Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

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.
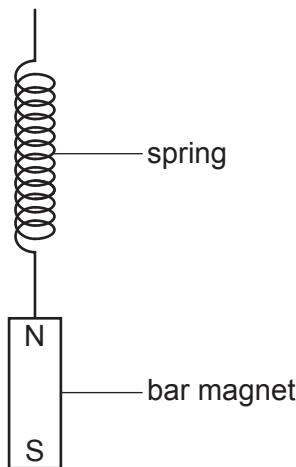
Fig. 1.1

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 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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.... [15]

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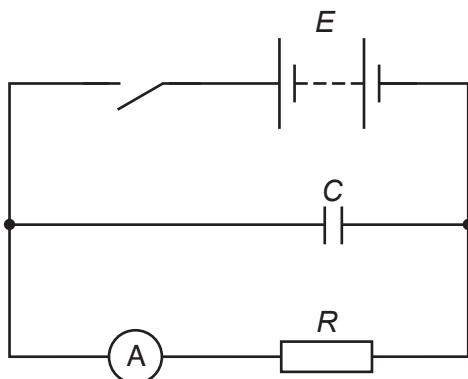

Fig. 2.1

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]

Graph with y-axis labelled ln (*I*/μA) ranging from 2.8 to 3.9 and x-axis labelled *t*/s ranging from 0 to 70.
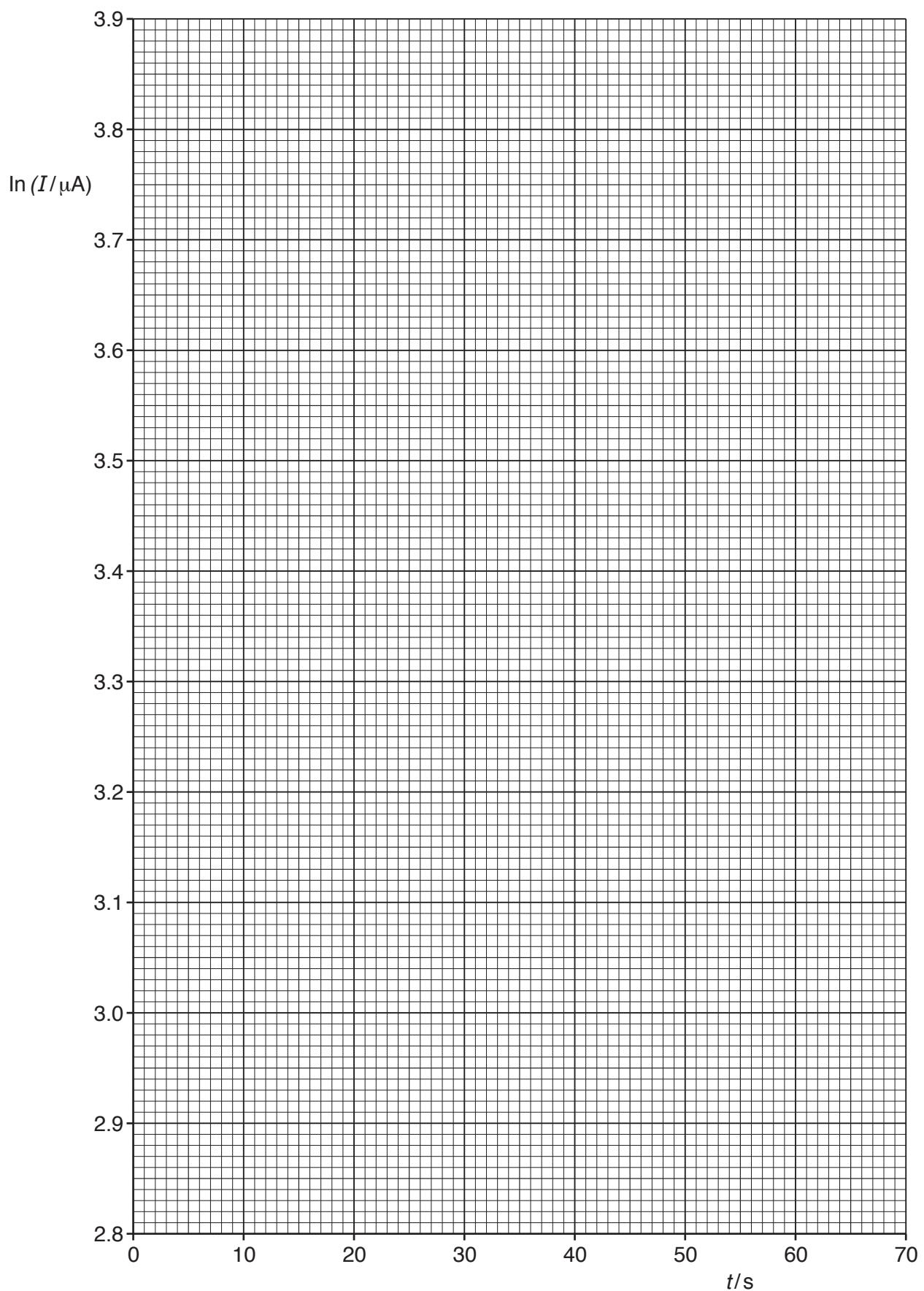
(iv) Determine the *y*-intercept of the line of best fit. Do **not** include the absolute uncertainty in your answer.

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 kΩ

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]