Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

PHYSICS **9702/52**

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

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1 A thin copper sheet is suspended from a small hole near the top of the sheet and placed in a magnetic field, as shown in Fig. 1.1.

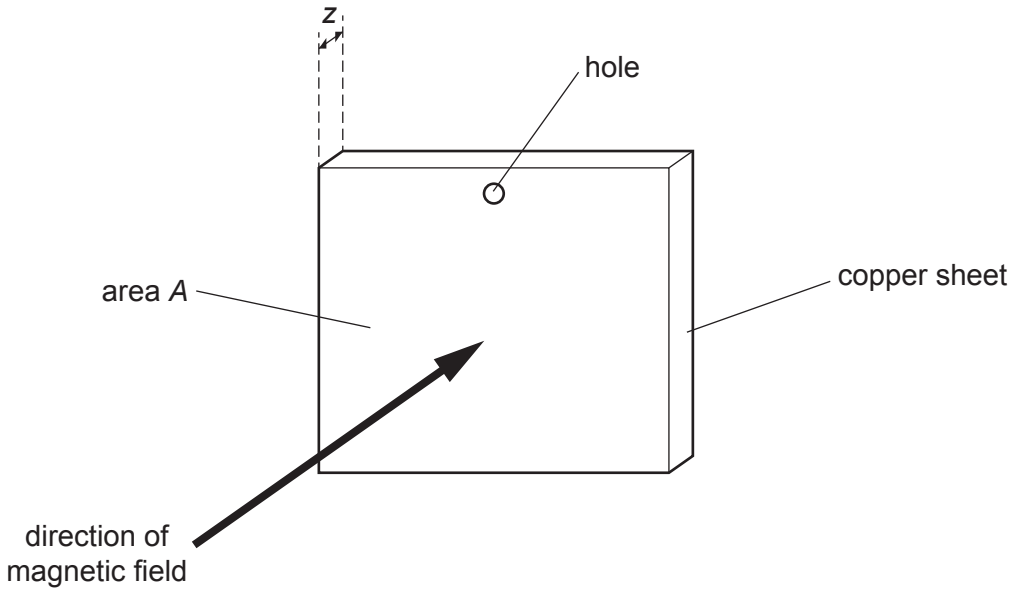

Fig. 1.1 (not to scale)

The sheet has area A and thickness z.

The sheet is displaced from its equilibrium position and then released so that it oscillates perpendicular to the direction of the magnetic field. The time t from when the sheet is released to when it becomes stationary is measured.

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

$$t = \frac{Kz^q}{AB\rho}$$

where B is the magnetic flux density of the field, ρ is the density of copper, and K and q are constants.

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

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for K 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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..... [15]

2 A student investigates stationary waves in a vertical tube using the apparatus shown in Fig. 2.1.

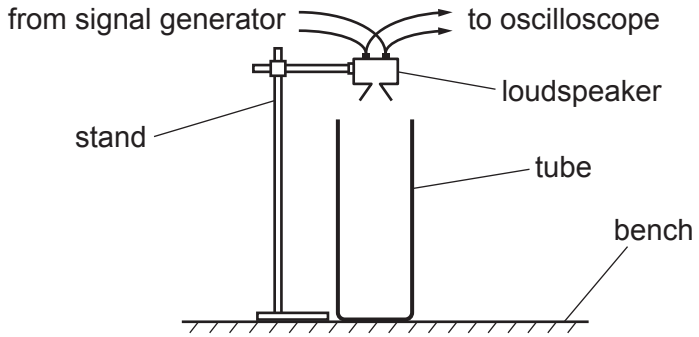


Fig. 2.1

The student slowly increases the frequency of the signal generator from zero and listens to the sound. The loudness of the sound varies several times between minimum and maximum as the frequency is increased. The lowest frequency giving maximum loudness is identified by $n = 1$. The next frequencies giving maximum loudness are identified by $n = 2, 3, 4, 5$ and 6.

For each value of n, the student observes the trace on the oscilloscope screen. The student measures the distance d on the screen between two successive crests, as shown in Fig. 2.2.

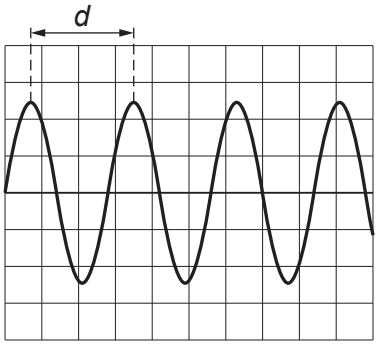


Fig. 2.2

The student then determines the period T and frequency f of the signal.

It is suggested that f and n are related by the equation

$$f = \frac{(2n - 1)c}{4h}$$

where c is the speed of sound in air and h is the height of the tube.

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

Determine expressions for the gradient and y-intercept.

gradient = ...

y-intercept = ...

[1]

(b) The period T and frequency f are given by the equations

$$T = d \times \text{time-base} \quad \text{and} \quad f = \frac{1}{T}.$$

Values of n, d and the time-base of the oscilloscope are given in Table 2.1.

Table 2.1

n	d / cm	time-base / ms cm^{-1}	T / ms	f / Hz
1	1.4 ± 0.2	5		
2	2.9 ± 0.2	1		
3	3.6 ± 0.2	0.5		
4	2.7 ± 0.2	0.5		
5	2.1 ± 0.2	0.5		
6	8.8 ± 0.2	0.1		

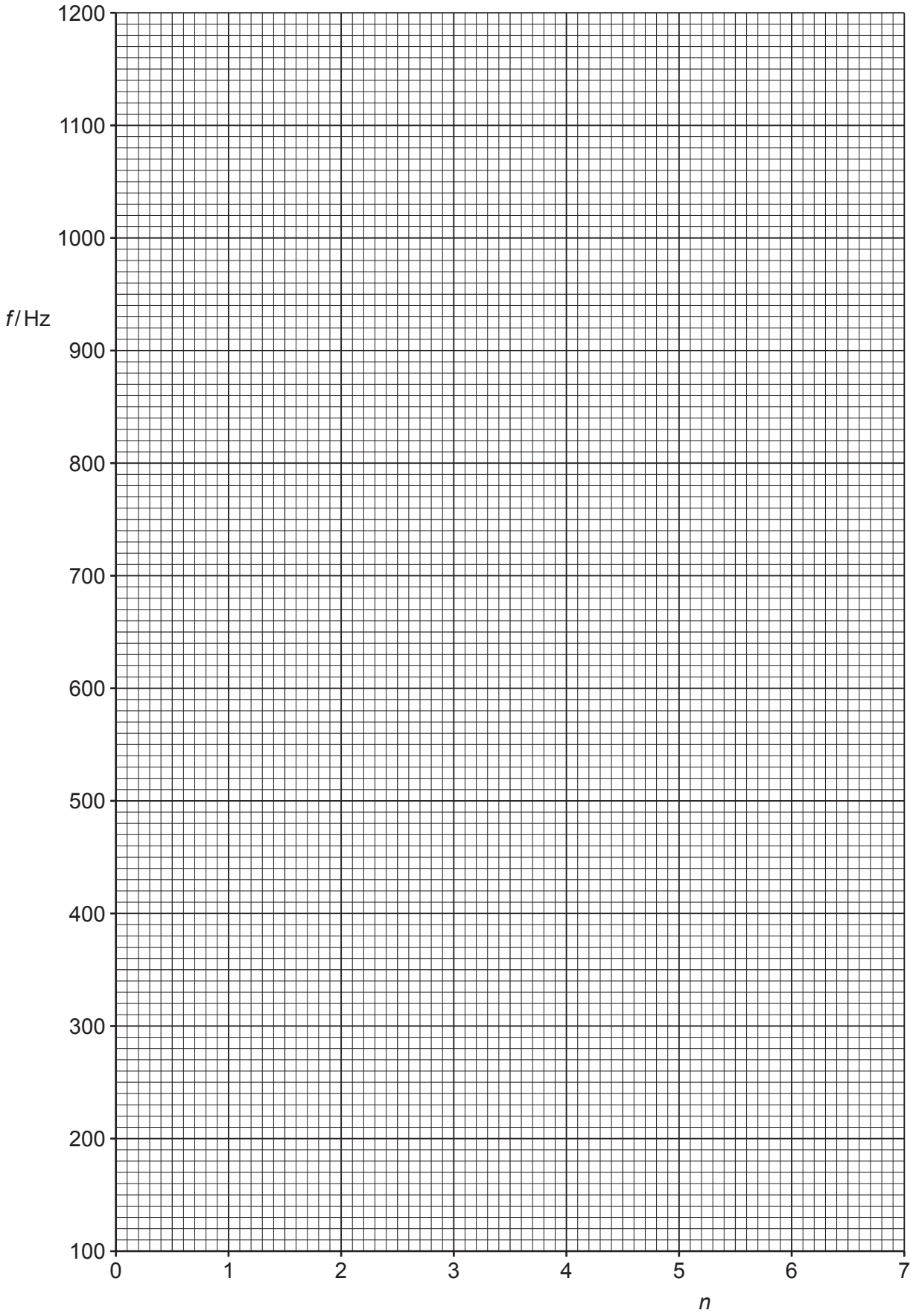
Calculate and record values of T / ms and f / Hz in Table 2.1.
Include the absolute uncertainties in T and f. [2]

(c) **(i)** Plot a graph of f / Hz against n. Include error bars for f. [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]


1200
1100
1000
f / Hz
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5
6
7
n

(d) The student measures the height of the tube. The student's values are:

83.5 cm 82.9 cm 83.3 cm 83.1 cm.

Determine the average height *h*. Include the absolute uncertainty in *h*.

h = ... cm [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 with a different tube.
When $n = 2$, the frequency is (130 ± 5) Hz.

Determine the height *h* of this tube. Include the absolute uncertainty in your answer.

h = ... m [2]

[Total: 15]

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