Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 4 4 7 7 0 6 1 8 6 4 *

PHYSICS **9702/53**

Paper 5 Planning, Analysis and Evaluation **May/June 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 A student investigates springs made of metal wire, as shown in Fig. 1.1.

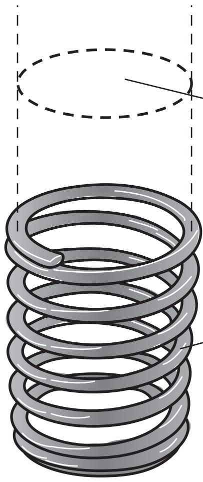

Fig. 1.1

The student constructs several springs from wire of thickness t. Each spring has a different cross-sectional area A.

The student investigates how the spring constant k varies with A.

It is suggested that the relationship between k and A is

$$k = \frac{\beta \rho t^4}{A^{\frac{3}{2}} N}$$

where ρ is the density of the metal, N is the number of turns of wire on the spring and β is a constant.

Design a laboratory experiment to test the relationship between k and A.
Explain how your results could be used to determine a value for β.

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 using the circuit shown in Fig. 2.1.

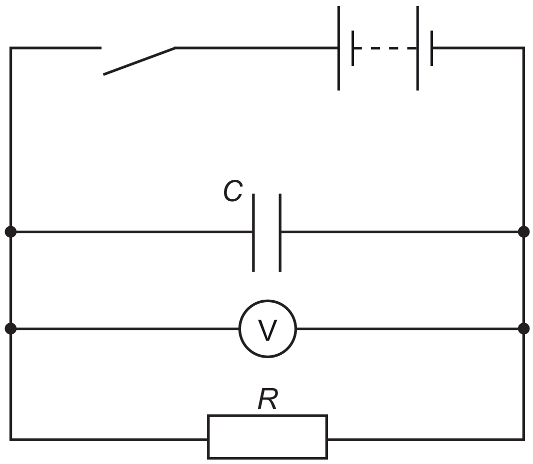


Fig. 2.1

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 time t the potential difference V across the capacitor is measured.

It is suggested that V and t are related by the equation

$$V = \left(\frac{Q_0}{C}\right)e^{-\left(\frac{t}{RC}\right)}$$

where Q_0 is the charge of the fully charged capacitor, C is the capacitance of the capacitor and R is the resistance of the resistor.

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

Determine expressions for the gradient and y-intercept.

gradient = ...

y-intercept = ...
[1]

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

Table 2.1

t / s	V / V	ln (V / V)
0	6.2 ± 0.2	
6	4.6 ± 0.2	
12	3.4 ± 0.2	
18	2.6 ± 0.2	
24	2.0 ± 0.2	
30	1.4 ± 0.2	

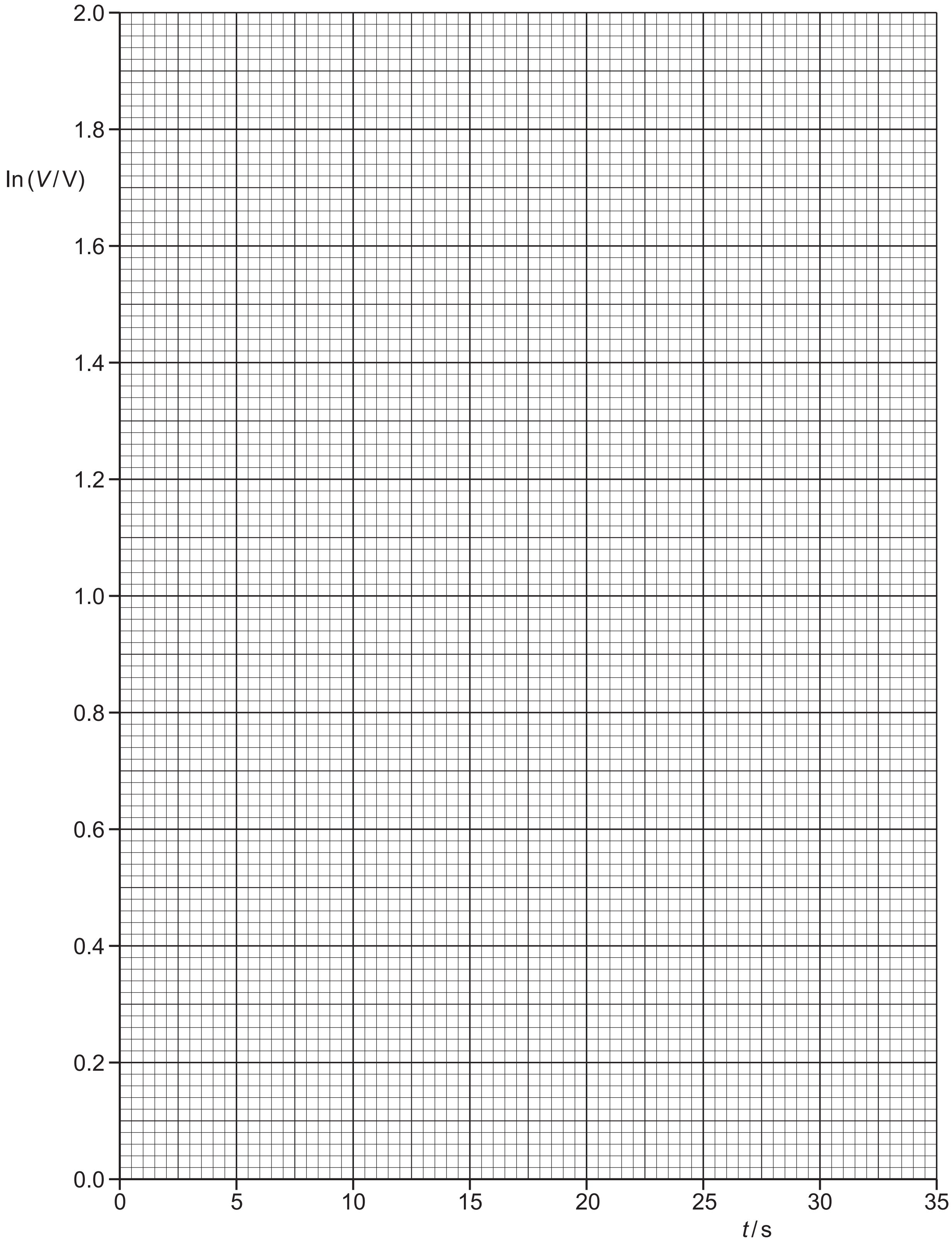
Calculate and record values of ln (V / V) in Table 2.1.
Include the absolute uncertainties in ln (V / V). [2]

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



2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
ln (V / V)
0
5
10
15
20
25
30
35
t / s

(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 values of C and Q_0. Include appropriate units.

Data: $R = 39\,\text{k}\Omega$

C = ...

Q_0 = ...
[3]

(ii) The percentage uncertainty in the value of R is 5%.

Determine the absolute uncertainty in C.

absolute uncertainty in C = ... [1]

(e) Using your results, determine the value of V when the time t is 1.0 minute.

V = ... V [1]

[Total: 15]