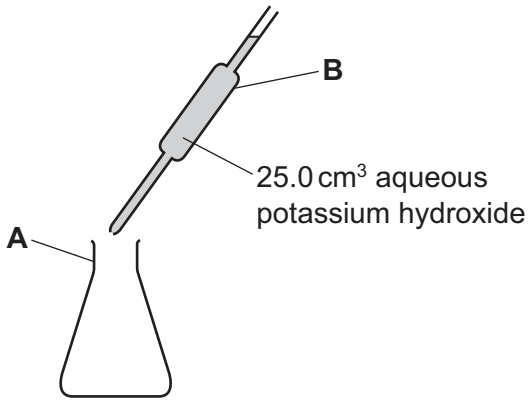

Fig. 1.1

- adds a few drops of a suitable indicator to the apparatus labelled **A**
- uses a burette to add dilute hydrochloric acid to the aqueous potassium hydroxide and indicator mixture in the apparatus labelled **A**.

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

View solution

A .....

B .....

[2]

(b) The student adds the indicator after the volume of the 25.0 cm^3 of aqueous potassium hydroxide has been measured.

(i) Explain why the student adds an indicator to the aqueous potassium hydroxide.

View solution

..... [1]

(ii) Name a suitable indicator.

View solution

..... [1]

(c) Describe how the student can determine the volume of dilute hydrochloric acid used in this titration.

.....

..... [2]

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(d) The student observes the colour changes that occur as they add dilute hydrochloric acid from the burette.

State one **other** thing the student should do as they add the dilute hydrochloric acid to the aqueous potassium hydroxide.

.....

..... [1]

[Total: 7]

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2 A student investigates the temperature change when magnesium reacts with dilute sulfuric acid.

The student does five experiments.

Experiment 1

- Use a 25 cm^3 measuring cylinder to pour 20 cm^3 of dilute sulfuric acid into a boiling tube.
- Use a thermometer to measure the initial temperature of the acid in the boiling tube. Record the initial temperature.
- Add a coiled 5 cm length of magnesium ribbon to the acid in the boiling tube. At the same time start a timer.
- Continually stir the contents of the boiling tube using the thermometer.
- After 45 seconds, measure the temperature of the mixture in the boiling tube. Record this temperature.
- Rinse the boiling tube with distilled water.

Experiment 2

- Use the 25 cm^3 measuring cylinder to pour 20 cm^3 of dilute sulfuric acid into the boiling tube.
- Use a 10 cm^3 measuring cylinder to add 2.0 cm^3 of distilled water to the acid in the boiling tube.
- Place a bung in the boiling tube and invert the tube to mix the acid and water.
- Use the thermometer to measure the initial temperature of the contents of the boiling tube. Record the initial temperature.
- Add a coiled 5 cm length of magnesium ribbon to the contents of the boiling tube. At the same time start a timer.
- Continually stir the contents of the boiling tube using the thermometer.
- After 45 seconds, measure the temperature of the mixture. Record this temperature.
- Rinse the boiling tube with distilled water.

Experiment 3

- Repeat Experiment 2, adding 4.0 cm^3 of distilled water instead of 2.0 cm^3.

Experiment 4

- Repeat Experiment 2, adding 6.0 cm^3 of distilled water instead of 2.0 cm^3.

Experiment 5

- Repeat Experiment 2, adding 10.0 cm^3 of distilled water instead of 2.0 cm^3.

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

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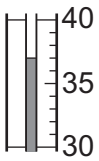
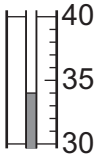
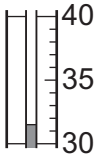
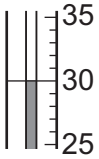
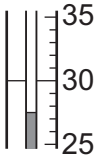
Table 2.1

experiment	volume of dilute sulfuric acid / cm^3	volume of distilled water / cm^3	initial temperature / °C	thermometer diagram after 45 s / °C	temperature after 45 s / °C	temperature increase / °C
1			25.0			
2			25.5			
3			25.5			
4			26.0			
5			26.0			

[5]

(b) (i) State which Experiment, 1, 2, 3, 4 or 5, had the smallest temperature change.

View solution

.....[1]

(ii) Explain why the temperature change was smallest in the experiment you have given in **(b)(i)**.

.....

.....[1]

View solution

(c) Complete a suitable scale on the *y*-axis and plot your results from Experiments 1 to 5 on Fig. 2.1. Draw a line of best fit.

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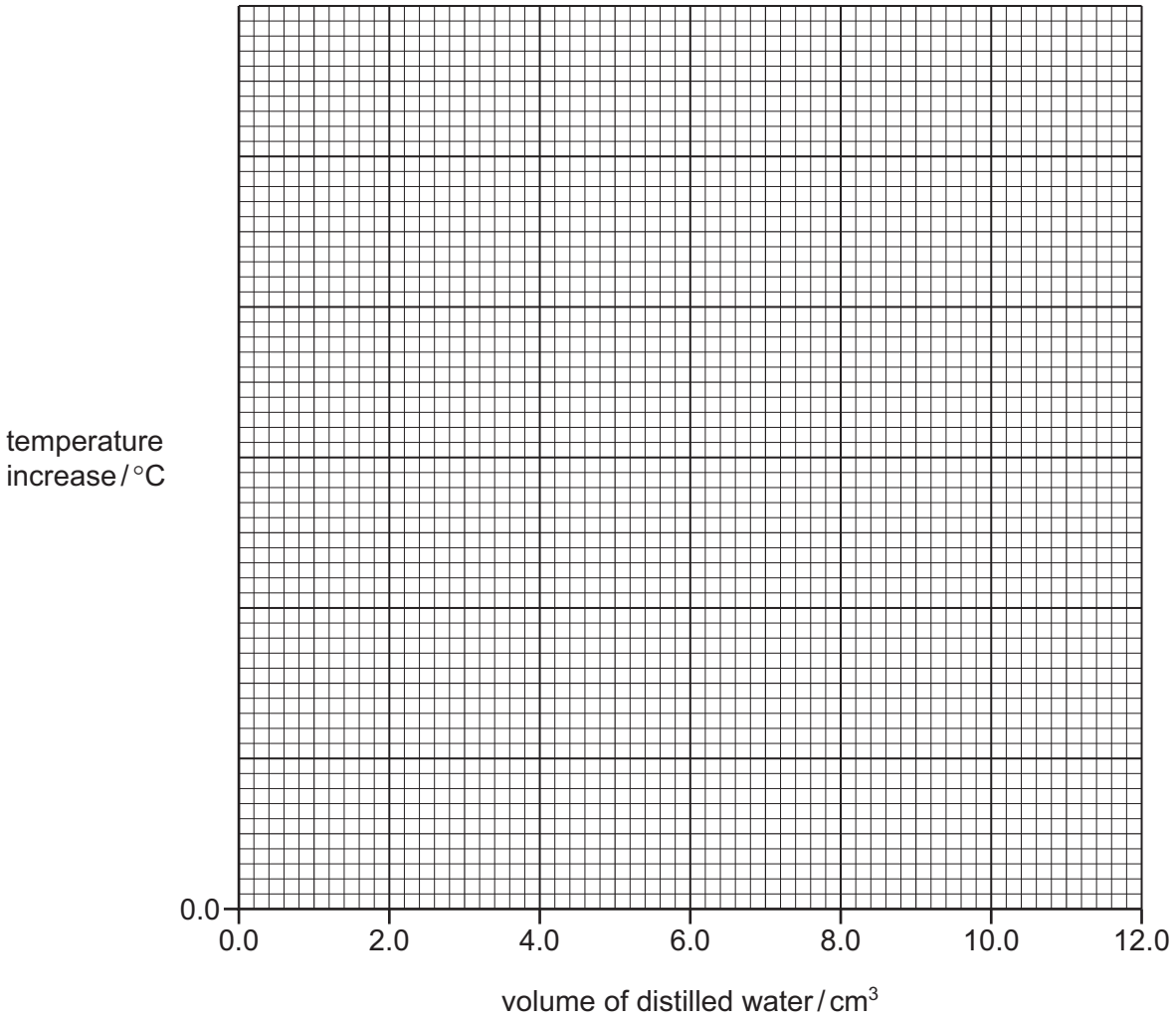

Fig. 2.1

[4]

(d) Use your graph in Fig. 2.1 to deduce the temperature increase when Experiment 2 is repeated with 7.5 cm^3 of distilled water instead of 2.0 cm^3.

Show clearly **on Fig. 2.1** how you worked out your answer.

View solution

..... °C

[2]

(e) The average rate of temperature increase in each experiment is calculated using the equation shown.

View solution

$$\text{average rate of temperature increase} = \frac{\text{temperature increase}}{45 \text{ seconds}}$$

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

average rate of temperature increase = ...

units = ...
[2]

(f) **(i)** Explain why the results of the experiment are more accurate if the boiling tube is wrapped in cotton wool.

.....

.....

..... [2]

(ii) Explain why a 25.0 cm^3 volumetric pipette **cannot** be used to accurately measure the volume of the distilled water added.

.....

..... [1]

(iii) State one **other** way in which the **apparatus** can be changed to give more accurate results.

.....

.....

..... [1]

(g) Sketch **on Fig. 2.1** the graph you would expect if all of the experiments were repeated using a 2 cm length of magnesium ribbon instead of the 5 cm length.

Label your line **g**. [1]

[Total: 20]

View solution

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

Tests on solution E

Solution **E** is aqueous chromium(III) bromide.

Solution **E** is divided into two portions.

Record the expected observations.

View solution

(a) To the first portion of solution **E**, the student adds aqueous sodium hydroxide dropwise and then in excess.

observations adding dropwise .....

.....

observation in excess .....

.....

[2]

(b) To the second portion of solution **E**, the student adds about 1 cm^3 of dilute nitric acid and a few drops of aqueous silver nitrate.

observations .....

..... [1]

View solution

Tests on solid F

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

Table 3.1

tests	observations
test 1 Heat about half of solid **F** in a boiling tube until there is no further change.	the white solid forms a colourless liquid, steam comes out from the boiling tube and condensation is seen at the top of the boiling tube, after a while the colourless liquid becomes a white solid
test 2 The remaining solid **F** is dissolved in water to form solution **F**. Solution **F** is divided into three portions. To the first portion of solution **F** in a boiling tube, add aqueous sodium hydroxide dropwise and then in excess. Warm the product and hold damp red litmus paper at the mouth of the boiling tube.	no change the damp red litmus paper remains red
test 3 To the second portion of solution **F**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.	white precipitate
test 4 To the third portion of solution **F**, add a few drops of acidified aqueous potassium manganate(VII).	the solution becomes light purple

(c) The observations in **test 1** show that solid **F** is hydrated.

Describe a chemical test to show that the condensation at the top of the boiling tube contains water.

test .....

result .....

[2]

View solution

(d) From the tests and observations in Table 3.1 it is **not** possible to identify the cation in solid **F**.

Give another test that can be carried out to help identify the cation in solid **F**.

View solution

.....

..... [1]

(e) Identify the anion in solid **F**.

View solution

..... [1]

[Total: 7]

4 A **mixture** contains three compounds:

View solution

- liquid ethanol
- solid sodium chloride
- solid zinc carbonate.

Table 4.1 gives some information about these three compounds.

Table 4.1

name of compound	solubility in water	solubility in ethanol
ethanol	soluble	
sodium chloride	soluble	insoluble
zinc carbonate	insoluble	insoluble

Describe how to obtain a pure sample of each of the three compounds, ethanol, sodium chloride and zinc carbonate, from the mixture.

You are provided with 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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