Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

3220459137

PHYSICS **9702/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2024**

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 Fig. 1.1 shows a small solid metal cylinder of mass m, length L and diameter d.

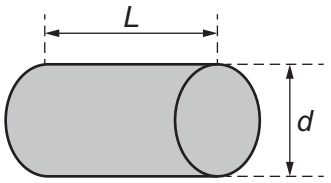

Fig. 1.1

The cylinder is heated to a uniform temperature. The cylinder is then removed from the heat source and the cylinder is wrapped in an insulating material.

The temperature of the room is T_R. At time t after the cylinder starts to cool, the surface temperature of the cylinder is T_C.

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

$$(T_C - T_R) = Ze^{-\frac{UAt}{mc}}$$

where A is the total surface area of the cylinder, c is the specific heat capacity of the metal, and U and Z are constants.

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

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for U and Z.

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 the sound from a horn attached to a car, as shown in Fig. 2.1.

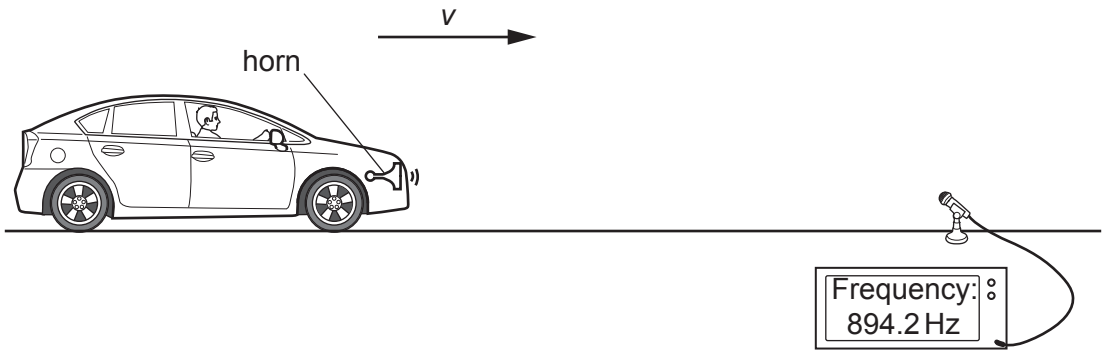

Fig. 2.1 (not to scale)

A microphone is placed at the side of the road and connected to a frequency meter. The car travels towards the microphone. The frequency f of the sound detected by the microphone is read from the frequency meter.

The speed of the car is measured by two speed detectors. The two measurements of speed are v_1 and v_2. The average speed v of the car is determined from v_1 and v_2.

The experiment is repeated for different speeds of the car.

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

$$f = \frac{f_s k}{k - v}$$

where f_s is the frequency of the sound emitted by the horn and k is a constant.

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

Determine expressions for the gradient and y-intercept.

gradient = ...

y-intercept = ...

[1]

(b) Values of v_1, v_2 and f are given in Table 2.1.

Table 2.1

v_1 / m s^{-1}	v_2 / m s^{-1}	v / m s^{-1}	f / Hz	$\frac{1}{f}$ / 10^{-3} Hz^{-1}
3.1	3.9		894.2	
6.7	5.9		901.2	
9.2	8.2		908.0	
11.9	10.9		915.8	
13.3	14.5		923.6	
15.6	16.8		931.2	

Calculate and record values of v / m s^{-1} and $\frac{1}{f}$ / 10^{-3} Hz^{-1} in Table 2.1.

Include the absolute uncertainties in v. [2]

(c) (i) Plot a graph of $\frac{1}{f}$ / 10^{-3} Hz^{-1} against v / m s^{-1}. Include error bars for v. [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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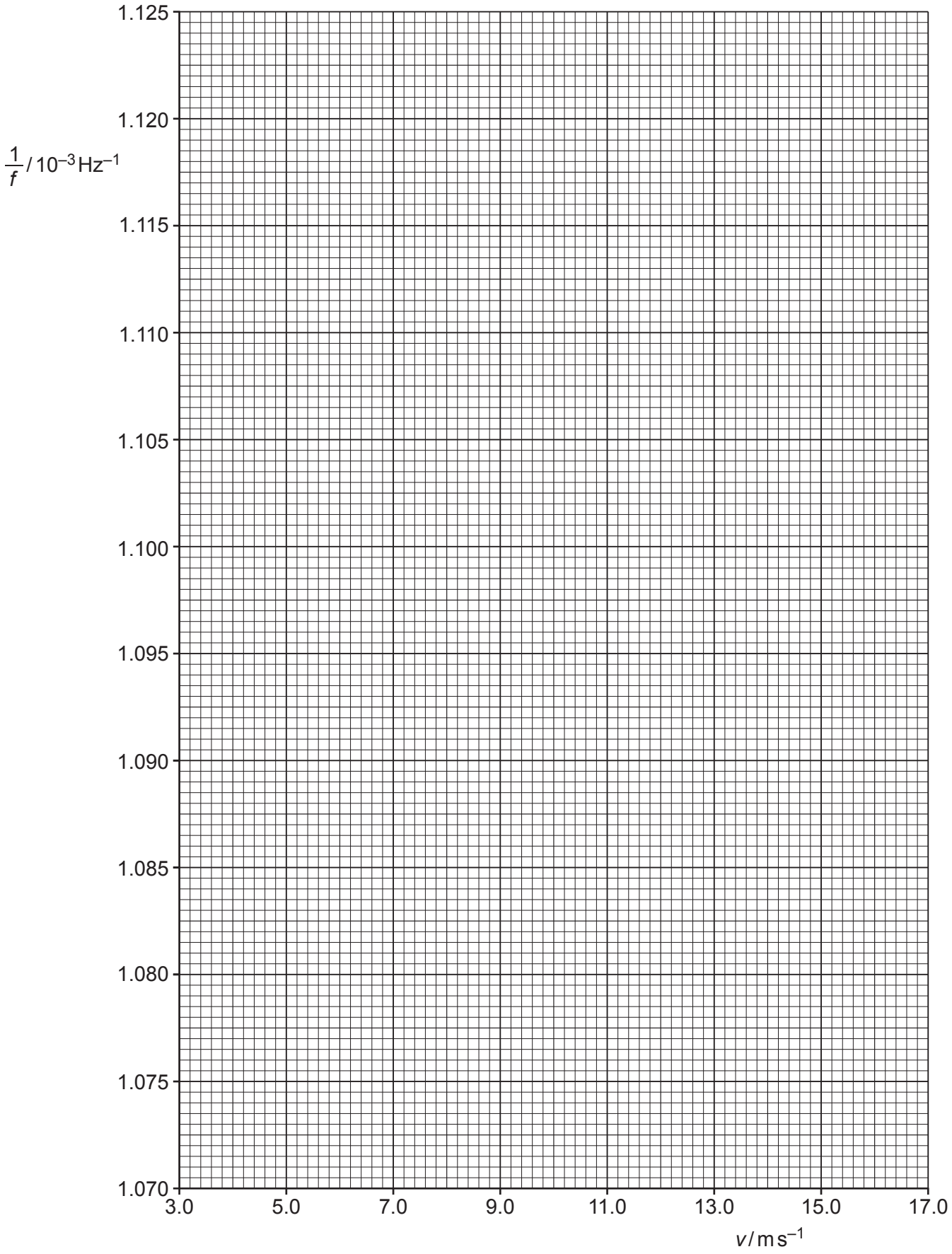

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[Turn over

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

y-intercept = ... [2]

(d) (i) Using your answers to **(a)**, **(c)(iii)** and **(c)(iv)**, determine the values of f_s and *k*. Include appropriate units.

f_s = ...

k = ...
[2]

(ii) Determine the percentage uncertainty in *k*.

percentage uncertainty in *k* = ... % [1]

(e) The experiment is repeated. Determine the speed *v* that gives a value of *f* of 987.8 Hz.

v = ... $m\,s^{-1}$ [1]

[Total: 15]

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