Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

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.

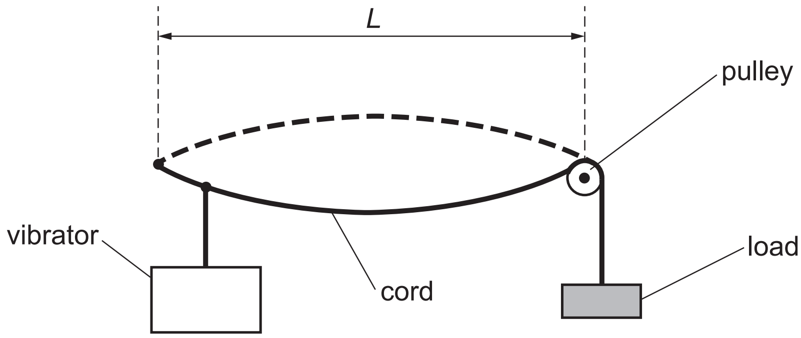

Fig. 1.1

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

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[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.

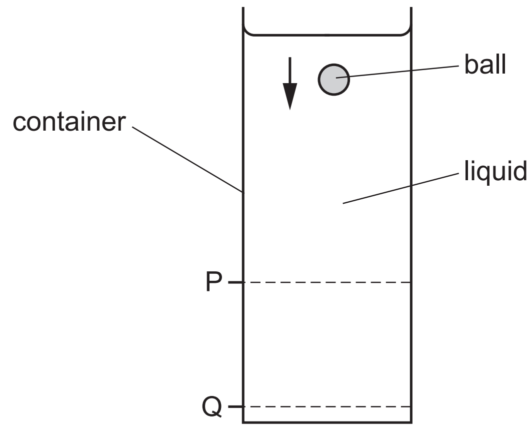


Fig. 2.1

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 $\ln \eta$ on the *y*-axis against $\frac{1}{T}$ on the *x*-axis.

Determine expressions for the gradient and *y*-intercept.

gradient = ...

y-intercept = ...
[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	
303	9.8 ± 0.2	3.30	
311	8.4 ± 0.2	3.22	
323	6.8 ± 0.2	3.10	
335	5.6 ± 0.2	2.99	
346	4.8 ± 0.2	2.89	

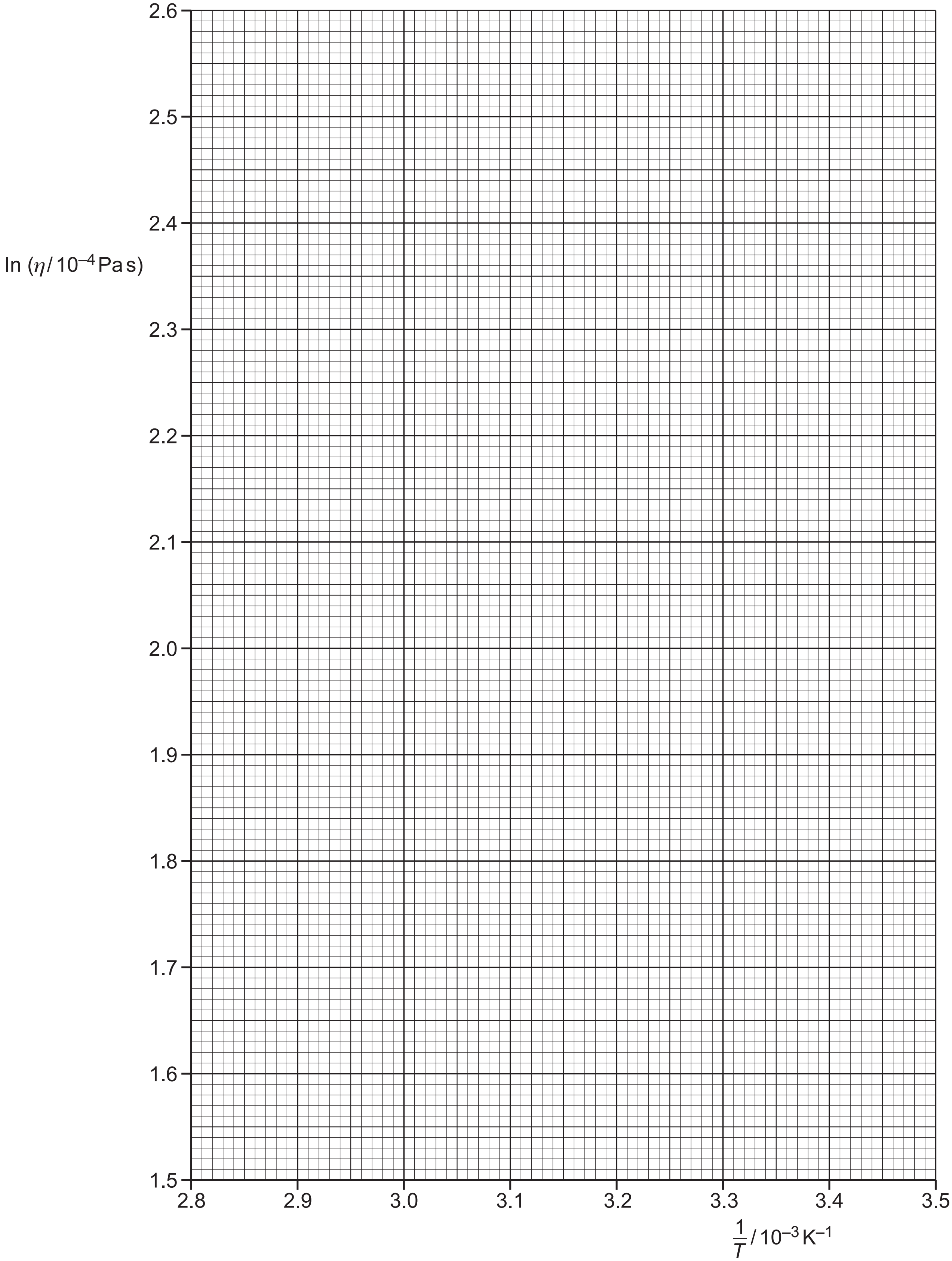
Calculate and record values of ln (η / 10^{-4} Pa s) in Table 2.1.
Include the absolute uncertainties in ln (η / 10^{-4} Pa s). [2]

(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]

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

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

gradient = ... [2]


ln (η / 10⁻⁴ Pa s)
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
2.8
2.9
3.0
3.1
3.2
3.3
3.4
3.5
1/T / 10⁻³ K⁻¹

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

y-intercept = ... [1]

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

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

E = ...

H = ...
[3]

(ii) Determine the absolute uncertainty in E.

absolute uncertainty in E = ... [1]

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

η = ... Pa s [1]

[Total: 15]