Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **February/March 2022**

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.

[Turn over

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

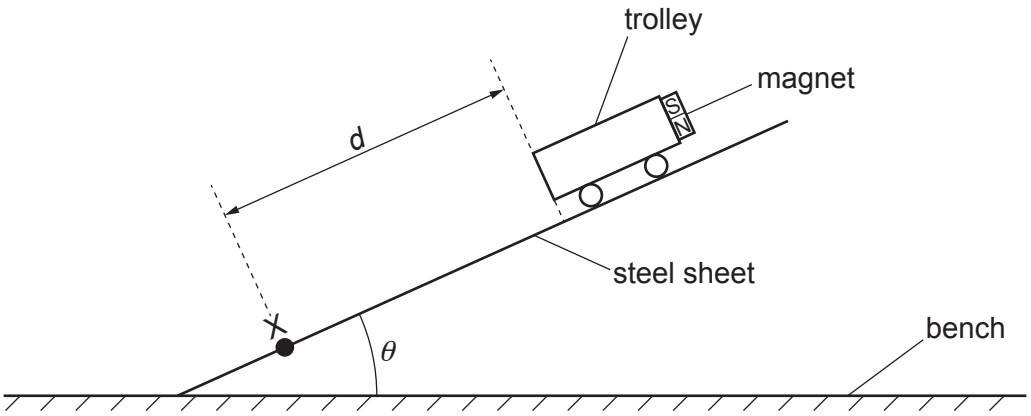


Fig. 1.1

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

[15]

2 A student investigates a circuit containing a capacitor and a resistor as shown in Fig. 2.1.

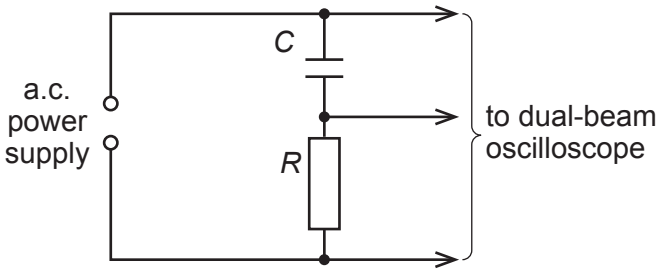


Fig. 2.1

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.

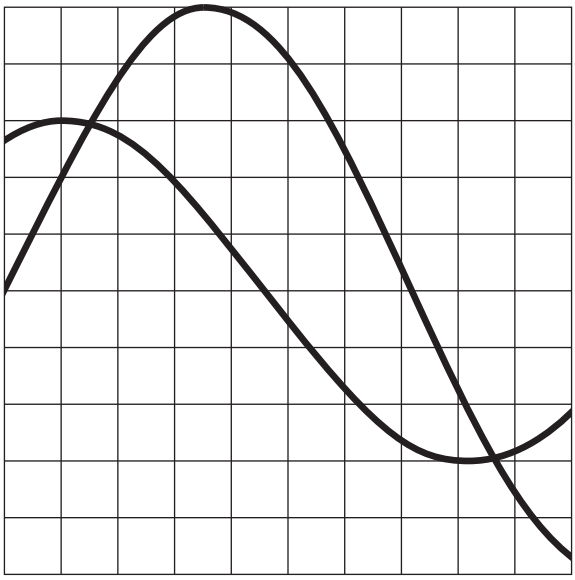


Fig. 2.2

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 ±5%.

Table 2.1

R/Ω	$\frac{1}{R}/10^{-3}\,\Omega^{-1}$	$\theta/°$	$\tan\theta$
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]

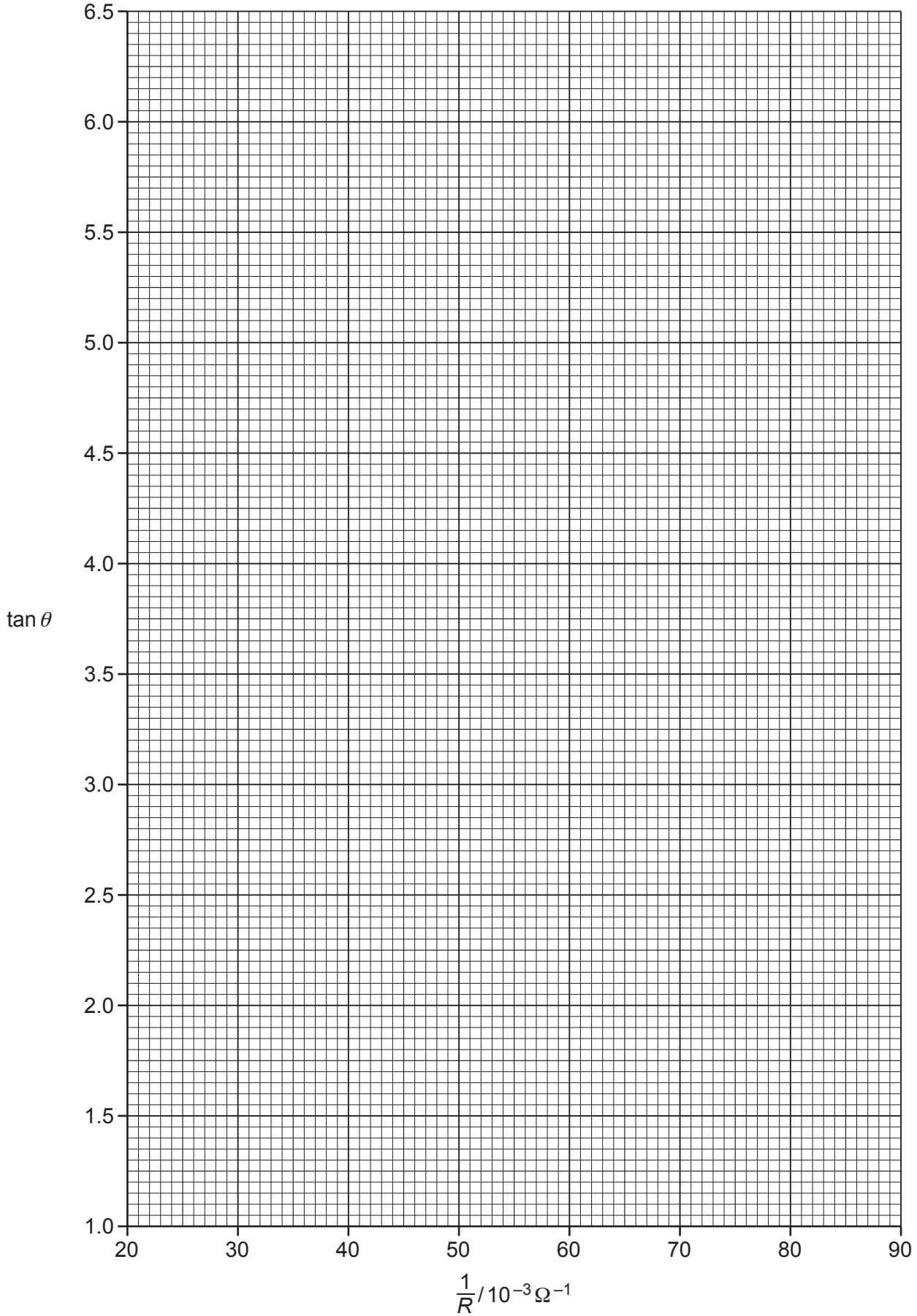
(c) (i) Plot a graph of $\tan\theta$ against $\frac{1}{R}/10^{-3}\,\Omega^{-1}$.

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]


6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
tan θ
20
30
40
50
60
70
80
90
1/R / 10^−3 Ω^−1

(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 = ... Hz [1]

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

C = ... [2]

(ii) Determine the percentage uncertainty in C.

percentage uncertainty in C = ...% [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 = ... Ω [2]

[Total: 15]