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.


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

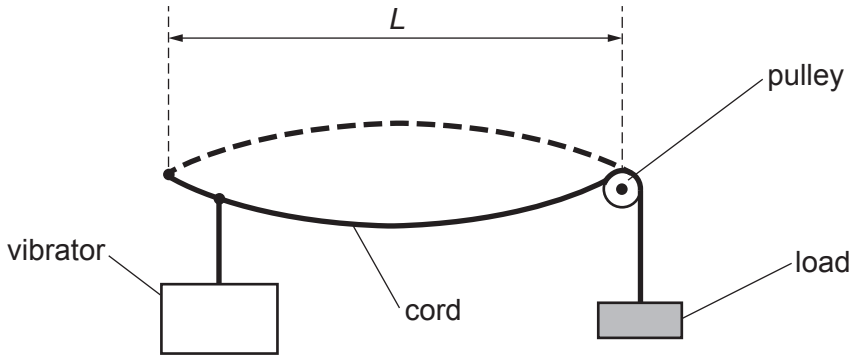


**Fig. 1.1**

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.

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**Diagram**

.....

.....

.....

**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.

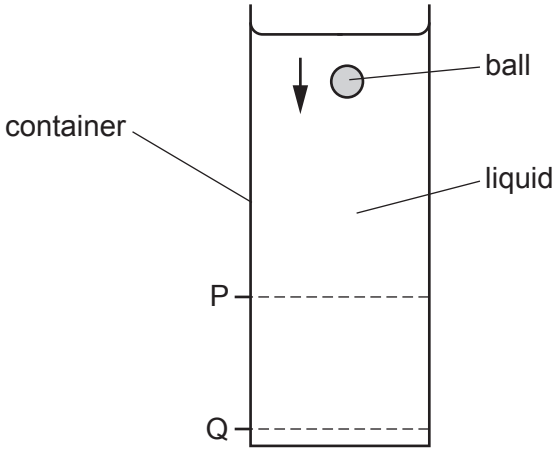


**Fig. 2.1**

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 $\eta$ 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 $\eta$ and $T$ are related by the equation

$$\eta = H\mathrm{e}^{\left(\frac{E}{kT}\right)}$$

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 $\eta$ are given in Table 2.1.

**Table 2.1**

| $T$/K | $\eta/10^{-4}$ Pa s | $\frac{1}{T}/10^{-3}$ K$^{-1}$ | ln ($\eta/10^{-4}$ 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 ($\eta/10^{-4}$ Pa s) in Table 2.1.
Include the absolute uncertainties in ln ($\eta/10^{-4}$ Pa s). [2]

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

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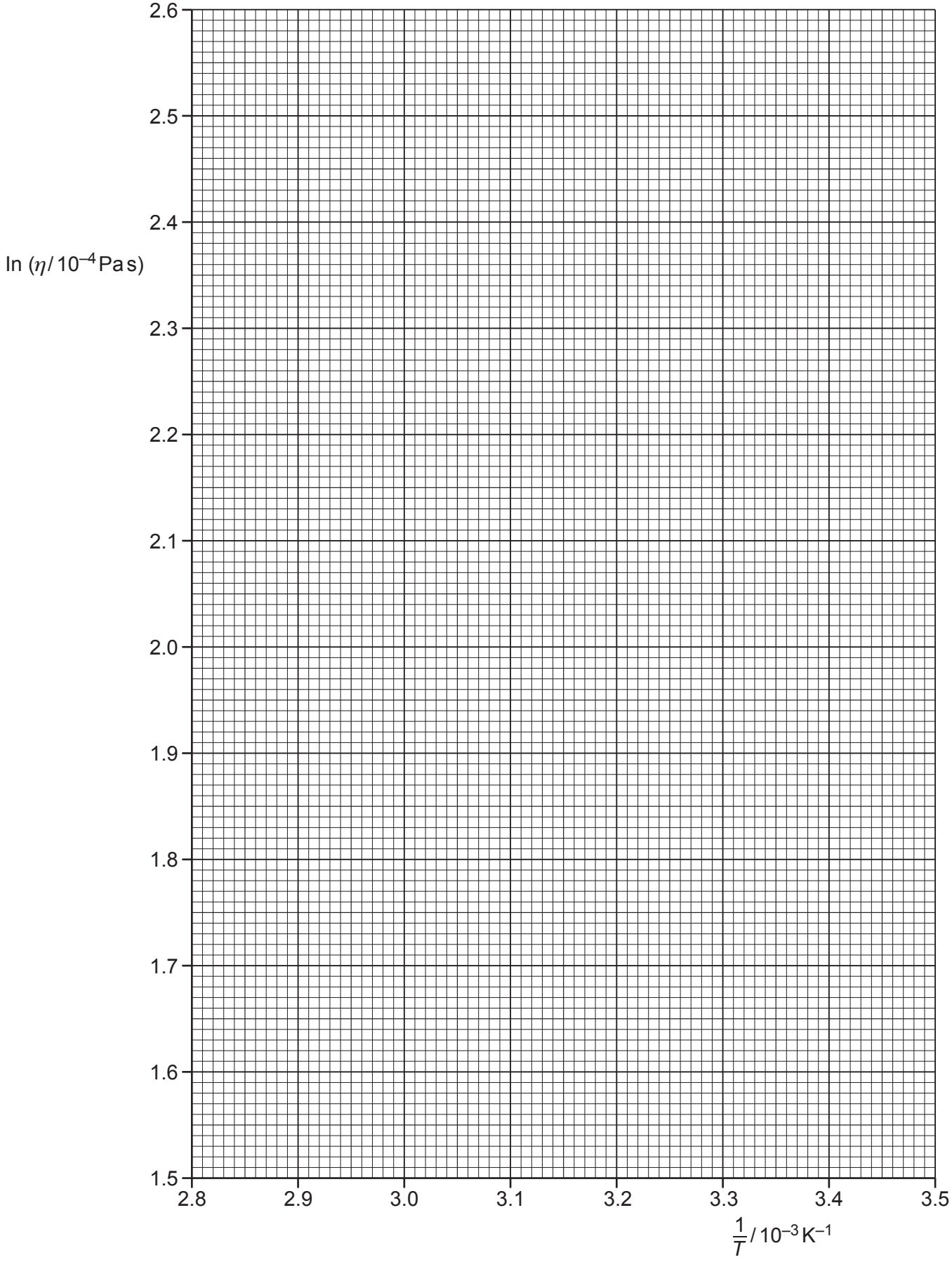
2.6
2.5
2.4
ln ($\eta$/ $10^{-4}$ Pa s)
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
2.8
2.9
3.0
3.1
3.2
3.3
3.4
3.5
$\frac{1}{T}$ / $10^{-3}$ K$^{-1}$

**(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: $k = 1.38 \times 10^{-23}\,\text{J K}^{-1}$

*E* = .....

*H* = .....
[3]

**(ii)** Determine the absolute uncertainty in *E*.

absolute uncertainty in *E* = ..... [1]

**(e)** Determine the value of $\eta$ for a temperature of 273 K.

$\eta$ = .....Pa s [1]

[Total: 15]

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