Cambridge Assessment International Education

# Cambridge O Level

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| CANDIDATE NAME | | | | | | | | | |
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**CHEMISTRY** **5070/41**

Paper 4 Alternative to Practical **October/November 2022**

**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**

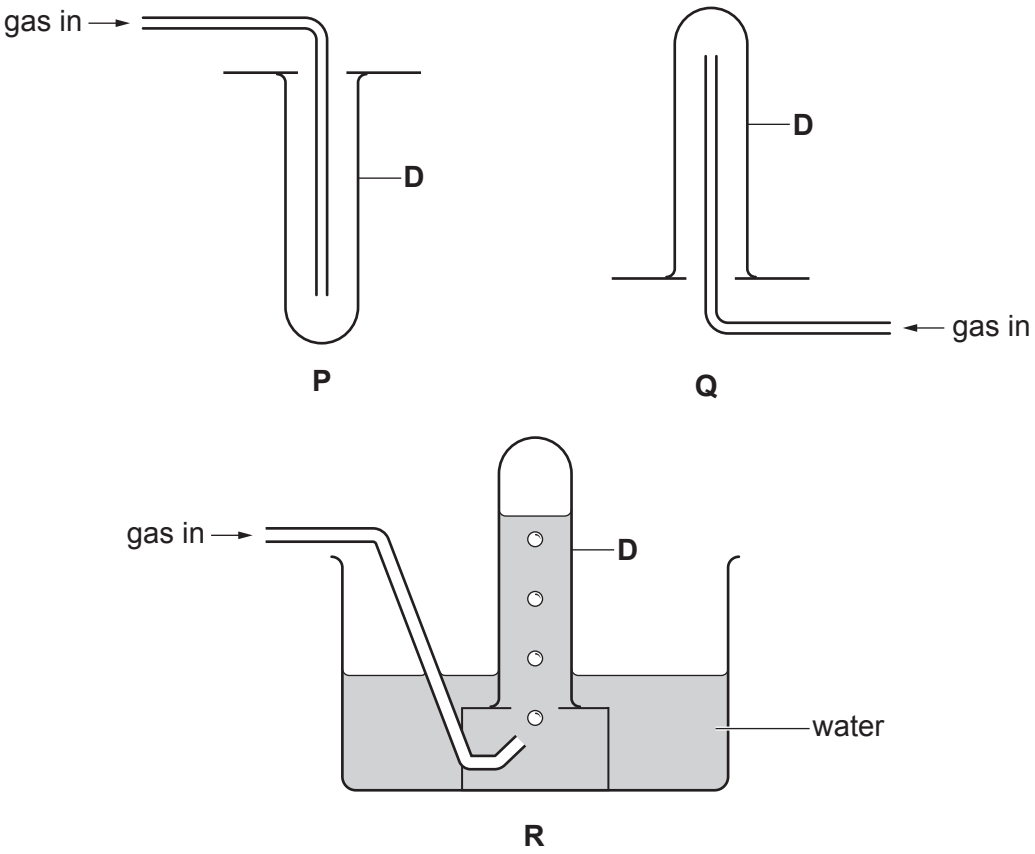
- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

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

**1** Two gases **A** and **B** have the properties shown.

| gas | density | solubility in water | appearance |
|---|---|---|---|
| **A** | less dense than air | insoluble | colourless |
| **B** | less dense than air | soluble | brown |

Some sets of apparatus, **P**, **Q** and **R**, used to collect gases are shown.




**(a)** Name apparatus **D**.

..... [1]

**(b)** **Q** is used to collect gas **B**.

**(i)** State why **R** is **not** used to collect gas **B**.

..... [1]

**(ii)** State why **P** is **not** used to collect gas **B**.

..... [1]

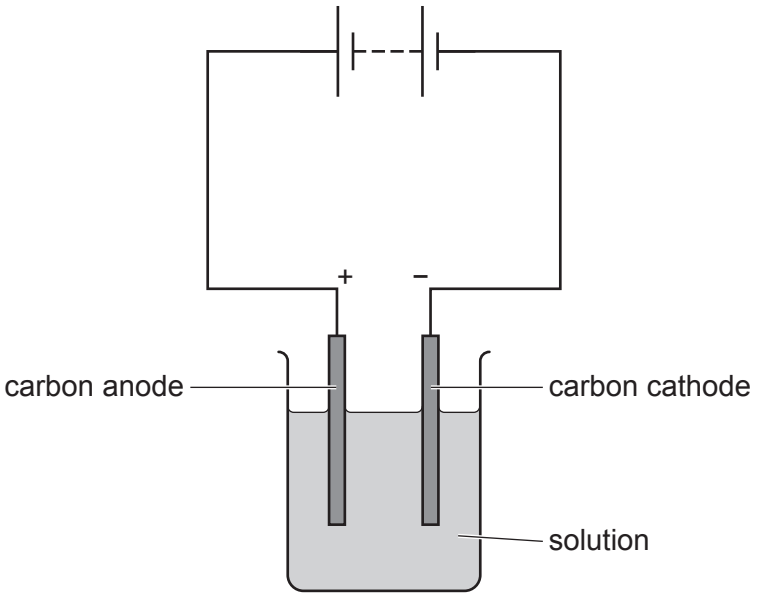
**(c)** State why **R** is more suitable than **Q** to collect gas **A**.

.....

..... [1]

[Total: 4]

**2** A student electrolyses two aqueous solutions using the apparatus shown.




**(a)** Complete the table.

| | anode (+) | | cathode (–) | |
|---|---|---|---|---|
| solution | name of product | observation | name of product | observation |
| aqueous copper(II) sulfate | oxygen | | | |
| concentrated aqueous sodium chloride | chlorine | | hydrogen | |

[5]

**(b)** **(i)** Describe the test used to identify chlorine gas.

test .....

observation .....

[2]

**(ii)** Chlorine gas is toxic.

Describe a safety precaution that the student should take because of this hazard.

..... [1]

[Total: 8]

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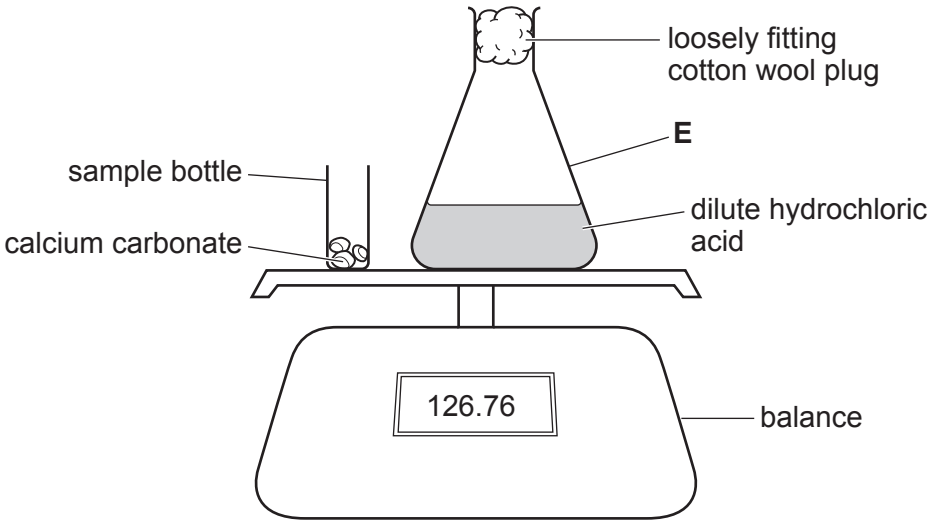
**3** Calcium carbonate reacts with dilute hydrochloric acid.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

A student investigates the rate of this reaction using three different concentrations of hydrochloric acid.




The student:

- adds all of the calcium carbonate in the sample bottle to the dilute hydrochloric acid in **E**
- replaces the sample bottle on the balance
- records the mass every 30 seconds.

**(a)** Name apparatus **E**.

..... [1]

**(b)** Carbon dioxide gas is a product of the reaction.

**(i)** Describe the test used to identify carbon dioxide gas.

test .....

observation .....
[2]

**(ii)** Explain why the mass decreases as time increases.

..... [1]

**(iii)** The student uses the measurement of mass as time increases to determine the rate of this reaction.

State a **different** measurement that the student could make as time increases to determine the rate of this reaction.

..... [1]

**(c)** In each of the three experiments the student uses a different concentration of hydrochloric acid.

All other variables are kept constant.

The three experiments are labelled **X**, **Y** and **Z**.

| experiment | concentration of hydrochloric acid in mol / $dm^3$ |
|---|---|
| **X** | 1.00 |
| **Y** | 0.50 |
| **Z** | 0.25 |

The hydrochloric acid is in excess in each of the three experiments.

A catalyst is not used.

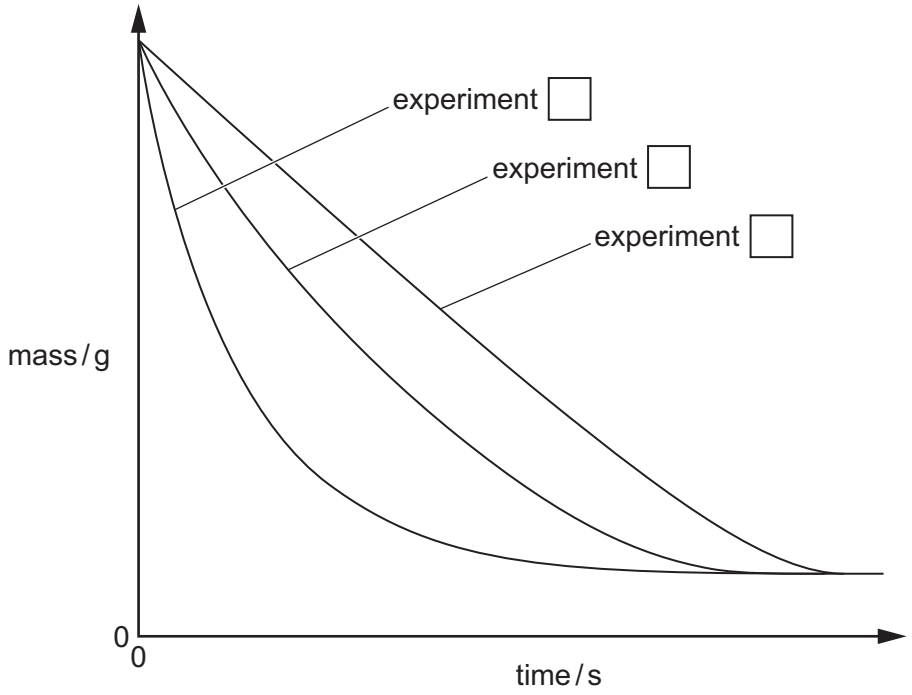
Identify two variables that should be kept constant in this investigation.

1 .....

2 .....

[2]

**(d)** The student plots a graph of the results.




**(i)** Describe how the graph is used to decide which experiment has the greatest rate.

.....

..... [1]

**(ii)** Write a letter in each box on the graph to identify experiments **X**, **Y** and **Z**. [1]

**(iii)** Describe how the graph shows that the reactions stop.

..... [1]

**(iv)** Explain why the reactions stop.

..... [1]

[Total: 11]

**4** A student is provided with two bottles labelled **A** and **B** and a supply of dilute hydrochloric acid.

One of the bottles contains 1.00 g of solid potassium carbonate, $K_2CO_3$.

The other bottle contains 1.00 g of solid potassium hydrogencarbonate, $KHCO_3$.

The reaction between potassium carbonate and dilute hydrochloric acid is exothermic.

The reaction between potassium hydrogencarbonate and dilute hydrochloric acid is endothermic.

Plan experiments using the reaction of each solid with dilute hydrochloric acid to decide:

- which solid is in each bottle
- which reaction has the greatest heat change per gram of solid.

Your plan may use any of the apparatus normally found in a chemistry laboratory but no other chemicals.

Your plan must state all the measurements you need to make.

Your plan must use the same experimental procedure for each solid.

.....

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.....

..... [6]

**5** Solution **K** is an aqueous solution of sodium hydroxide, NaOH.

A student determines the concentration of solution **K** using a method that involves titration.

The student measures 25.0 $cm^3$ of solution **K** using a pipette.

The student makes up the solution to 250 $cm^3$ with distilled water. This is solution **L**.

**(a)** Explain why a pipette is used instead of a measuring cylinder to measure 25.0 $cm^3$ of solution **K**.

..... [1]

**(b)** Name the container in which solution **L** is made.

..... [1]

**(c)** A pipette is used to transfer 20.0 $cm^3$ of solution **L** into a flask.

The pipette is washed out before measuring solution **L**.

Identify the liquid that is used to wash out the pipette.

..... [1]

**(d)** The student adds two drops of methyl orange to solution **L** in the flask and then places the flask on a white tile.

The student fills a burette with 0.100 mol / $dm^3$ sulfuric acid, $H_2SO_4(aq)$.

The $H_2SO_4(aq)$ is added to the flask until there is a colour change.

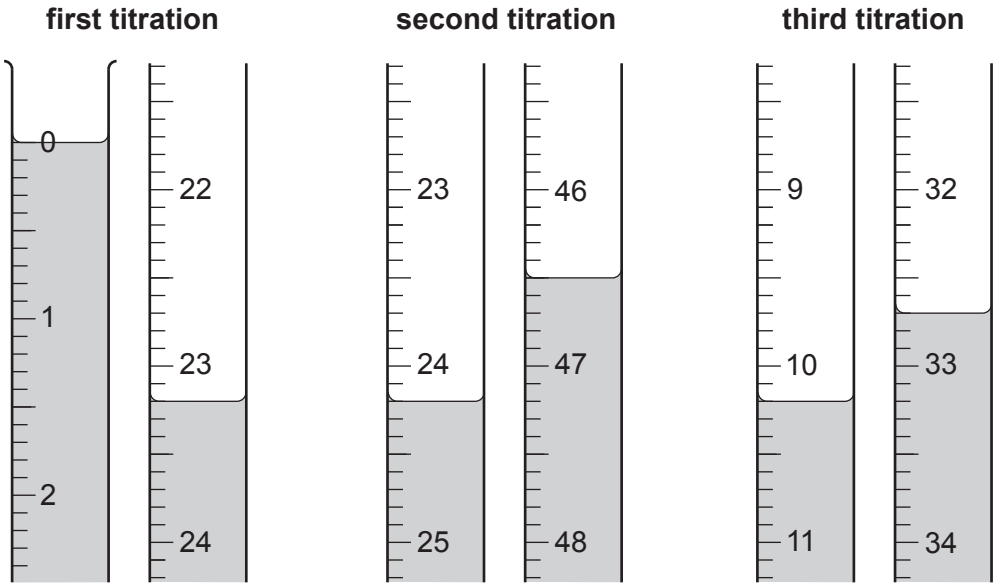
**(i)** Explain why the conical flask is placed on a white tile.

..... [1]

**(ii)** State the colour change of the methyl orange indicator at the end-point.

The colour changes from ..... to ..... . [1]

**(e)** The student does three titrations. The diagrams below show parts of the burette with the liquid levels both at the beginning and at the end of each titration.




Use the diagrams to complete the table.

| titration number | 1 | 2 | 3 |
|---|---|---|---|
| final burette reading / $cm^3$ | | | |
| initial burette reading / $cm^3$ | | | |
| volume of $H_2SO_4(aq)$ added / $cm^3$ | | | |
| best titration results (✓) | | | |

Tick (✓) the best titration results in the table.

Use the best titration results to calculate the average volume of $H_2SO_4(aq)$ added.

..... $cm^3$ [4]

**(f)** Calculate the number of moles of $H_2SO_4$ in the average volume of 0.100 mol / $dm^3$ $H_2SO_4(aq)$ added in **(e)**.

..... mol [1]

**(g)** The equation for the reaction of sodium hydroxide with sulfuric acid is shown.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

Use this equation to calculate the number of moles of NaOH in 20.0 $cm^3$ of solution **L**.

..... mol [1]

**(h)** Calculate the number of moles of NaOH in 250 $cm^3$ of solution **L**.

..... mol [1]

**(i)** Deduce the number of moles of NaOH in 25.0 $cm^3$ of solution **K**.

..... mol [1]

**(j)** Calculate the concentration of solution **K** in mol / $dm^3$.

..... mol / $dm^3$ [1]

**(k)** A different student does the same experiment using 20 drops of methyl orange instead of 2 drops of methyl orange.

Methyl orange is acidic.

State if the average titration volume of $H_2SO_4(aq)$ is smaller, larger, or unchanged when 20 drops of methyl orange are used.

Explain your answer.

.....

.....

..... [2]

[Total: 16]

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**6** A student is provided with aqueous copper(II) sulfate, aqueous aluminium sulfate and an aqueous solution labelled **X**.

The student tests the three solutions by adding each reagent shown in the table.

**(a)** Complete the table with the expected observations.

| | aqueous solutions | | |
|---|---|---|---|
| reagents | copper(II) sulfate | aluminium sulfate | **X** |
| aqueous sodium hydroxide | ..... ..... ..... | ..... ..... ..... | red-brown precipitate |
| aqueous sodium hydroxide in excess | ..... ..... ..... | ..... ..... ..... | precipitate remains |
| aqueous ammonia | ..... ..... ..... | ..... ..... ..... | red-brown precipitate |
| aqueous ammonia in excess | ..... ..... ..... | ..... ..... ..... | precipitate remains |
| aqueous silver nitrate and dilute nitric acid | ..... ..... ..... | ..... ..... ..... | white precipitate |
| aqueous barium nitrate and dilute nitric acid | ..... ..... ..... | ..... ..... ..... | no change |

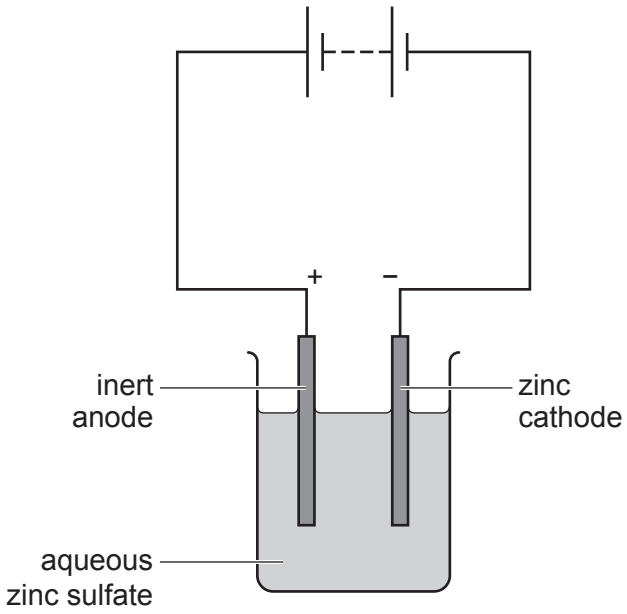
[7]

**(b)** Identify **X**.

..... [2]

[Total: 9]

**7** A student passes electricity through an aqueous solution of zinc sulfate using an inert anode and a zinc cathode of known mass.




Zinc is deposited at the cathode.

After 5 minutes, the student removes the cathode to determine the mass of zinc deposited.

**(a)** State what the student does to the cathode after removing it from the solution but before placing it on the balance to measure its mass.

..... [1]

**(b)** The student measures the mass of the cathode and then puts it back into the circuit and continues the experiment.

The student determines the mass of zinc deposited every five minutes.

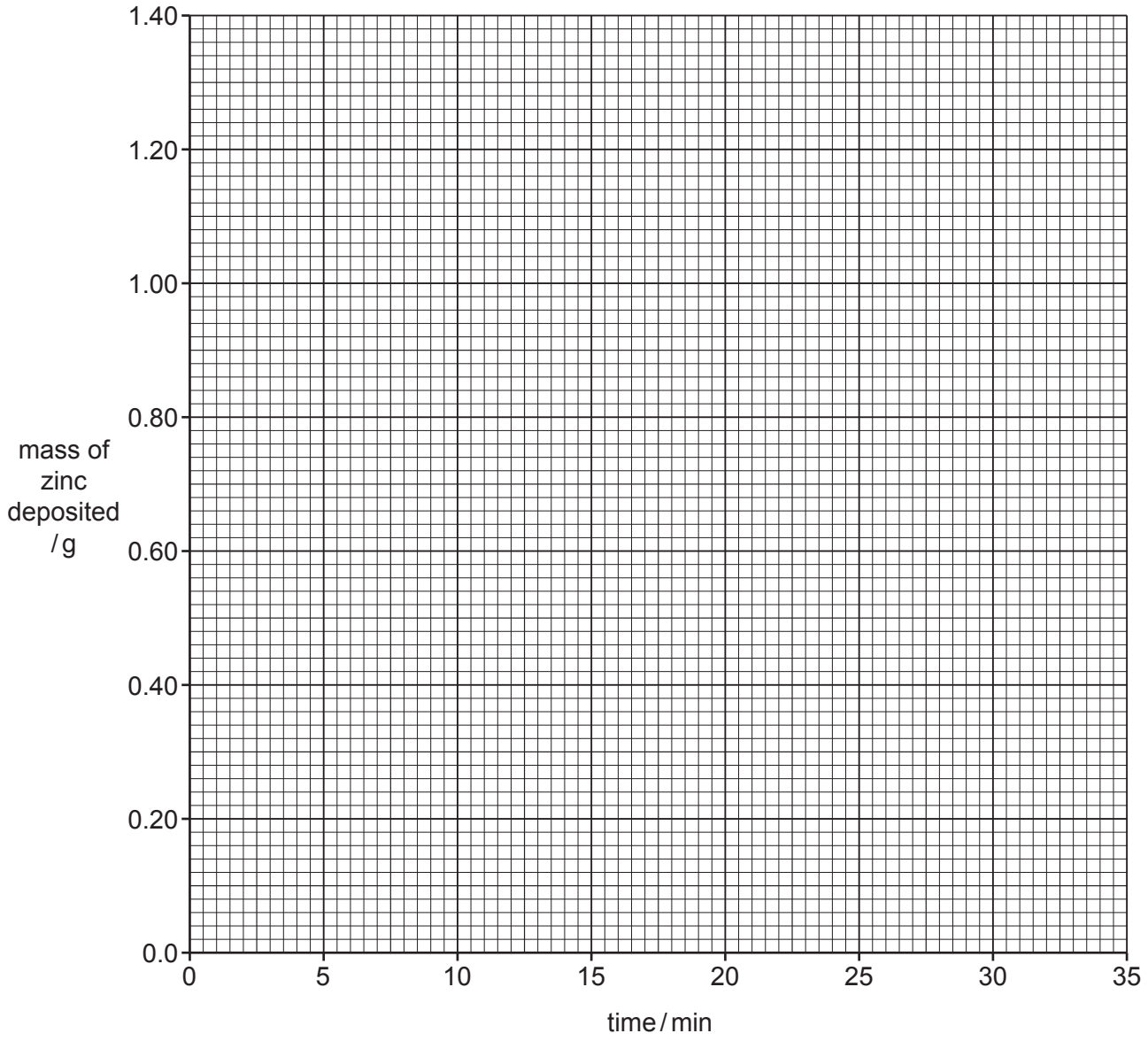
| time / min | mass of zinc deposited / g |
|---|---|
| 0 | 0.00 |
| 5 | 0.29 |
| 10 | 0.59 |
| 15 | 0.88 |
| 20 | 1.20 |
| 25 | 1.30 |
| 30 | 1.30 |
| 35 | 1.30 |

Plot the results from the table on the grid.

Draw a straight line through the first five points.

Draw another straight line through the last three points.

Extend both lines so they intersect.




[3]

**(c) (i)** Use your graph to determine the mass of zinc deposited after 18 minutes.

..... g [1]

**(ii)** Use your graph to determine the minimum time taken for all the zinc to be deposited.

..... min [1]

[Total: 6]

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