



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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9702/53

May/June 2023

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.

- 1 A wooden cube of mass A is placed on an inclined plane. The cube is attached to a cylinder of mass B using string that passes over a pulley, as shown in Fig. 1.1.

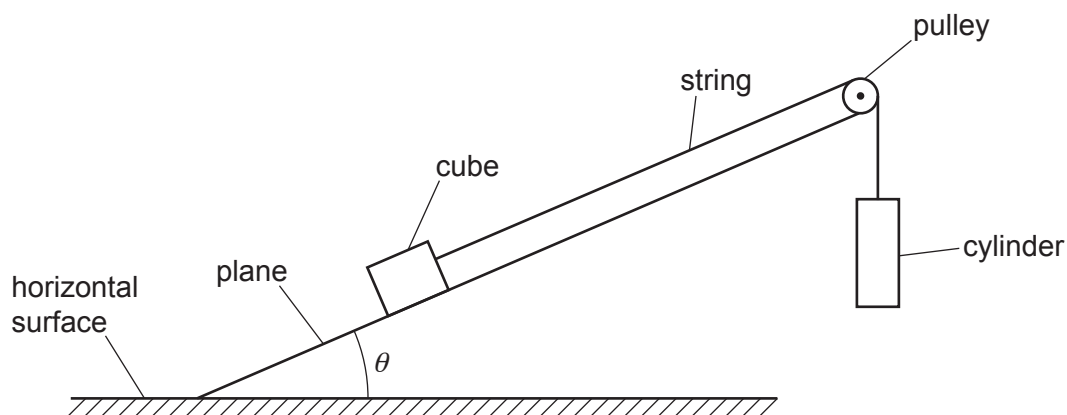


Fig. 1.1 (not to scale)

The angle between the plane and the horizontal surface is θ . Initially the cylinder is held at rest.

The cylinder is released. The time for the cylinder to fall a distance d is t .

It is suggested that t is related to θ by the relationship

$$\frac{2d}{t^2} = -\frac{AH \sin \theta}{(A + B)} - \frac{KA}{(A + B)}$$

where H and K are constants.

Plan a laboratory experiment to test the relationship between t and θ .

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for H and K .

In your plan you should include:

- 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 capacitors in the circuit shown in Fig. 2.1.

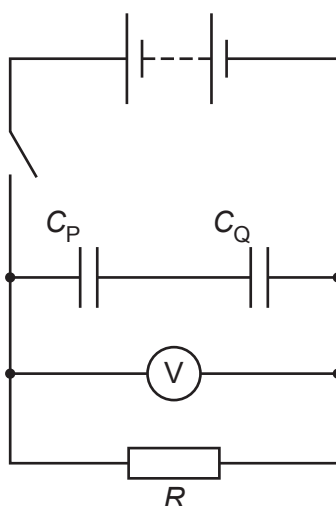


Fig. 2.1

The capacitors have capacitances C_P and C_Q .

The student closes the switch to charge the capacitors and then records the maximum reading V_0 on the voltmeter.

The switch is opened and a stop-watch is started. The capacitors discharge through the resistor and the reading on the voltmeter decreases. When the reading on the voltmeter is V the time t is recorded. The discharge of the capacitors is repeated and the mean time T is calculated.

The experiment is repeated for different values of C_P and C_Q .

For each combination of C_P and C_Q , the combined capacitance C is calculated.

It is suggested that C and T are related by the equation

$$\ln \left(\frac{V}{V_0} \right) = - \frac{T}{CR}$$

where R is the resistance of the resistor.

- (a) A graph is plotted of T on the y -axis against C on the x -axis.

Determine an expression for the gradient.

gradient = [1]

(b) Values of C_P , C_Q and t are given in Table 2.1.

Table 2.1

$C_P/10^{-4}\text{F}$	$C_Q/10^{-4}\text{F}$	$C/10^{-4}\text{F}$	t/s	t/s	T/s
2.2	1.5		12.9	14.5	
2.2	3.3		21.1	19.7	
2.2	5.6		23.7	24.9	
3.3	1.5		15.3	16.9	
5.6	1.5		19.0	17.6	
5.6	3.3		30.9	32.1	

The relationship between C , C_P and C_Q is

$$C = \frac{C_P C_Q}{C_P + C_Q}.$$

Calculate and record values of $C/10^{-4}\text{F}$ and T/s in Table 2.1.
Include the absolute uncertainties in T .

[2]

(c) (i) Plot a graph of T/s against $C/10^{-4}\text{F}$.
Include error bars for T .

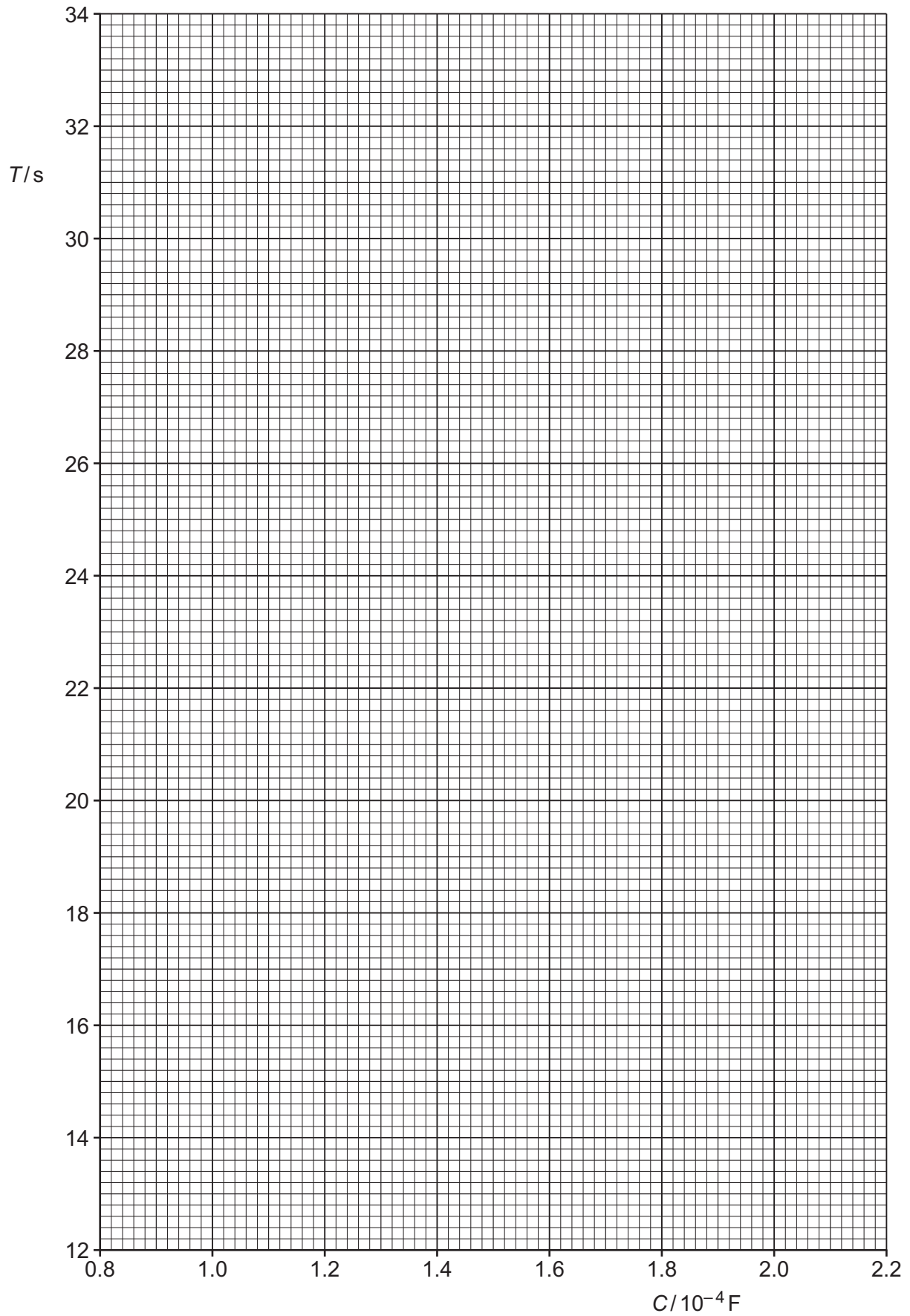
[2]

(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Label both lines.

[2]

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

gradient = [2]



- (d) The values of V_0 and V are:

$$V_0 = (4.8 \pm 0.1) \text{ V}$$

$$V = (2.4 \pm 0.1) \text{ V}$$

Calculate $\ln\left(\frac{V}{V_0}\right)$. Include the absolute uncertainty in $\ln\left(\frac{V}{V_0}\right)$.

$$\ln\left(\frac{V}{V_0}\right) = \dots\dots\dots [1]$$

- (e) (i) Using your answers to (a), (c)(iii) and (d), determine the value of R . Include an appropriate unit.

$$R = \dots\dots\dots [2]$$

- (ii) Determine the percentage uncertainty in R .

$$\text{percentage uncertainty in } R = \dots\dots\dots \% [1]$$

- (f) The experiment is repeated. Determine the value of C that gives a value of T of 60.0 s. Include the absolute uncertainty in your answer.

$$C = \dots\dots\dots \text{ F } [2]$$

[Total: 15]