Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME: Fuzail

CENTRE NUMBER

CANDIDATE NUMBER

3831942328

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2020**

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. Blank pages are indicated.

DC (ST/CT) 182958/2

1 A student investigates stationary waves with an elastic cord of circular cross-section attached to a load, as shown in Fig. 1.1.

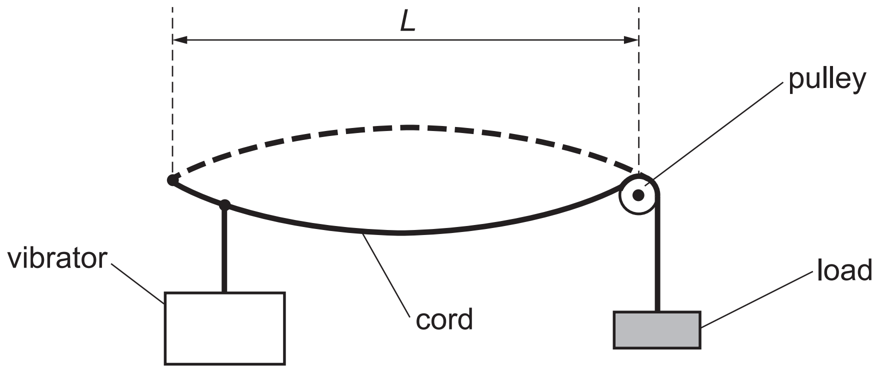


Fig. 1.1

When the frequency of the vibrator is *f*, the cord vibrates with the stationary wave pattern shown. The student investigates how *f* varies with the cross-sectional area *A* of the cord.

It is suggested that the relationship between *f* and *A* is

$$f = \frac{1}{2L}\sqrt{\frac{M}{kA}}$$

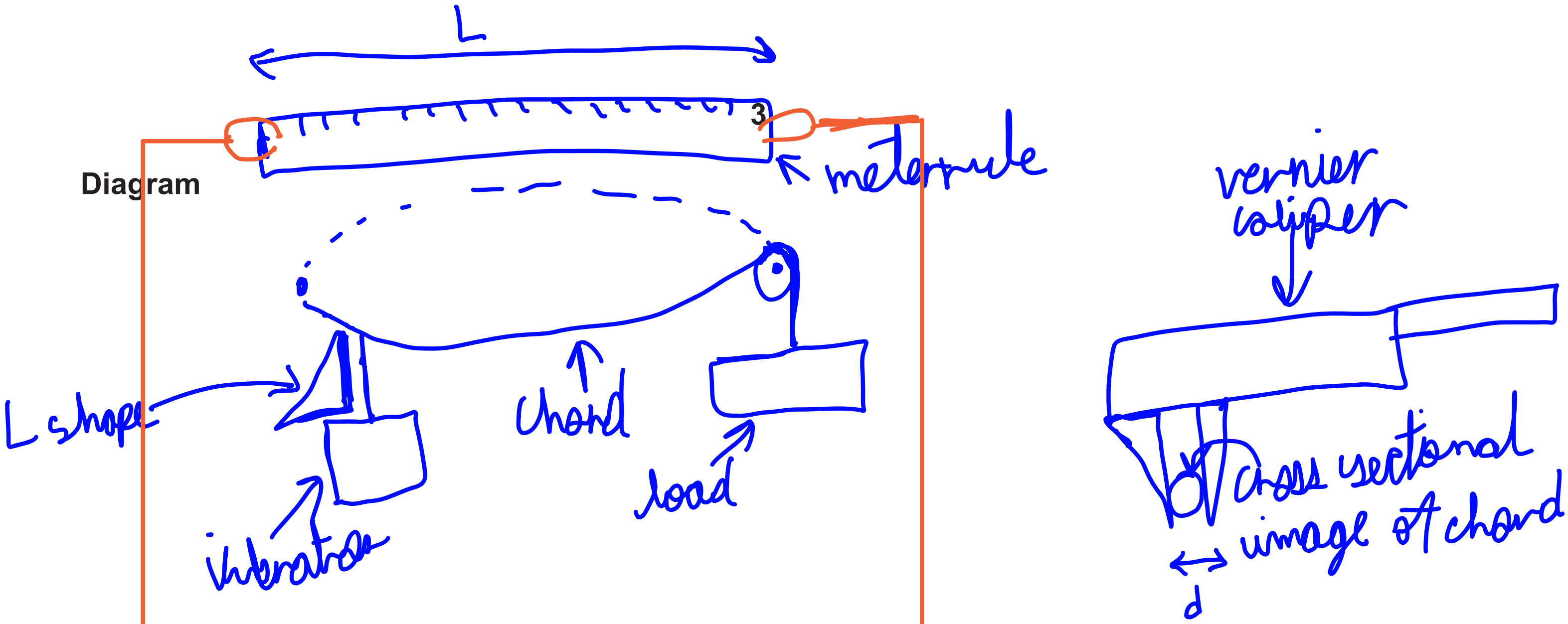
where *L* is the distance between the two nodes, *M* is the mass of the load and *k* is a constant.

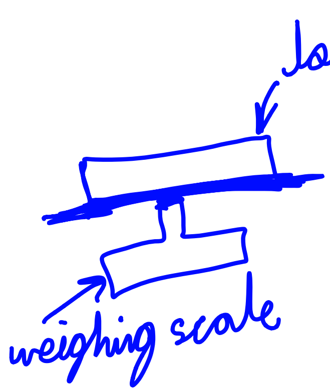
Design a laboratory experiment to test the relationship between *f* and *A*.
Explain how your results could be used to determine a value for *k*.

You should draw a diagram, on page 3, showing the arrangement of your equipment.
In your account you should pay particular attention to:

- 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





Measure at multiple points.
take

In this experiment, A is the independent variable. and, f, is the dependent variable. Mass of the load is kept controlled and same throughout the experiment. L should also be kept constant.

To measure the crossectional area of the chord, vernier calipers are used to measure the diameter, d, and $A = \frac{\pi d^2}{4}$. Cords of multiple cross sectional areas should be used to vary A, making sure its made of same material. To find the frequency, f, at which stationary waves form, the operating frequency of the vibrator is varied, and the frequency at which stationary waves form is noted. The mass, M, of the load is measured using a ~~weighing scale~~ balance. The length, L, is measured using a meter rule.

connect it to CRO, and find time period, then find frequency by $\frac{1}{\text{time period}}$

A graph of f^2 is plotted against $\frac{1}{A}$, it should be a straight line starting from the origin. The gradient of the graph is now determined.

$K = \frac{M}{4L \times \text{gradient}}$

A sand bed should be put below the load in case it falls. Insulation gloves should be used when handling with the vibrator.

Using set squares, ensure the vibrator's rod is perfectly vertical, like shown in the diagram.

Repeat exp for same diameter of chord and use the avg freq in the table

[15]

11/15

2 A student investigates how the viscous force in a liquid varies with temperature.

The student releases a ball from the surface of the liquid in a container. The ball falls as shown in Fig. 2.1.

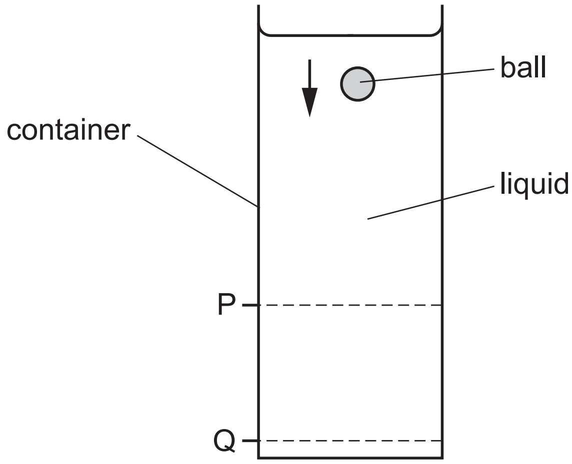


Fig. 2.1

The student determines the speed of the ball between P and Q and measures the thermodynamic temperature T of the liquid.

Viscosity is a term used to describe the viscous forces acting in a liquid. Viscosity has the unit pascal second (Pa s). The viscosity η of the liquid is calculated from the speed of the ball.

The experiment is repeated for the same liquid at different temperatures.

It is suggested that η and T are related by the equation

$$\eta = He^{\left(\frac{E}{kT}\right)}$$

where E and H are constants and k is the Boltzmann constant.

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

Determine expressions for the gradient and y-intercept.

$\ln(\eta) = \ln He^{\left(\frac{E}{KT}\right)}$

$\ln(\eta) = \ln H + \frac{E}{K}\left(\frac{1}{T}\right)$

gradient = $\frac{E}{K}$

y-intercept = ln H

[1]

(b) Values of T and η are given in Table 2.1.

Table 2.1

T/K	η/ 10^{-4} Pa s	$\frac{1}{T}$/ 10^{-3} K^{-1}	ln (η/ 10^{-4} Pa s)
292	12.3 ± 0.2	3.42	2.51 ± 0.016
303	9.8 ± 0.2	3.30	2.28 ± 0.020
311	8.4 ± 0.2	3.22	2.13 ± 0.024
323	6.8 ± 0.2	3.10	1.92 ± 0.029
335	5.6 ± 0.2	2.99	1.72 ± 0.035
346	4.8 ± 0.2	2.89	1.57 ± 0.041

Calculate and record values of ln (η/ 10^{-4} Pa s) in Table 2.1.
Include the absolute uncertainties in ln (η/ 10^{-4} Pa s). [2] 2

(c) **(i)** Plot a graph of ln (η/ 10^{-4} Pa s) against $\frac{1}{T}$/ 10^{-3} K^{-1}.
Include error bars for ln η. [2] 2

(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Both lines should be clearly labelled. [2] 1

(iii) Determine the gradient of the line of best fit. Include the absolute uncertainty in your answer.

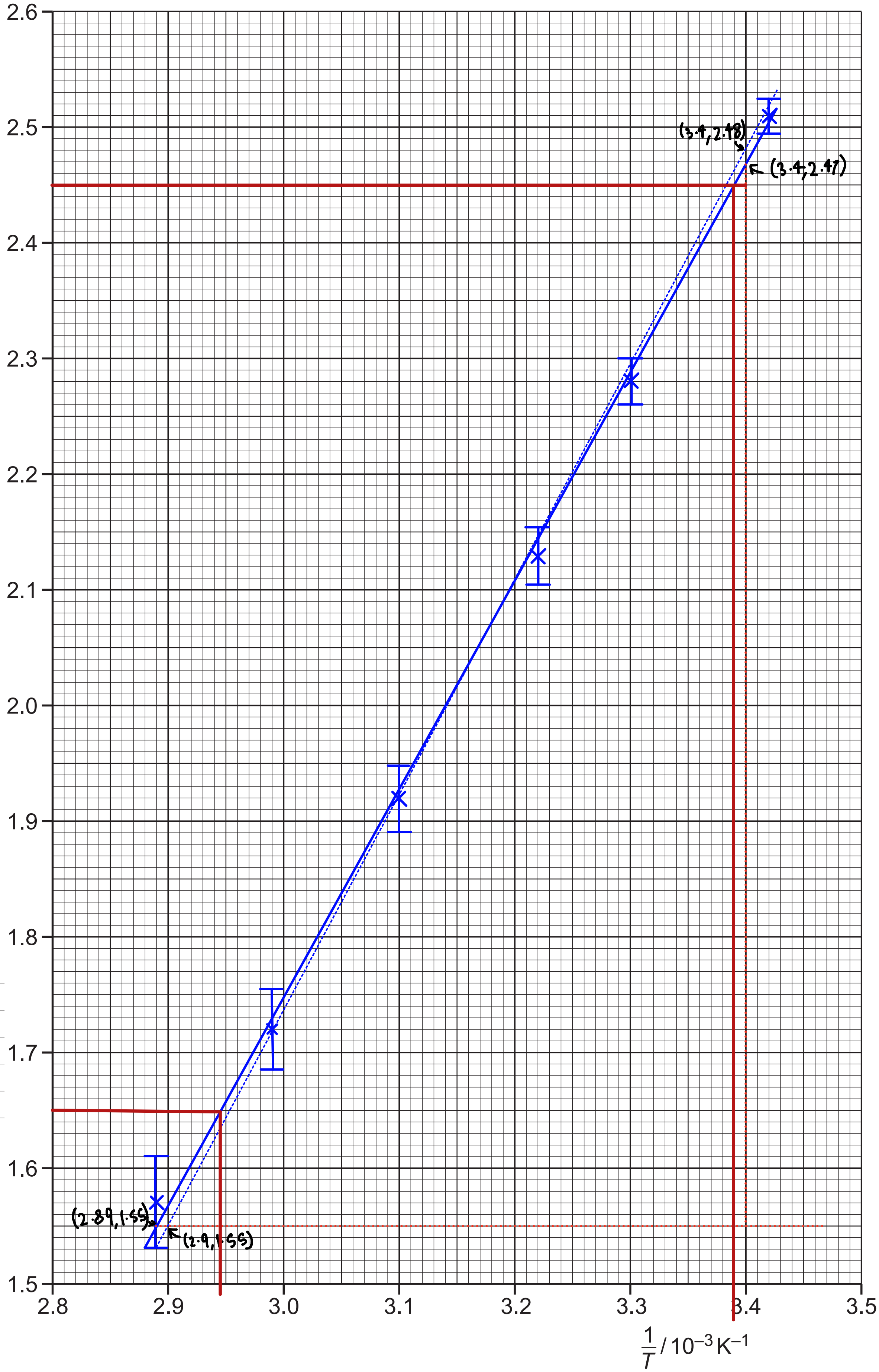
gradient of line of best fit $= \frac{(2.47 - 1.55)}{(3.4 - 2.89)} = 0.18039$

gradient of worst fit $= \frac{(2.48 - 1.55)}{(3.4 - 2.9)} = 0.18600$

$\therefore \Delta g = 1.8600 - 1.8039$
$= 0.00561$

1

gradient = 0.18 ± 0.0056 [2]



$\frac{1}{T}$ / 10^{-3} K^{-1}	ln (η / 10^{-4} Pa s)
3.42	2.51 ± 0.016
3.30	2.28 ± 0.020
3.22	2.13 ± 0.024
3.10	1.92 ± 0.029
2.99	1.72 ± 0.035
2.89	1.57 ± 0.041

[Turn over

(iv) Determine the y-intercept of the line of best fit. Do **not** include the absolute uncertainty in your answer.

$y = 0.18x + c$

$1.56 = 0.18(2.89) + c$

$c = 1.0298$

y-intercept = 1.03 [1]

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

units ??

Data: $k = 1.38 \times 10^{-23}\,\mathrm{J\,K^{-1}}$

$\ln(\eta) = \ln H + \frac{E}{K}\left(\frac{1}{T}\right)$

$y = c + m\,x$

$\ln H = 1.0298$

$H = 2.80$

$0.18 = \frac{E}{K}$

$E = 2.484 \times 10^{-24}$

E = 2.48×10^{-24} Pa s J

H = 2.80 Pa s

[3]

(ii) Determine the absolute uncertainty in E.

absolute uncertainty in E = 0.0058 [1]

(e) Determine the value of η for a temperature of 273 K.

$n = He^{\left(\frac{E}{KT}\right)}$

$n = 2.80 \times e^{\left(\frac{2.48 \times 10^{-24}}{1.38 \times 10^{-23} \times 273}\right)}$

$= 2.8018$

η = 2.80 Pa s [1]

[Total: 15]

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