



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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9702/52

February/March 2022

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 trolley with a magnet attached is placed on a thin steel sheet as shown in Fig. 1.1.

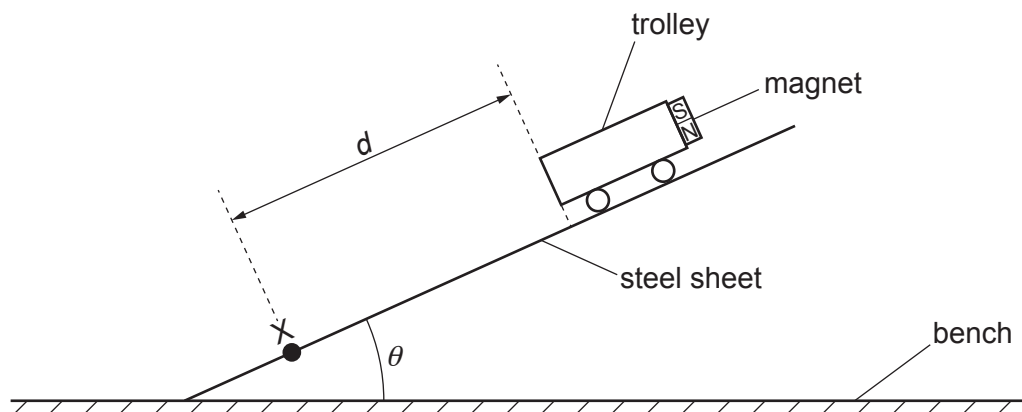


Fig. 1.1

The angle between the sheet and the bench is θ . The distance from point X to the trolley is d .

The trolley is released from rest and travels down the slope. The velocity v of the trolley at X is determined using a light gate.

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

$$mp \sin \theta - qB = \frac{mv^2}{2d}$$

where m is the mass of the trolley and magnet, B is the magnetic flux density between the magnet and the steel sheet, and p and q are constants.

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

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for p and q .

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 a circuit containing a capacitor and a resistor as shown in Fig. 2.1.

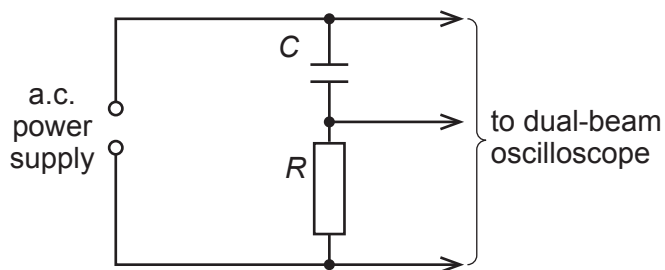


Fig. 2.1

A dual-beam oscilloscope is connected across the capacitor of capacitance C and resistor of resistance R . The oscilloscope displays two traces as shown in Fig. 2.2.

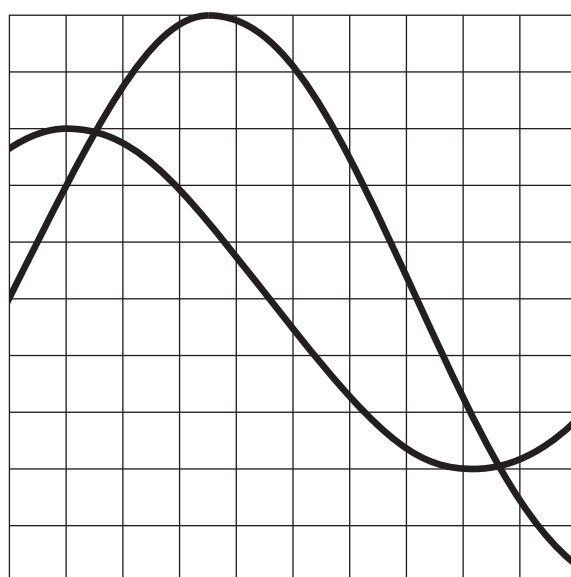


Fig. 2.2

The student determines the phase difference θ between the two traces.

The student repeats the experiment with different resistors.

It is suggested that θ and R are related by the equation

$$\tan \theta = \frac{1}{2\pi fCR}$$

where f is the frequency of the a.c. power supply.

- (a) A graph is plotted of $\tan \theta$ on the y -axis against $\frac{1}{R}$ on the x -axis.

Determine an expression for the gradient.

gradient = [1]

(b) Values of R and θ are given in Table 2.1.

Each value of R has a percentage uncertainty of $\pm 5\%$.

Table 2.1

R/Ω	$\frac{1}{R}/10^{-3}\Omega^{-1}$	$\theta/^\circ$	$\tan \theta$
12		80.8	
16		77.5	
22		73.0	
33		65.2	
39		61.7	
43		59.3	

Calculate and record values of $\frac{1}{R}/10^{-3}\Omega^{-1}$ and $\tan \theta$ in Table 2.1.

Include the absolute uncertainties in $\frac{1}{R}$. [2]

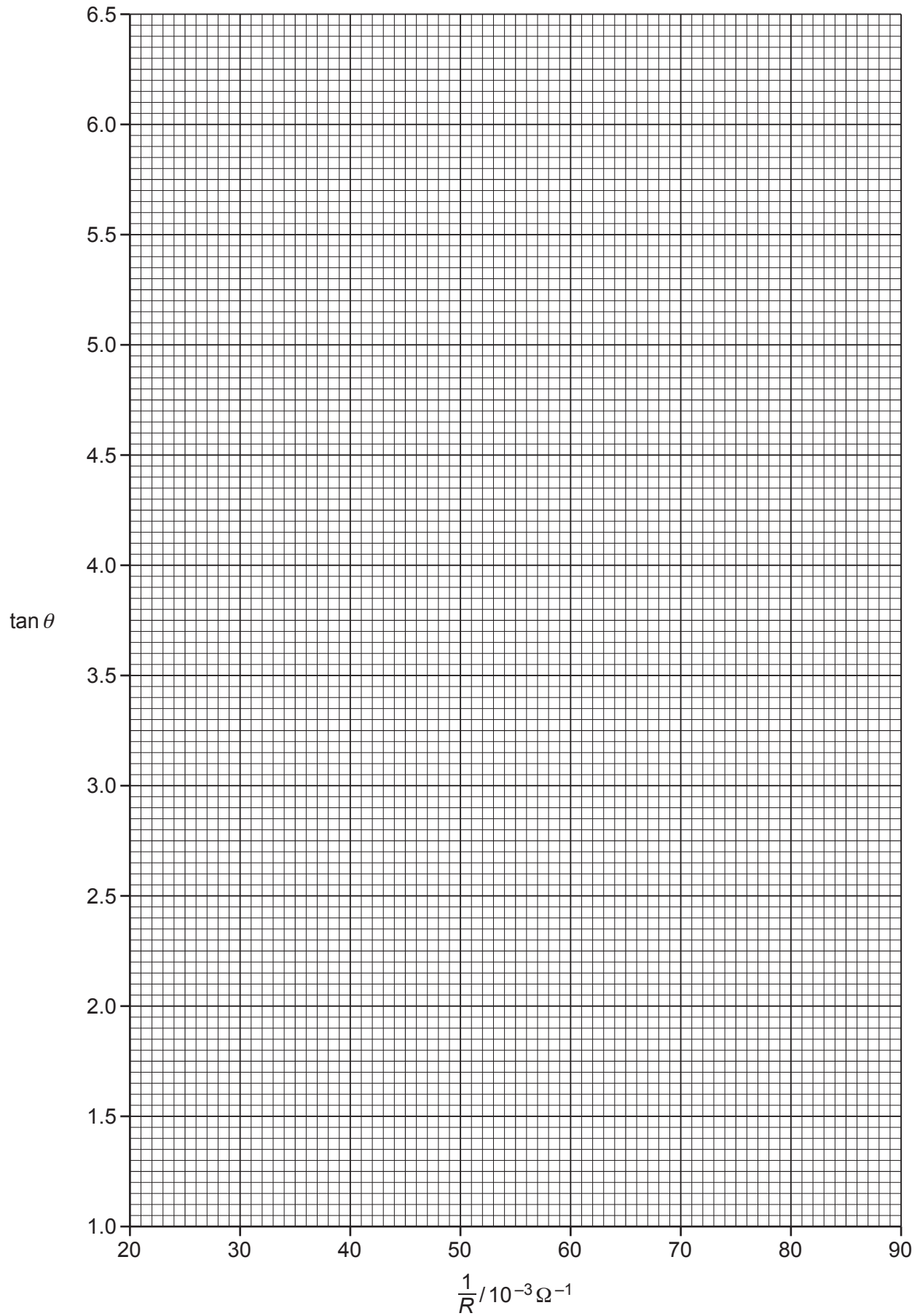
(c) (i) Plot a graph of $\tan \theta$ against $\frac{1}{R}/10^{-3}\Omega^{-1}$.

Include error bars for $\frac{1}{R}$. [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 student measured the frequency of the a.c. power supply twice. The student's values were 101 Hz and 97 Hz.

Determine the average frequency f of the power supply. Include the absolute uncertainty in f .

$$f = \dots\dots\dots \text{ Hz [1]}$$

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

$$C = \dots\dots\dots [2]$$

- (ii) Determine the percentage uncertainty in C .

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

- (f) The experiment is repeated using the same power supply and capacitor.
Determine the resistance of R that would give a phase difference of 40° . Include the absolute uncertainty in your answer.

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

[Total: 15]