



# Cambridge International AS & A Level

CANDIDATE  
NAME

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CENTRE  
NUMBER

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**PHYSICS**

**9702/52**

Paper 5 Planning, Analysis and Evaluation

**May/June 2021**

**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

## INSTRUCTIONS

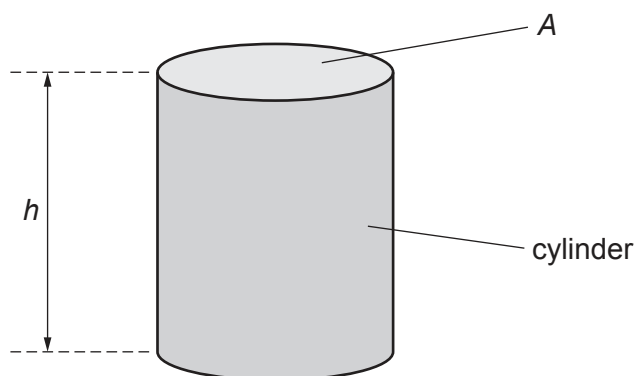
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction 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.

- 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.





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

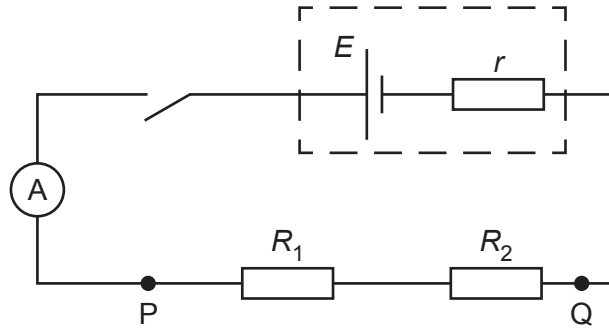


Fig. 2.1

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**

$R_1/\Omega$	$R_2/\Omega$	$(R_1 + R_2)/\Omega$	$I/\text{mA}$	$\frac{1}{I}/\text{A}^{-1}$
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]

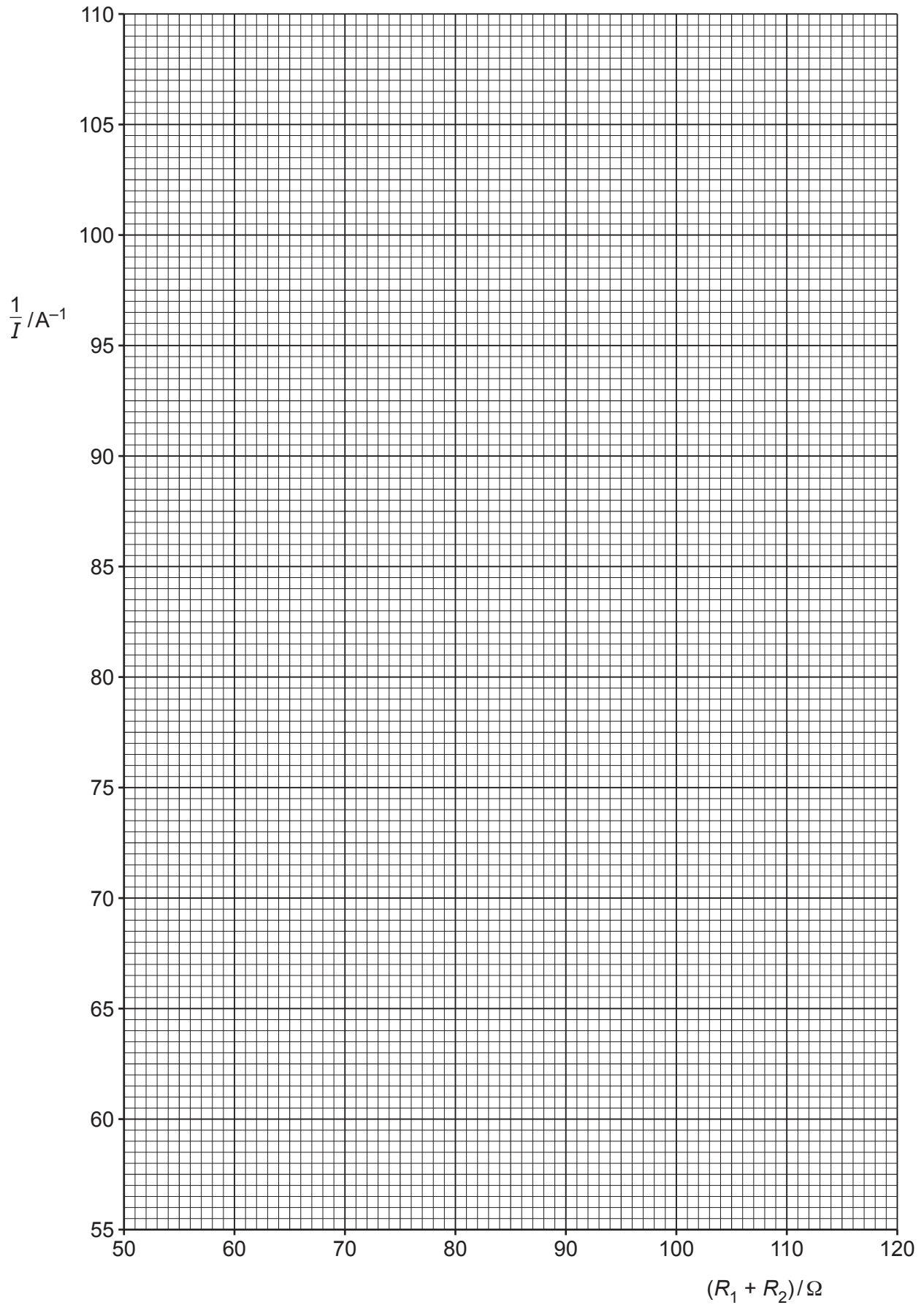
(c) (i) Plot a graph of  $\frac{1}{I}/\text{A}^{-1}$  against  $(R_1 + R_2)/\Omega$ .

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]



- (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]