



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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9702/52

May/June 2021

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

- 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.

- 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.

- 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 .

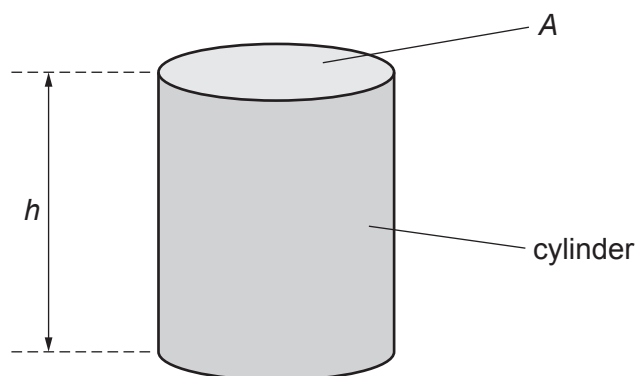


Fig. 1.1

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

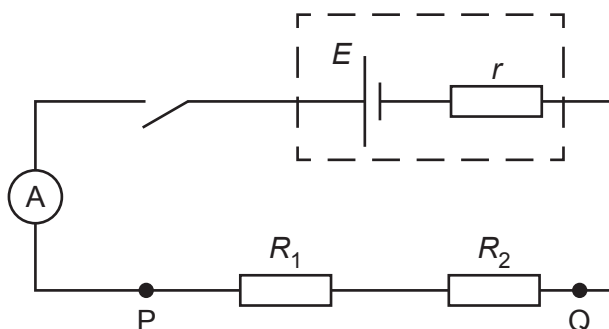


Fig. 2.1

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 $\pm 5\%$.

Table 2.1

R_1/Ω	R_2/Ω	$(R_1 + R_2)/\Omega$	I/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]

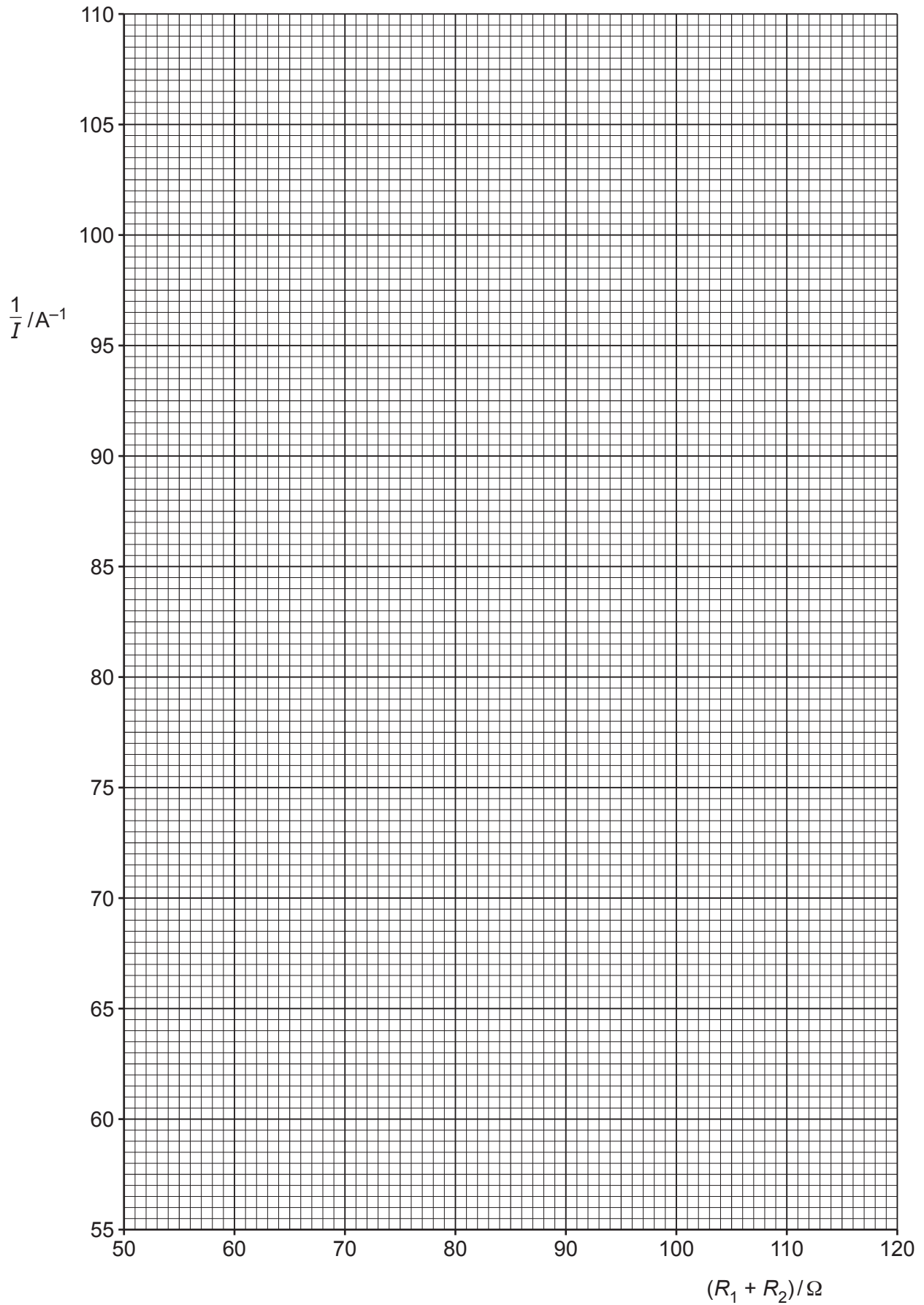
(c) (i) Plot a graph of $\frac{1}{I}/\text{A}^{-1}$ against $(R_1 + R_2)/\Omega$.

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]



- (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 mA .

R_2 = Ω [1]

[Total: 15]