# Cambridge International AS & A Level

| CANDIDATE NAME | |
|---|---|

| CENTRE NUMBER | | CANDIDATE NUMBER | |
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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.
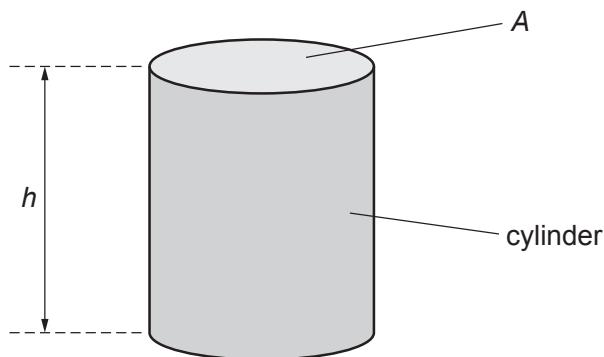
## INFORMATION

- The total mark for this paper is 30.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **8** pages.

**[Turn over**

**1** A student investigates the heating of a solid metal cylinder. Fig. 1.1 shows the cylinder of cross-sectional area *A* and height *h*.



**Fig. 1.1**

The student places the cylinder and an electrical heater in a beaker of water. The electrical heater is switched on and the student measures the time *t* for the temperature of the water to increase by $\Delta\theta$.

A number of cylinders of the same material but with different cross-sectional areas are available.

It is suggested that the relationship between *t* and *A* is

$$Pt = AhW\Delta\theta + Z\Delta\theta$$

where *P* is the power of the heater and *W* and *Z* are constants.

Design a laboratory experiment to test the relationship between *t* and *A*.
Explain how your results could be used to determine values for *W* and *Z*.

You should draw a diagram, on page 3, showing the arrangement of your equipment.
In your account you should pay particular attention to:

● the procedure to be followed

● the measurements to be taken

● the control of variables

● the analysis of the data

● any safety precautions to be taken.

**Diagram**

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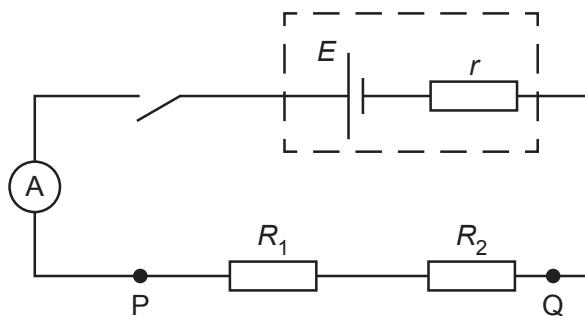
...................................................................................................................... [15]

**2** A student investigates the current in a circuit containing a cell, as shown in Fig. 2.1.



**Fig. 2.1**

The student connects two resistors of resistances $R_1$ and $R_2$ between P and Q. The ammeter measures the current $I$.

The student repeats the experiment with different resistors between P and Q.

It is suggested that $I$, $R_1$ and $R_2$ are related by the equation

$$E = I(R_1 + R_2 + r)$$

where $E$ is the electromotive force (e.m.f.) and $r$ is the internal resistance of the cell.

**(a)** A graph is plotted of $\frac{1}{I}$ on the $y$-axis against $(R_1 + R_2)$ on the $x$-axis.

Determine expressions for the gradient and $y$-intercept.

gradient = ...........................................................

$y$-intercept = ...........................................................

[1]

**(b)** Values of $R_1$, $R_2$ and $I$ are given in Table 2.1.

Each resistance value has a percentage uncertainty of ±5%.

**Table 2.1**

| $R_1/\Omega$ | $R_2/\Omega$ | $(R_1 + R_2)/\Omega$ | $I/\text{mA}$ | $\frac{1}{I}/\text{A}^{-1}$ |
|---|---|---|---|---|
| 22 | 33 | | 17.2 | |
| 22 | 47 | | 14.2 | |
| 22 | 56 | | 12.8 | |
| 33 | 47 | | 12.4 | |
| 33 | 56 | | 11.4 | |
| 47 | 56 | | 10.1 | |

Calculate and record values of $(R_1 + R_2)/\Omega$ and $\frac{1}{I}/\text{A}^{-1}$ in Table 2.1.

Include the absolute uncertainties in $(R_1 + R_2)$. [2]

**(c) (i)** Plot a graph of $\frac{1}{I}/\text{A}^{-1}$ against $(R_1 + R_2)/\Omega$.

Include error bars for $(R_1 + R_2)$. [2]
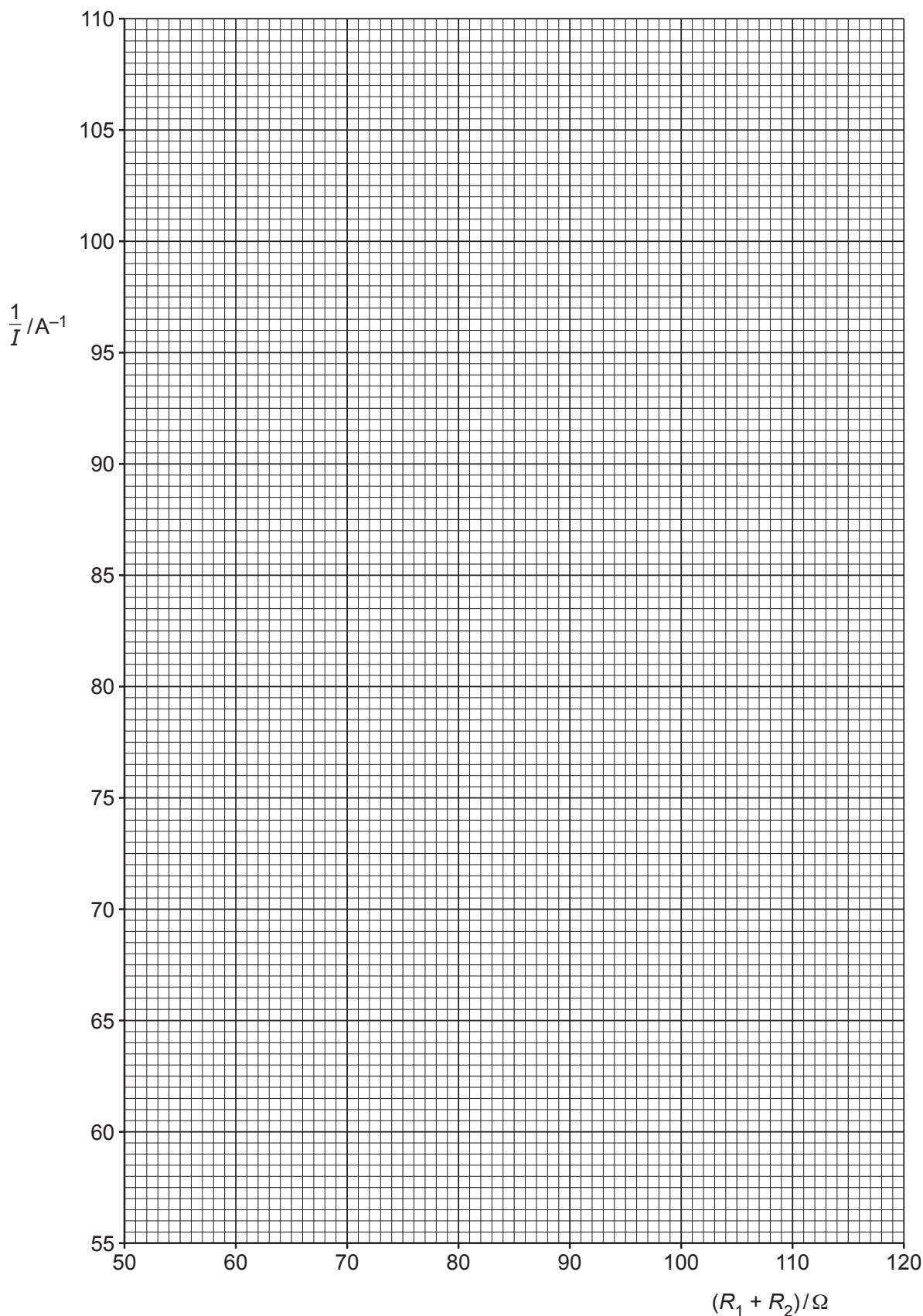
**(ii)** Draw the straight line of best fit and a worst acceptable straight line on your graph. Both lines should be clearly labelled. [2]

**(iii)** Determine the gradient of the line of best fit. Include the absolute uncertainty in your answer.

gradient = ........................................................ [2]

$\frac{1}{I}$ /A$^{-1}$

$(R_1 + R_2)/\Omega$

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**(iv)** Determine the *y*-intercept of the line of best fit. Include the absolute uncertainty in your answer.

*y*-intercept = ......................................................... [2]

**(d) (i)** Using your answers to **(a)**, **(c)(iii)** and **(c)(iv)**, determine values of *E* and *r*. Include appropriate units.

*E* = ..............................................................

*r* = ..............................................................
[2]

**(ii)** Determine the absolute uncertainty in *E*.

absolute uncertainty in *E* = ......................................................... [1]

**(e)** The experiment is repeated using the same cell. The value of $R_1$ is $22\,\Omega$. Determine the resistance $R_2$ that would give a current of $7.5\,\text{mA}$.

$R_2$ = .................................................. $\Omega$ [1]

[Total: 15]

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