



## Cambridge International AS & A Level

CANDIDATE  
NAME

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CENTRE  
NUMBER

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CANDIDATE  
NUMBER

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**PHYSICS**

**9702/52**

Paper 5 Planning, Analysis and Evaluation

**February/March 2020**

**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

### INSTRUCTIONS

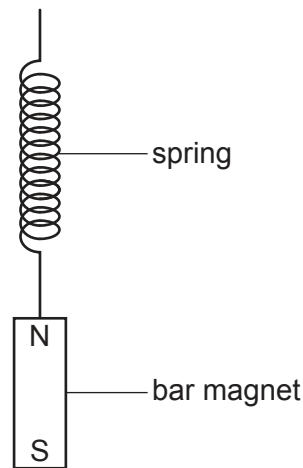
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction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

1 Fig. 1.1 shows a bar magnet attached to a spring.



**Fig. 1.1**

The bar magnet is displaced a distance  $x$  from its equilibrium position and released. It then oscillates vertically.

A student investigates how the maximum induced electromotive force (e.m.f.)  $E$  in a coil placed below the magnet depends on  $x$ .

It is suggested that the relationship between  $E$  and  $x$  is

$$E = \alpha BNx \sqrt{\frac{k}{m}}$$

where  $B$  is the magnetic flux density at one of the poles of the bar magnet,  $N$  is the number of turns on the coil,  $k$  is the spring constant,  $m$  is the mass of the magnet and  $\alpha$  is a constant.

Design a laboratory experiment to test the relationship between  $E$  and  $x$ .

Explain how your results could be used to determine a value for  $\alpha$ .

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 discharge of a capacitor through a resistor as shown in Fig. 2.1.

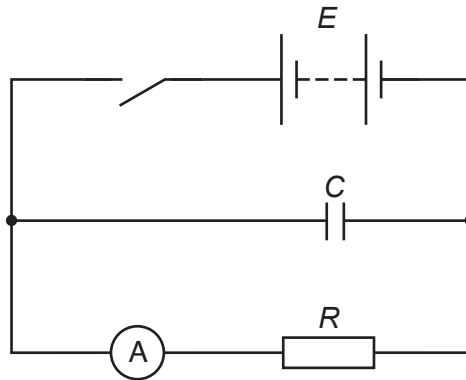


Fig. 2.1

The student initially closes the switch and charges the capacitor. The switch is then opened and a stop-watch is started. The capacitor discharges through the resistor. At different times  $t$  the current  $I$  is measured.

It is suggested that  $I$  and  $t$  are related by the equation

$$I = \frac{E}{R} e^{-\left(\frac{t}{RC}\right)}$$

where  $E$  is the e.m.f. of the power supply,  $C$  is the capacitance of the capacitor and  $R$  is the resistance of the resistor.

- (a) A graph is plotted of  $\ln I$  on the  $y$ -axis against  $t$  on the  $x$ -axis.

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

gradient = .....

$y$ -intercept = .....

[1]

(b) Values of  $t$  and  $I$  are given in Table 2.1.

**Table 2.1**

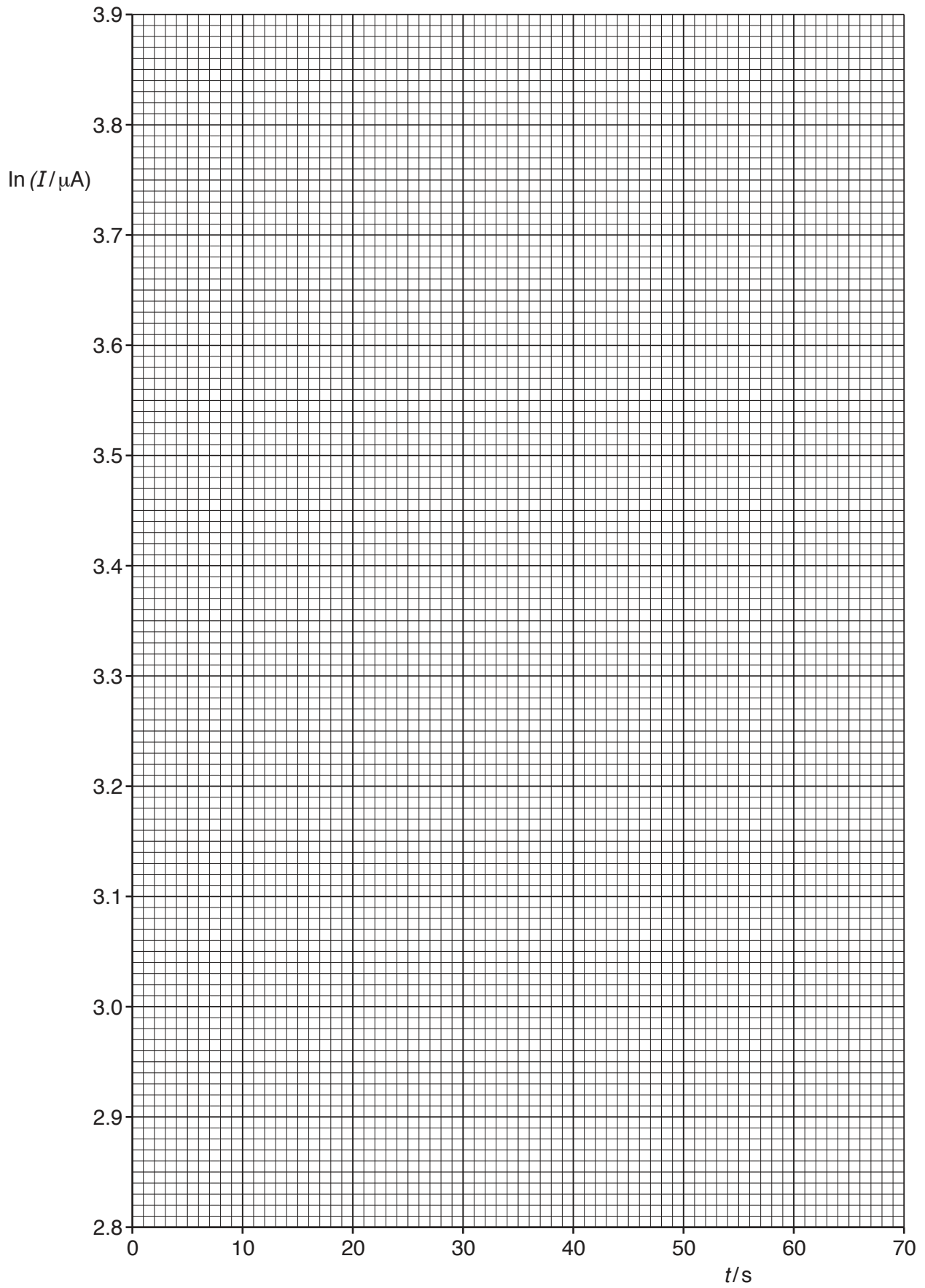
$t/s$	$I/\mu\text{A}$	$\ln(I/\mu\text{A})$
0	$46 \pm 2$	
12	$40 \pm 2$	
24	$34 \pm 2$	
36	$28 \pm 2$	
48	$24 \pm 2$	
60	$20 \pm 2$	

Calculate and record values of  $\ln(I/\mu\text{A})$  in Table 2.1.  
Include the absolute uncertainties in  $\ln(I/\mu\text{A})$ .

[2]

- (c) (i) Plot a graph of  $\ln(I/\mu\text{A})$  against  $t/s$ .  
Include error bars for  $\ln(I/\mu\text{A})$ . [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. Do **not** include the absolute uncertainty in your answer.

$y$ -intercept = ..... [1]

- (d) (i) Using your answers to (a), (c)(iii) and (c)(iv), determine the values of  $C$  and  $E$ . Include appropriate units.

Data:  $R = 150 \text{ k}\Omega$

$C = \dots\dots\dots$

$E = \dots\dots\dots$  [3]

- (ii) The percentage uncertainty in the resistance  $R$  of the resistor is 5%.

Determine the absolute uncertainty in  $C$ .

absolute uncertainty in  $C = \dots\dots\dots$  [1]

- (e) Using your results, determine the value of  $I$  after the capacitor has discharged through the resistor for 2.0 minutes.

$I = \dots\dots\dots$  A [1]  
[Total: 15]

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