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.

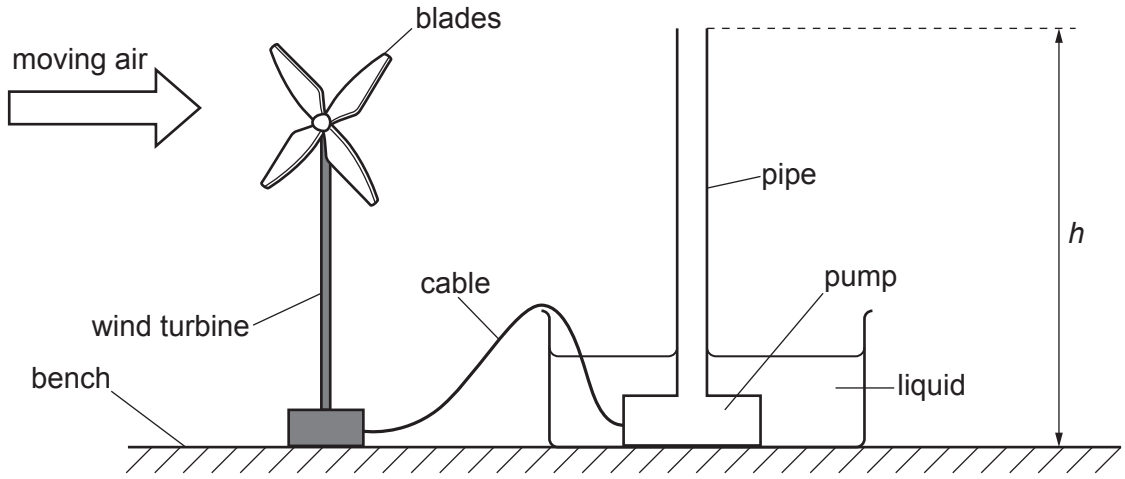


Fig. 1.1 (not to scale)

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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[15]

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.

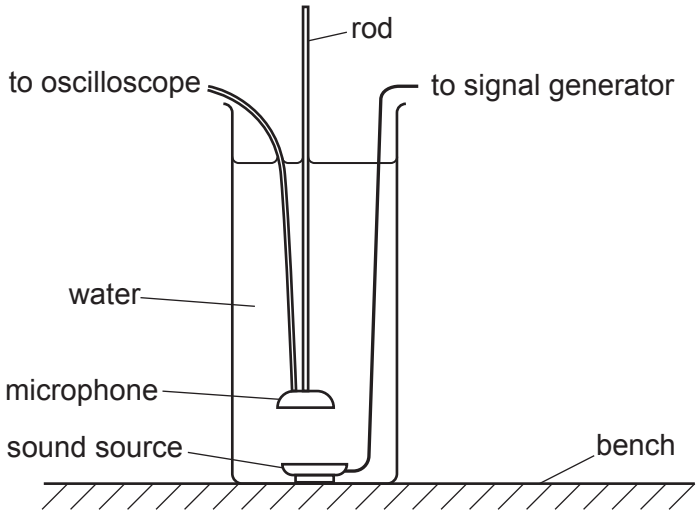


Fig. 2.1

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 $\frac{1}{f} / 10^{-3}\,\text{Hz}^{-1}$.

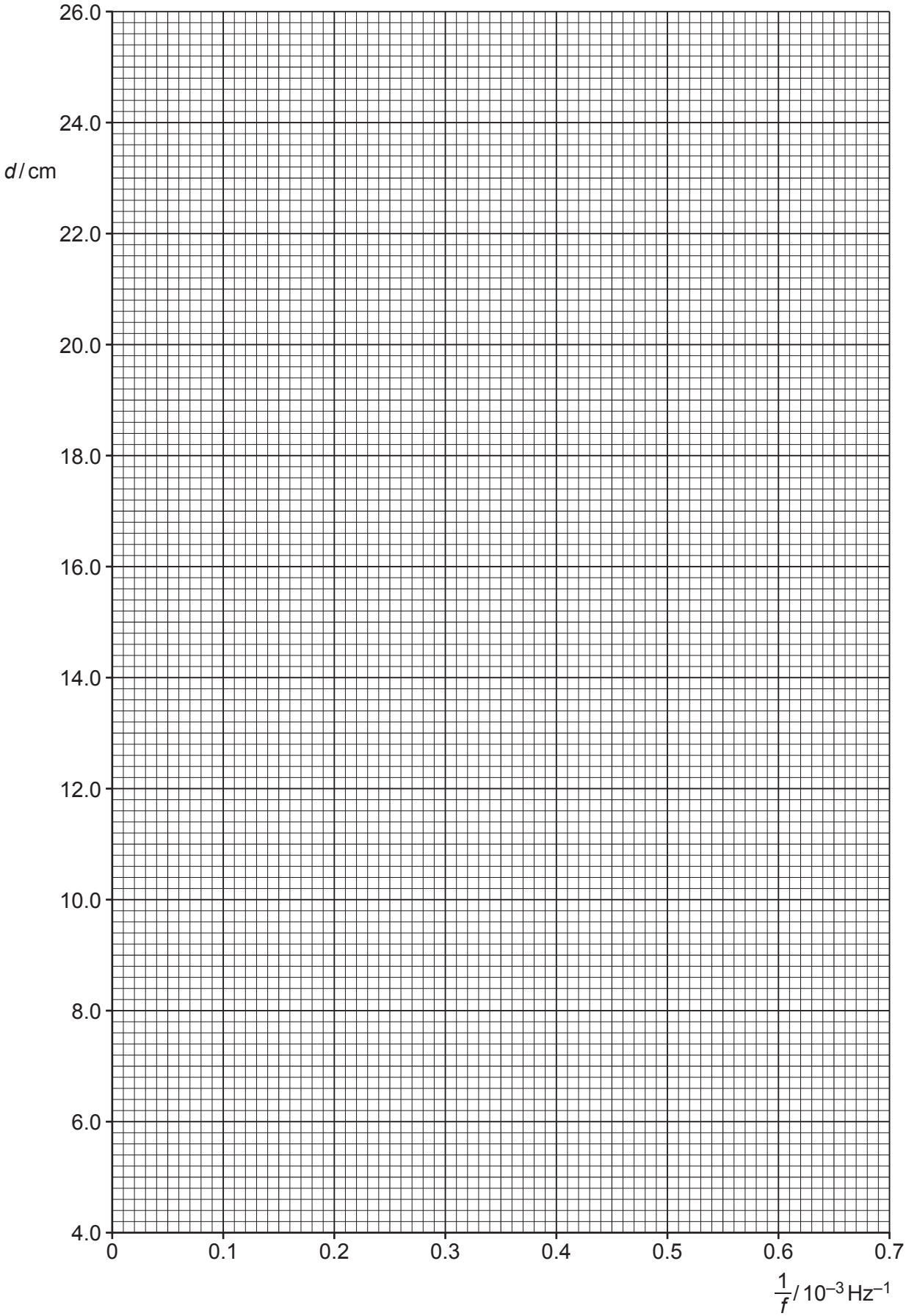
Include error bars for d. [2]

(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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