Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2105757152

CHEMISTRY **5070/42**

Paper 4 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.

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

DC (DE/CGW) 326711/4

1 **(a)** A student finds the amount of iron(II) ions in a solution by titration.

The student:

- uses a volumetric pipette to add $25.0\,cm^3$ of aqueous iron(II) sulfate to a conical flask
- adds approximately $20\,cm^3$ of dilute sulfuric acid to the flask
- slowly adds aqueous potassium manganate(VII) to the conical flask until the solution just turns pink
- repeats the titration several times.

(i) Fig. 1.1 shows the apparatus the student uses to measure the volume of dilute sulfuric acid.

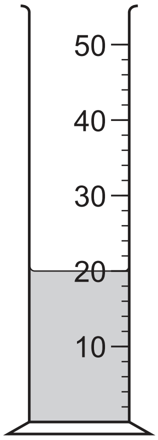

Fig. 1.1

Name the apparatus shown in Fig. 1.1.

.... [1]

(ii) Explain why the student does **not** need to use a volumetric pipette to measure the volume of dilute sulfuric acid.

....

.... [1]

(iii) Describe how the student uses the volumetric pipette to measure $25.0\,cm^3$ of aqueous iron(II) sulfate safely.

....

.... [1]

(b) Name the apparatus the student uses to add the aqueous potassium manganate(VII) to the flask.

.... [1]

(c) State why the student does **not** need to add an indicator to this titration.

....

.... [1]

(d) Explain how the student knows when they have done enough titrations.

....

.... [1]

[Total: 6]

2 A student investigates the temperature change when a solid completely dissolves in water.

The student:

- measures 25 cm^3 of distilled water and pours it into a beaker
- uses a thermometer to measure the initial temperature of the water in the beaker
- records this temperature in Table 2.1 at time 0 s
- adds a sample of the solid to the beaker and starts a stop-watch
- stirs the mixture and records the temperature and time at 60 s intervals for a total of 300 s.

Some of the results are shown in Table 2.1.

Table 2.1

time / s	temperature / °C
0	19.5
60	13.0
120	
180	14.0
240	14.5
300	

(a) **(i)** Fig. 2.1 shows the results for 120 s and 300 s.

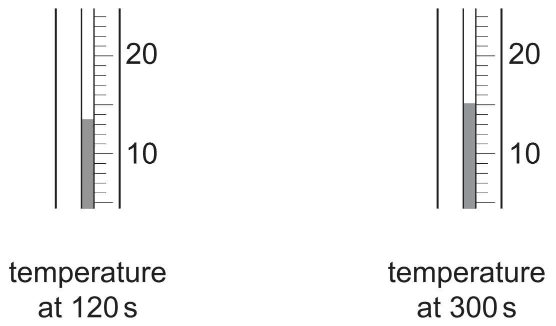

Fig. 2.1

Record the values from Fig. 2.1 to the nearest 0.5 °C in Table 2.1. [3]

(ii) Calculate the maximum temperature change in the investigation.

maximum temperature change .... °C [1]

(iii) Describe the trends shown in the results in Table 2.1.

....

....

.... [2]

(iv) Suggest the temperature of the mixture if it is left for 60 minutes.

Explain your answer.

temperature after 60 minutes .... °C

explanation ....

....
[2]

(b) Describe the energy change when the solid dissolves in water.

Explain how the results in Table 2.1 support your answer.

description ....

explanation ....

....
[2]

(c) Explain why it is important for the student to stir the mixture.

....

.... [1]

(d) The maximum temperature change calculated is **not** the true value for this investigation.

This may be because the volume of water and the temperature are **not** measured precisely.

Explain how to obtain a more precise **temperature** measurement.

....

.... [1]

(e) The maximum temperature change calculated is less than the true value for this investigation.

Suggest a reason for this, other than the precision of measurements.

Describe an improvement to the method which reduces this error.

reason ....

....

improvement ....

.... [2]

[Total: 14]

Question 3 starts on page 8

3 A student does a series of experiments to investigate solution **R**.

(a) **(i)** The student leaves a wooden splint with one end dipped into **R** for ten minutes. The student then places the damp end of the wooden splint into the flame of a Bunsen burner with the air hole open.

The student concludes that **R** contains sodium ions.

State the observation which allows the student to make this conclusion.

.... [1]

(ii) Explain why the air hole on the Bunsen burner must be open when doing this flame test.

....

.... [1]

(b) **(i)** The student adds dilute nitric acid to **R**.

The student observes effervescence of a colourless gas which turns limewater milky.

State the conclusions from these observations.

....

.... [2]

(ii) The student adds aqueous barium nitrate to some of the mixture from **(b)(i)**.

The student concludes that **R** contains sulfate ions.

State the observation which allows the student to make this conclusion.

.... [1]

(iii) The student adds aqueous silver nitrate to some of the mixture from **(b)(i)**.

The student observes a colourless solution.

State a conclusion from this observation.

....

.... [1]

(iv) The student adds aqueous sodium hydroxide to **R** and warms the mixture.

Describe a test and observation to show that **R** does **not** contain ammonium ions.

test ....

observation...

.... [2]

(c) Solution **R** is made from a mixture of two different ionic compounds.

Suggest the names of these **two** compounds.

....

.... [2]

(d) The student tests a different solution, **P**, and finds it difficult to decide whether the solution contains chloride ions or bromide ions.

The student also has aqueous potassium chloride and aqueous potassium bromide.

Suggest how the student could use the aqueous potassium chloride and aqueous potassium bromide to make it easier to decide whether **P** contains chloride ions or bromide ions.

....

....

....

.... [2]

(e) The student adds dilute hydrochloric acid to another solution and a gas is produced. The gas is passed through limewater.

Describe how the gas can be passed through limewater.

You may draw a labelled diagram to help answer the question.

....

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....

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[2]

[Total: 14]

Question 4 starts on page 12

4 Copper(II) carbonate reacts with dilute sulfuric acid at room temperature.

The word equation for the reaction is shown.

copper(II) carbonate + sulfuric acid → copper(II) sulfate + carbon dioxide + water

Plan an experiment to determine the volume of carbon dioxide formed when a known mass of copper(II) carbonate completely reacts with dilute sulfuric acid.

Your plan must include the use of common laboratory apparatus, dilute sulfuric acid and copper(II) carbonate. No other chemicals should be used.

Your plan must include:

- the apparatus needed
- the method to use and the measurements to take
- procedures to ensure that the volume measured is as accurate as possible.

You may draw a diagram to help answer the question.

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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