Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8464834960

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **October/November 2023**

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.

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1 Two identical beakers, each of mass M, are attached to each other using string and suspended from a pulley, as shown in Fig. 1.1.

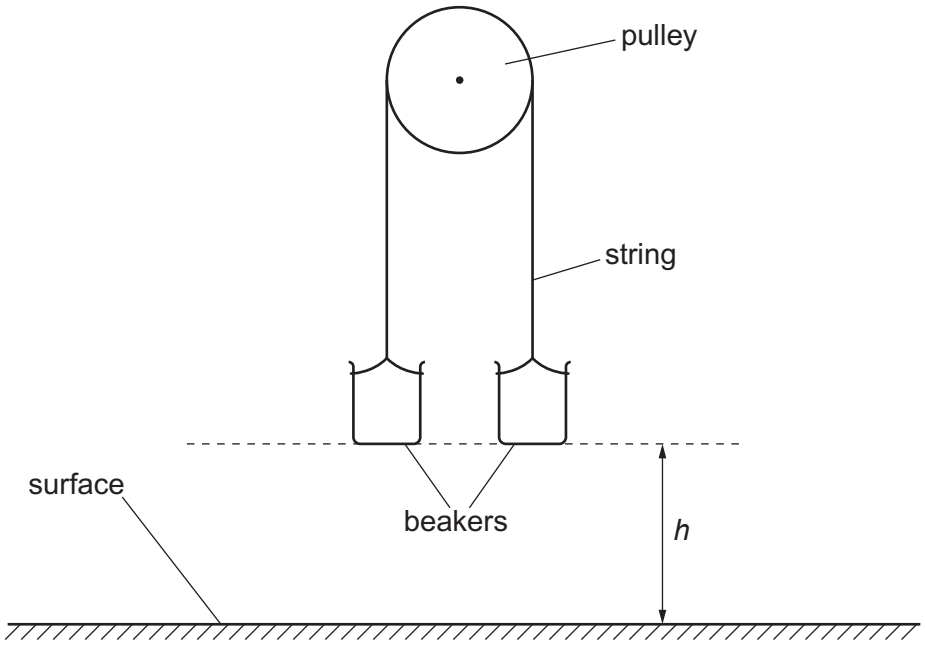

Fig. 1.1 (not to scale)

The beakers are held at rest at a height h above a surface. Cooking oil of volume V is added to one of the beakers.

The beakers are released so that the beaker with the oil begins to fall. The speed of the beaker as it reaches the surface is z.

It is suggested that z is related to V by the relationship

$$\frac{2h}{z^2} = \frac{2M}{abV} + \frac{1}{b}$$

where a and b are constants.

Plan a laboratory experiment to test the relationship between z and V.

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for a and b.

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.

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Diagram

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2 A student investigates the discharge of capacitors in the circuit shown in Fig. 2.1.

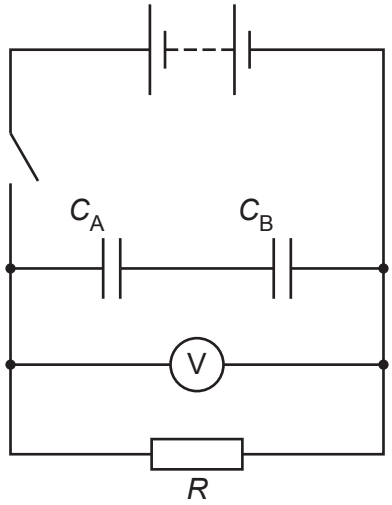

Fig. 2.1

The capacitors have capacitances C_A and C_B.

The student closes the switch to charge the capacitors.

The switch is opened and a stop-watch is started. The capacitors discharge through the resistor of resistance R. At a fixed time t the voltmeter reading V is recorded.

The experiment is repeated for different values of C_A and C_B.

For each combination of C_A and C_B, the combined capacitance C is calculated.

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

$$V = I_0 R e^{-\frac{t}{CR}}$$

where I_0 is the initial current in the resistor.

(a) A graph is plotted of $\ln V$ on the y-axis against $\frac{1}{C}$ on the x-axis.

Determine expressions for the gradient and y-intercept.

gradient = ...

y-intercept = ...

[1]

(b) Values of C_A, C_B and V are given in Table 2.1.

Table 2.1

$C_A / 10^{-4}\,F$	$C_B / 10^{-4}\,F$	$\frac{1}{C} / 10^4\,F^{-1}$	V / V	ln (V/V)
2.2	2.2		2.45 ± 0.05	
2.2	3.3		2.75 ± 0.05	
2.2	5.6		3.05 ± 0.05	
3.3	3.3		3.10 ± 0.05	
3.3	5.6		3.50 ± 0.05	
5.6	5.6		3.85 ± 0.05	

The relationship between C, C_A and C_B is

$$\frac{1}{C} = \frac{C_A + C_B}{C_A C_B}.$$

Calculate and record values of $\frac{1}{C} / 10^4\,F^{-1}$ and 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 $\frac{1}{C} / 10^4\,F^{-1}$.

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. Label both lines. [2]

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

gradient = ... [2]

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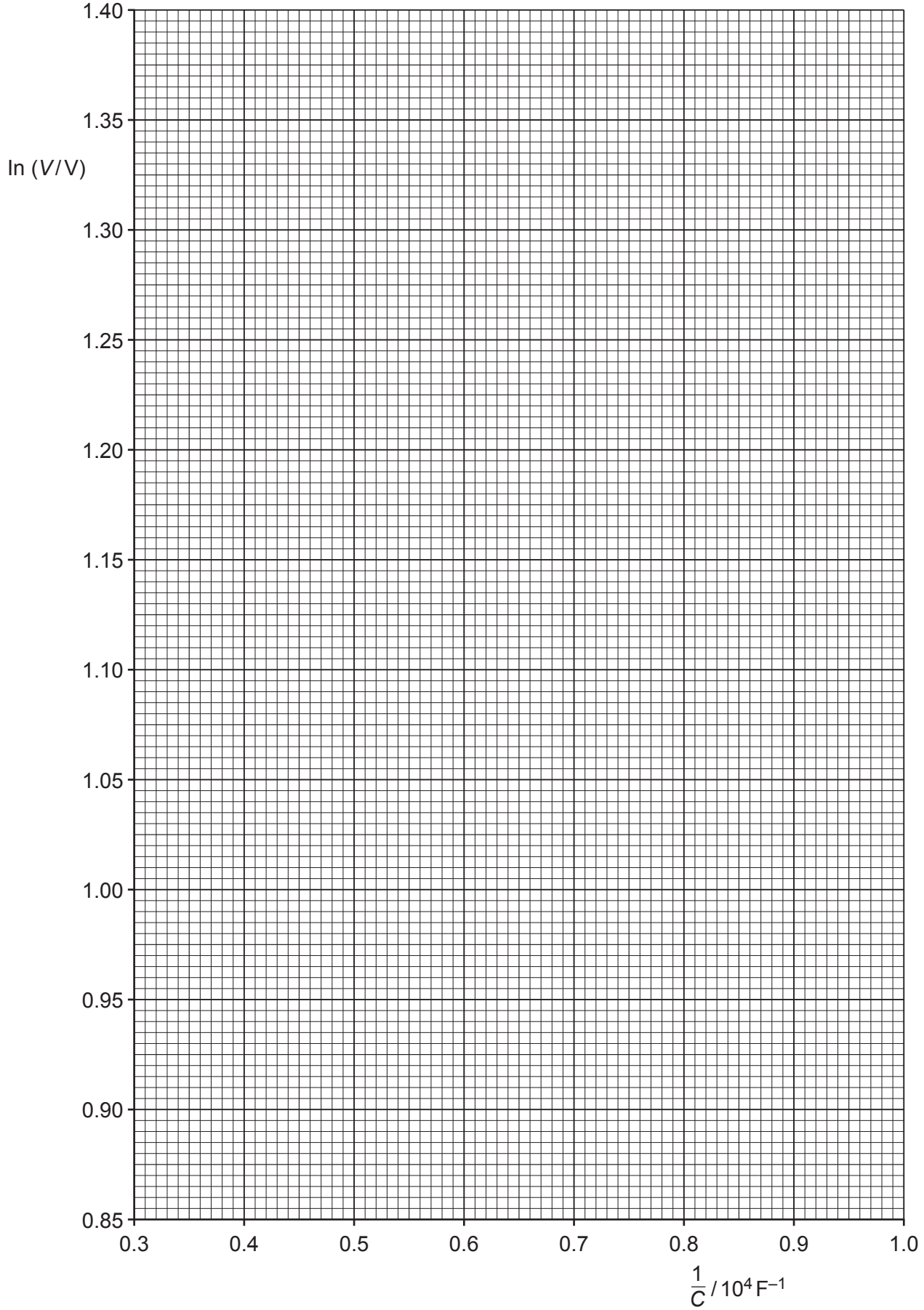
1.40
1.35
ln (V/V)
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1/C / 10^4 F^−1

(iv) Determine the *y*-intercept of the line of best fit. Do **not** include the absolute uncertainty.

y-intercept = ... [1]

(d) (i) Using your answers to **(a)**, **(c)(iii)** and **(c)(iv)**, determine the values of R and I_0. Include appropriate units.

Data: $t = (30 \pm 1)\,\text{s}$

R = ...

I_0 = ...
[3]

(ii) Determine the percentage uncertainty in R.

percentage uncertainty in R = ... % [1]

(e) The experiment is repeated with the same value of t. Determine the combined capacitance C that gives a value of V of 1.20 V.

C = ... F [1]

[Total: 15]

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