



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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9702/52

February/March 2020

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. Blank pages are indicated.

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

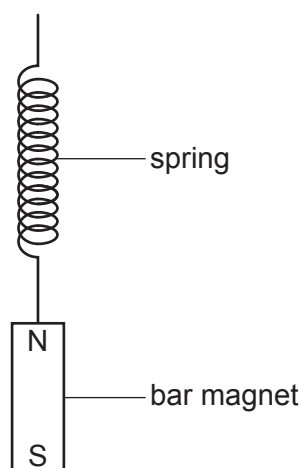


Fig. 1.1

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 α 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 α .

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

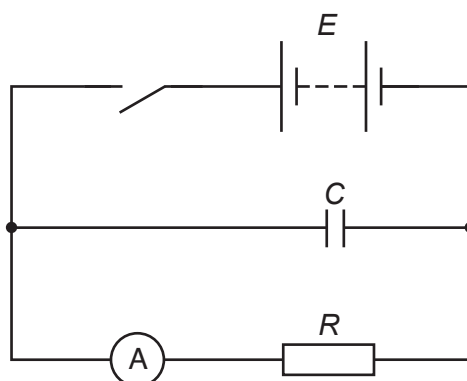


Fig. 2.1

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 ± 2	
12	40 ± 2	
24	34 ± 2	
36	28 ± 2	
48	24 ± 2	
60	20 ± 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 $\ln(I/\mu\text{A})$.

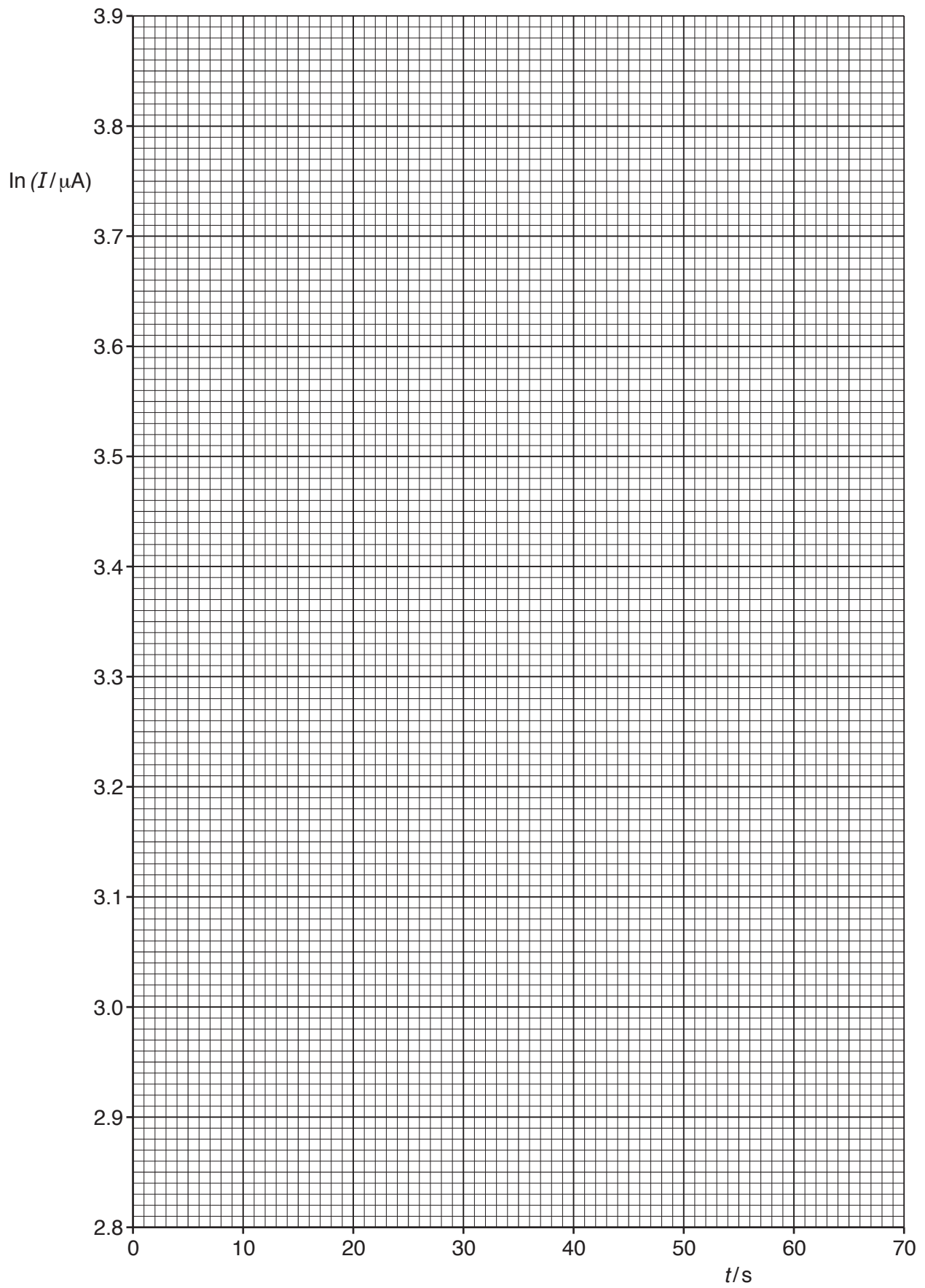
[2]

(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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