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Cambridge Assessment International Education

# Cambridge IGCSE™

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**CHEMISTRY** **0620/61**

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.

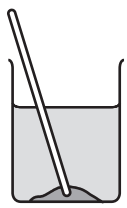
This document has **16** pages. Any blank pages are indicated.

1 A student has a mixture of copper(II) carbonate powder and crystals of sodium sulfate. Copper(II) carbonate is insoluble in water. Sodium sulfate is soluble in water.

The student tries to obtain pure copper(II) carbonate and crystals of pure sodium sulfate from the mixture. Fig. 1.1 shows four of the steps the student carries out.

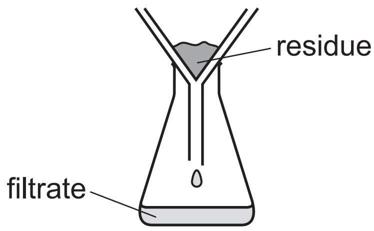
**step 1**

Add distilled water to the mixture and stir.



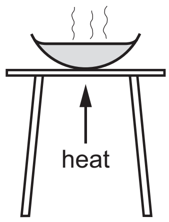
**step 2**

Filter the mixture.




**step 3**

Heat the filtrate from **step 2** until crystals start to form.




**step 4**

Leave the residue on the filter paper from **step 2** in a warm place to dry.

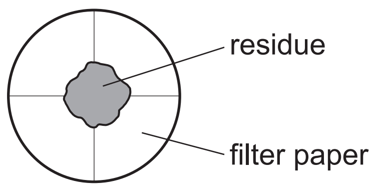



**Fig. 1.1**

**(a)** State what happens to the sodium sulfate in **step 1**.

.............................................................................................................................................. [1]

**(b)** State what is removed from the filtrate in **step 3**.

.............................................................................................................................................. [1]

**(c)** Describe what must be done after the filtrate has been heated in **step 3** to obtain a larger amount of sodium sulfate crystals.

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.............................................................................................................................................. [1]

**(d)** **(i)** State what must be done to the residue before it is allowed to dry in **step 4** to obtain pure copper(II) carbonate.

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.................................................................................................................................... [1]

**(ii)** Identify the substance removed from the copper(II) carbonate in **(d)(i)**.

.................................................................................................................................... [1]

[Total: 5]

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**2** A student investigates the reaction between aqueous magnesium sulfate and aqueous barium nitrate.
A precipitate of barium sulfate forms in the reaction.

The student does eight experiments.

Experiment 1

- Fill a burette with aqueous magnesium sulfate. Run some of the aqueous magnesium sulfate out of the burette so that the level of the aqueous magnesium sulfate is on the burette scale.
- Fill a second burette with aqueous barium nitrate. Run some of the aqueous barium nitrate out of the burette so that the level of the aqueous barium nitrate is on the burette scale.
- Add 4.0 $cm^3$ of aqueous magnesium sulfate from the first burette into a 10 $cm^3$ measuring cylinder.
- Add 1.0 $cm^3$ of aqueous barium nitrate from the second burette into the same measuring cylinder.
- Place a stopper in the top of the measuring cylinder and invert the measuring cylinder several times.
- Leave the measuring cylinder to stand for 15 minutes.
- Record the level of the precipitate on the measuring cylinder scale.
- Rinse the measuring cylinder with distilled water.

Experiment 2

- Repeat Experiment 1 using 1.5 $cm^3$ of aqueous barium nitrate instead of 1.0 $cm^3$.

Experiment 3

- Repeat Experiment 1 using 2.5 $cm^3$ of aqueous barium nitrate instead of 1.0 $cm^3$.

Experiment 4

- Repeat Experiment 1 using 3.0 $cm^3$ of aqueous barium nitrate instead of 1.0 $cm^3$.

Experiment 5

- Repeat Experiment 1 using 3.5 $cm^3$ of aqueous barium nitrate instead of 1.0 $cm^3$.

Experiment 6

- Repeat Experiment 1 using 4.5 $cm^3$ of aqueous barium nitrate instead of 1.0 $cm^3$.

Experiment 7

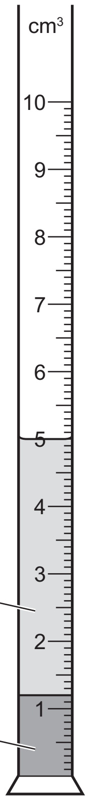
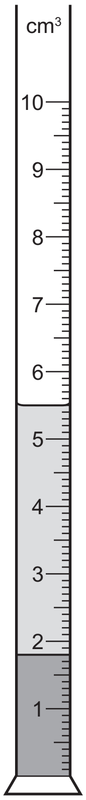
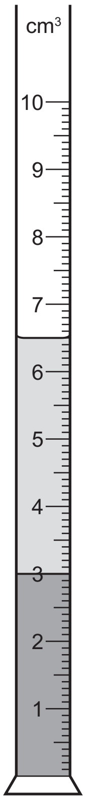
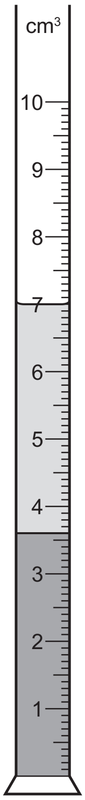
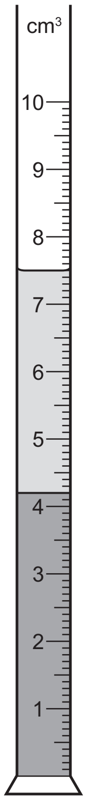
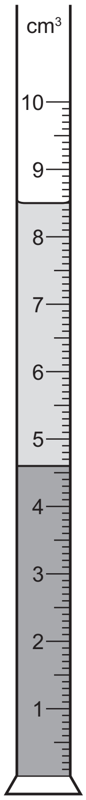
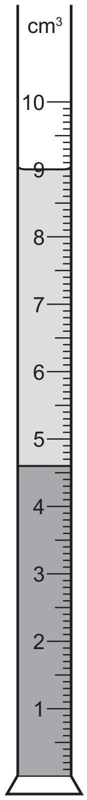
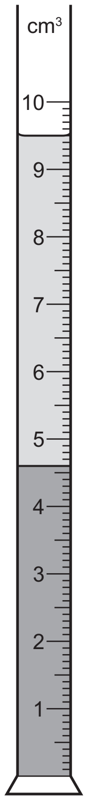
- Repeat Experiment 1 using 5.0 $cm^3$ of aqueous barium nitrate instead of 1.0 $cm^3$.

Experiment 8

- Repeat Experiment 1 using 5.5 $cm^3$ of aqueous barium nitrate instead of 1.0 $cm^3$.

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

**Table 2.1**

| experiment | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| volume of aqueous magnesium sulfate / $cm^3$ | 4.0 | | | | | | | |
| volume of aqueous barium nitrate / $cm^3$ | 1.0 | | | | | | | |
| measuring cylinder diagram<br>solution<br>precipitate |  |  |  |  |  |  |  |  |
| level of precipitate on the measuring cylinder scale / $cm^3$ | 1.2 | | | | | | | |

[4]

**(b)** Complete a suitable scale on the *y*-axis and plot the results from Experiments 1 to 8 on Fig. 2.1. Draw **two** straight lines of best fit through your points. The first straight line should be for the first five experiments and must be extended to pass through (0,0). The second straight line should be for the last three experiments and must be horizontal. Extend the straight lines so that they cross each other.

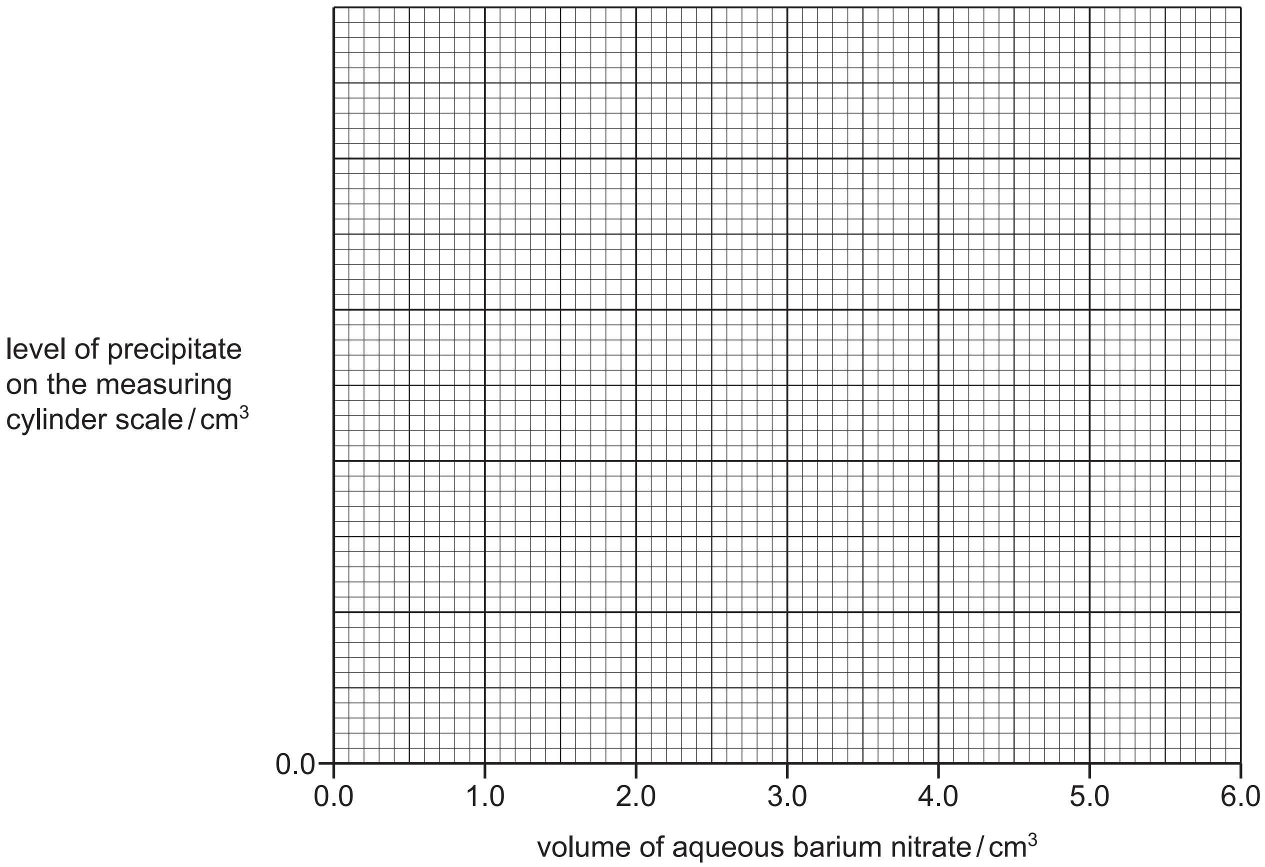



**Fig. 2.1**

[5]

**(c)** Use Fig. 2.1 to deduce the level of precipitate on the measuring cylinder scale when the experiment is repeated using 2.8 $cm^3$ of aqueous barium nitrate.
Show clearly on Fig. 2.1 how you worked out your answer.

level of precipitate = .............................. $cm^3$ [2]

**(d)** The student repeats the experiment using 6.5 $cm^3$ of aqueous barium nitrate.

Predict the level of precipitate on the measuring cylinder scale.

Explain your answer.

prediction ..........................................................................................................................

explanation ..........................................................................................................................

..........................................................................................................................

[2]

**(e)** Sketch on Fig. 2.1 the graph obtained if all of the experiments are repeated using aqueous barium nitrate of half the concentration used in Experiments 1 to 8. [2]

**(f)** Suggest why the measuring cylinder is inverted several times after the aqueous barium nitrate is added.

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.................................................................................................................................... [1]

**(g)** Suggest why the measuring cylinder is left to stand before the level of the precipitate is recorded.

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**(h)** The volumes of both aqueous solutions are measured using burettes.

**(i)** Give a reason why burettes are used rather than measuring cylinders.

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**(ii)** Suggest why burettes are used rather than volumetric pipettes.

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.................................................................................................................................... [1]

[Total: 19]

3 A student tests two solids: solid **T** and solid **U**.

**Tests on solid T**

Solid **T** is lithium sulfite.

Complete the expected observations.

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

observations .................................................................................................................. [1]

The student dissolves the remaining solid **T** in water to form solution **T**.

The student divides solution **T** into two portions.

**(b)** The student adds the first portion of solution **T** to a test-tube containing acidified aqueous potassium manganate(VII).

State the colour change.

from ............................................................... to ............................................................... [2]

**(c)** **(i)** To the second portion of solution **T**, the student adds excess dilute nitric acid. The gas produced turns filter paper soaked in acidified aqueous potassium manganate(VII) white.

Identify the gas produced.

.............................................................................................................................. [1]

**(ii)** To the solution produced in **(c)(i)**, the student adds aqueous barium nitrate.

observations .................................................................................................................. [1]

**Tests on solid U**

Solid **U** contains one cation and one anion.
Table 3.1 shows the tests and the student's observations for solid **U**.

The student dissolves solid **U** in distilled water to form solution **U**. The student then divides solution **U** into three portions.

**Table 3.1**

| tests | observations |
|---|---|
| **test 1**<br><br>To the first portion of solution **U**, add a few drops of aqueous ammonia. | green precipitate |
| **test 2**<br><br>To the second portion of solution **U**, add 1 $cm^3$ of dilute nitric acid followed by a few drops of aqueous silver nitrate. | yellow precipitate |
| **test 3**<br><br>To the third portion of solution **U**, add 1 $cm^3$ of aqueous chlorine. | the solution turns brown |

**(d)** Identify **two** cations that the tests and observations in Table 3.1 show could be in solid **U**.

..........................................................................................................................................

.................................................................................................................................... [2]

**(e)** Describe an additional test that the student could do to confirm which one of the two cations identified in **(d)** is in solid **U**.
Give the expected result for **one** of the cations.

test ...................................................................................................................................

cation ...............................................................................................................................

result ...............................................................................................................................
[2]

**(f)** Identify the anion in solid **U**.

.................................................................................................................................... [1]

[Total: 10]

**4** Beetroot is a coloured vegetable. The colour is caused by a mixture of water-soluble coloured compounds.

Plan an experiment to find how many water-soluble coloured compounds there are in a beetroot.

Include in your plan:

- how to extract the coloured compounds from a beetroot
- how to separate the mixture of coloured compounds
- how the results show how many coloured compounds there are in a beetroot.

You are provided with a beetroot, distilled water and common laboratory apparatus.

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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 |