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Cambridge Assessment International Education

# Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*8119336502*

**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.

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**[Turn over**

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

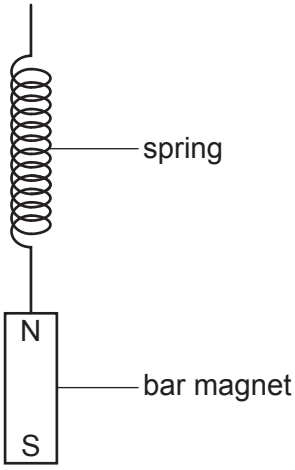



**Fig. 1.1**

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.

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**Diagram**

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**2** A student investigates the discharge of a capacitor through a resistor as shown in Fig. 2.1.

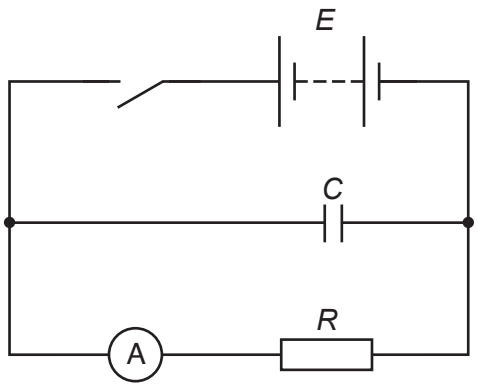



**Fig. 2.1**

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 | $I$/μA | ln($I$/μA) |
|---|---|---|
| 0 | 46 ± 2 | |
| 12 | 40 ± 2 | |
| 24 | 34 ± 2 | |
| 36 | 28 ± 2 | |
| 48 | 24 ± 2 | |
| 60 | 20 ± 2 | |

Calculate and record values of ln($I$/μA) in Table 2.1.
Include the absolute uncertainties in ln($I$/μA). [2]

**(c)** **(i)** Plot a graph of ln($I$/μA) against $t$/s.
Include error bars for ln($I$/μA). [2]

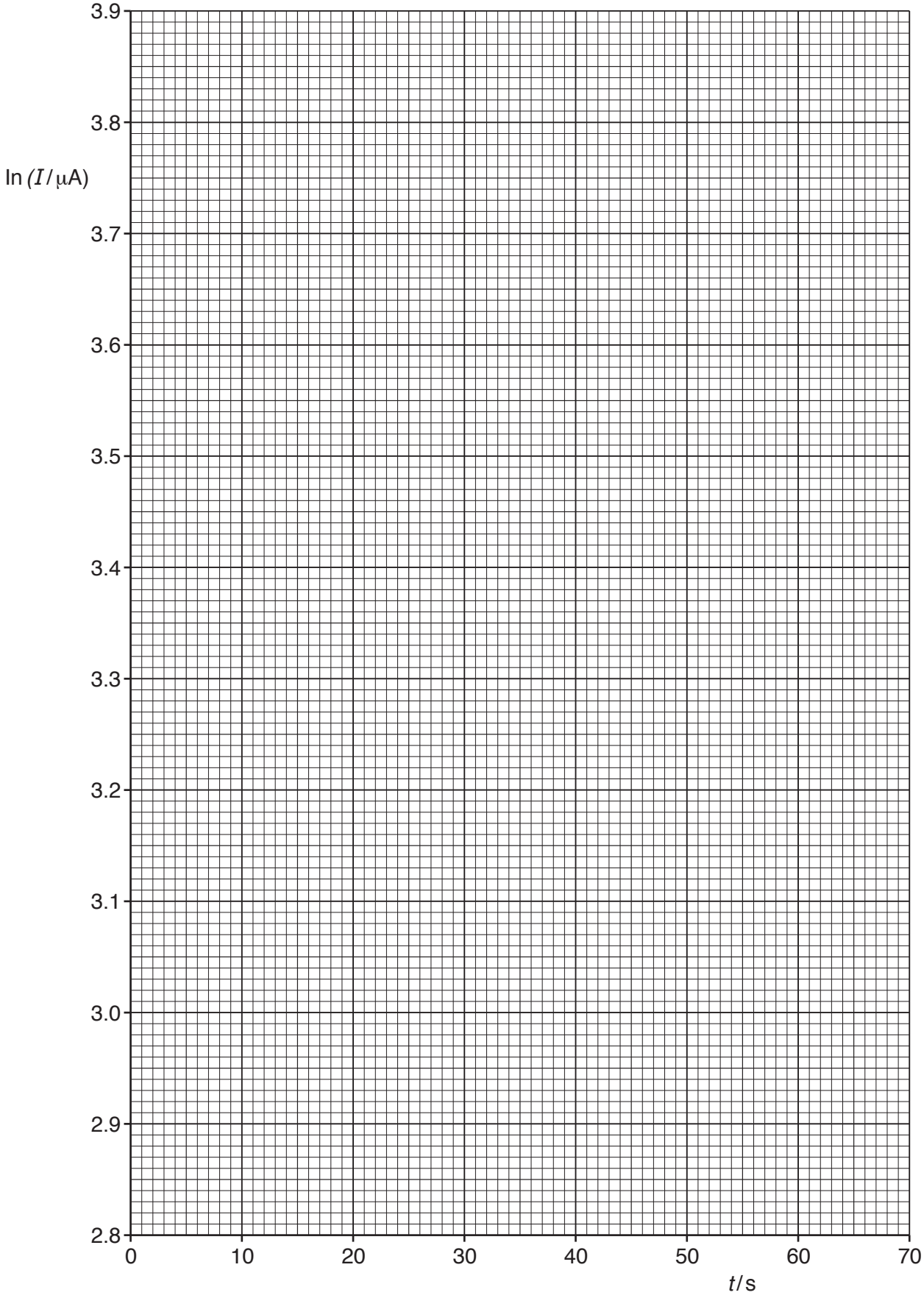
**(ii)** Draw the straight line of best fit and a worst acceptable straight line on your graph. Both lines should be clearly labelled. [2]

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

gradient = ..... [2]

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**(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* = .....

*E* = .....
[3]

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

Determine the absolute uncertainty in *C*.

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

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

$I$ = .....A [1]
[Total: 15]

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