Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3791585302

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **February/March 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 An electric pump is placed in a container of liquid. A model wind turbine is connected to the pump by a cable, as shown in Fig. 1.1.

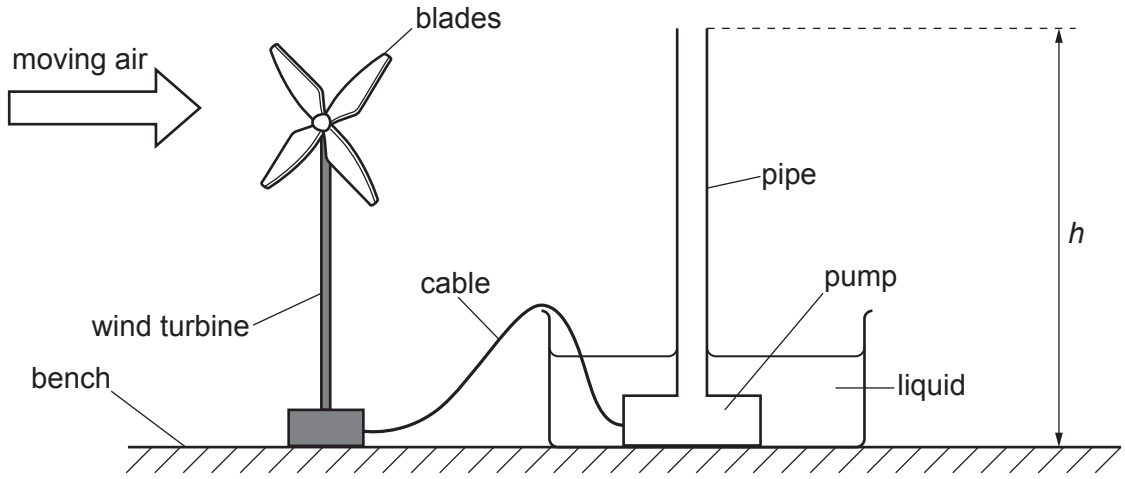

Fig. 1.1 (not to scale)

The turbine is placed in moving air. As the turbine blades turn, electricity is generated and the pump pushes liquid through a vertical pipe.

The frequency of rotation of the turbine blades is f. The height the liquid moves is h. The mass per unit time of the liquid leaving the top of the pipe is Q.

It is suggested that Q is related to f by the relationship

$$Qgh = C + Df^3$$

where g is the acceleration of free fall, and C and D are constants.

Plan a laboratory experiment to test the relationship between Q and f.

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for C and D.

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 standing waves in water. A sound source is placed at the bottom of a cylinder containing water. A microphone, attached to a rod, is placed above the sound source, as shown in Fig. 2.1.

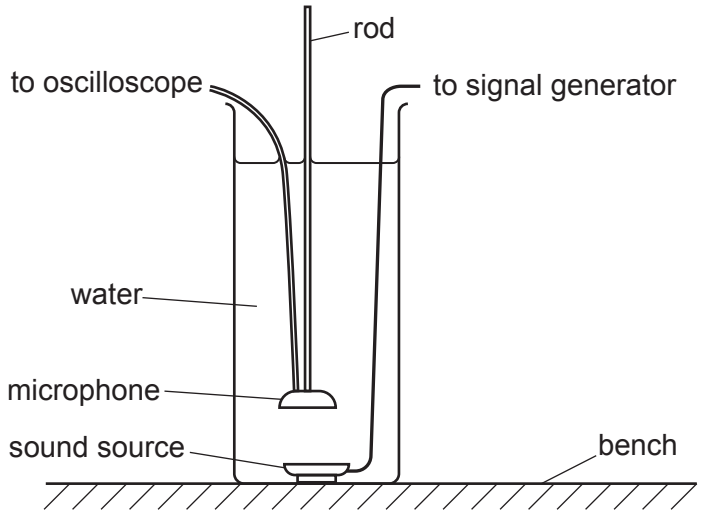

Fig. 2.1

The sound source is connected to a signal generator. The microphone is connected to an oscilloscope.

The signal generator is set to a frequency f. The microphone is moved up away from the sound source until the maximum amplitude is observed on the oscilloscope screen. The distance d_1 between the microphone and sound source is measured.

The microphone is moved up a further 2.0 cm. The microphone is then moved down until the maximum amplitude is observed on the oscilloscope screen. A second value d_2 is measured. The average value of d is calculated.

The experiment is repeated for different values of f.

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

$$\frac{v}{f} = 4\,(d + k)$$

where v is the speed of sound in water and k is a constant.

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

Determine expressions for the gradient and the y-intercept.

gradient = ...

y-intercept = ...

[1]

(b) Values of f, d_1 and d_2 are given in Table 2.1.

Table 2.1

$f / 10^3\,\text{Hz}$	$\frac{1}{f} / 10^{-3}\,\text{Hz}^{-1}$	d_1 / cm	d_2 / cm	d / cm
1.5		24.9	24.5	
2.1		17.2	17.6	
2.8		12.4	13.0	
4.1		8.1	8.7	
5.2		6.2	7.0	
7.6		5.0	4.2	

Calculate and record values of $\frac{1}{f} / 10^{-3}\,\text{Hz}^{-1}$ and d / cm in Table 2.1.

Include the absolute uncertainties in d. [2]

(c) **(i)** Plot a graph of d / cm against $\frac{1}{f} / 10^{-3}\,\text{Hz}^{-1}$.

Include error bars for d. [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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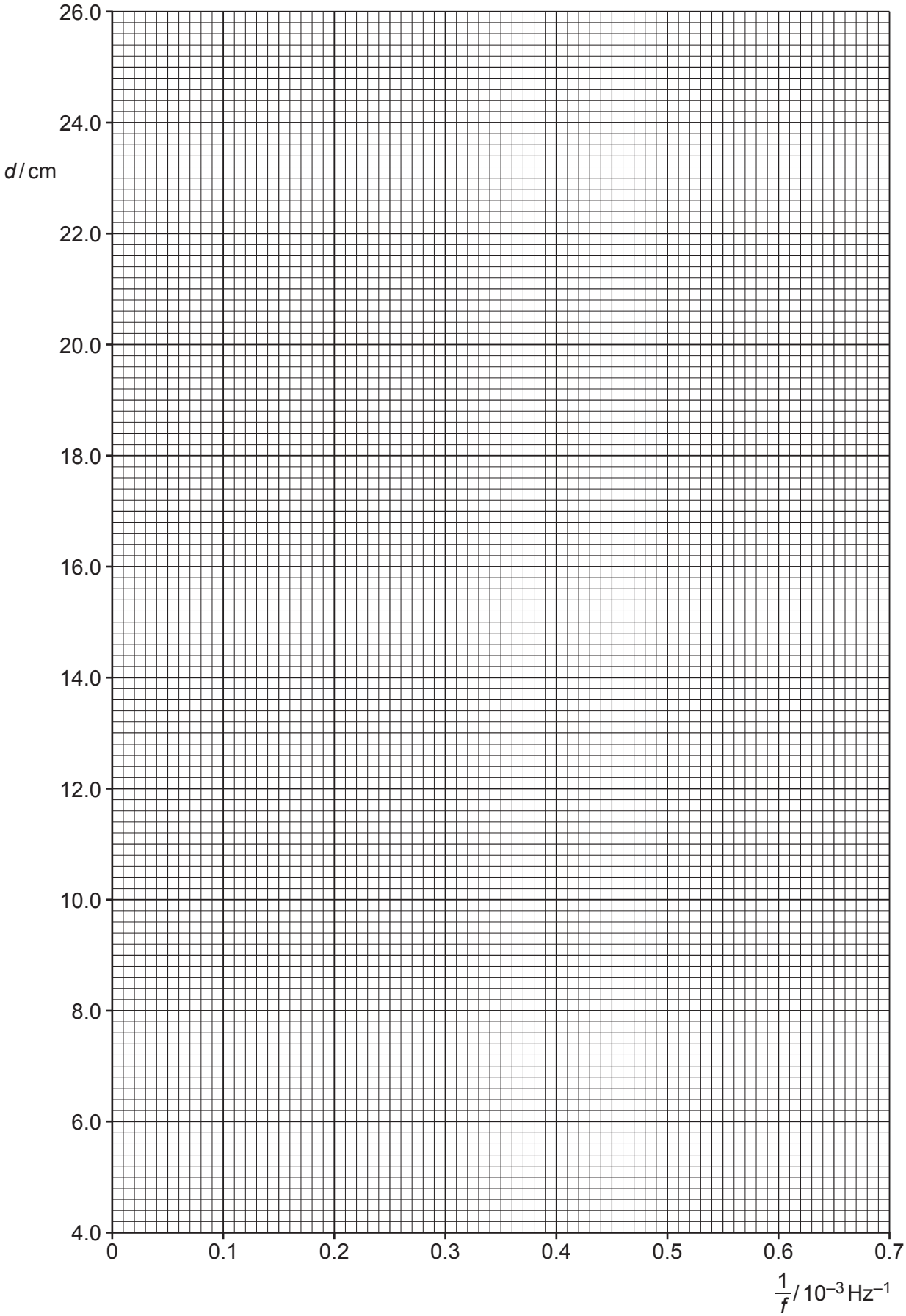
26.0
24.0
d / cm
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
1/f / 10^−3 Hz^−1

(iv) Determine the *y*-intercept of the line of best fit. Include the absolute uncertainty in your answer.

y-intercept = ... [2]

(d) Using your answers to **(a)**, **(c)(iii)** and **(c)(iv)**, determine the values of *v* and *k*. Include appropriate units and include the absolute uncertainties in your answers.

v = ...

k = ...
[3]

(e) The experiment is repeated. Determine the frequency *f* that gives a value of *d* of 30.0 cm.

f = ... Hz [1]

[Total: 15]

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