



# Cambridge International AS & A Level

CANDIDATE  
NAME

CENTRE  
NUMBER

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CANDIDATE  
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## 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.

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

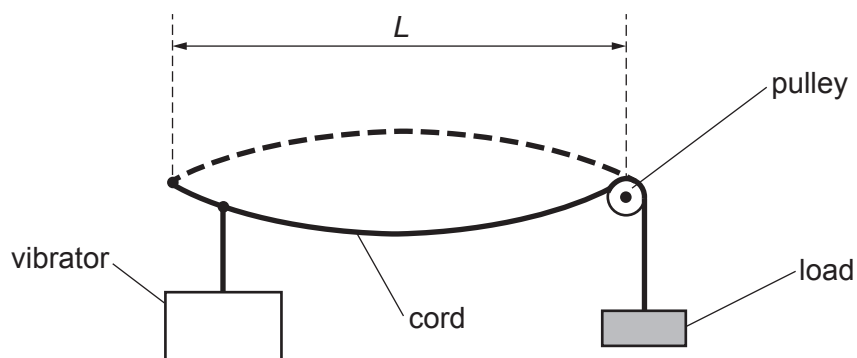


Fig. 1.1

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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A series of horizontal dotted lines for writing.

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.

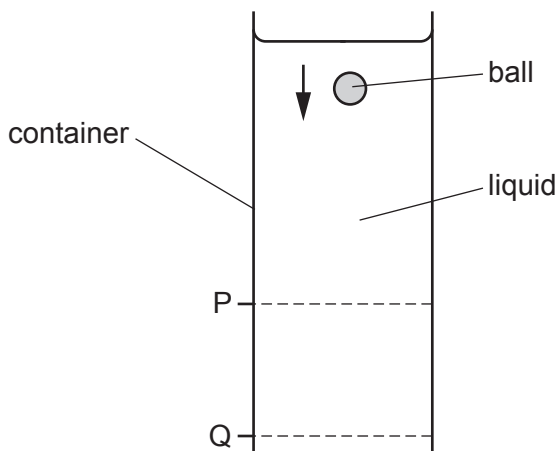


Fig. 2.1

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

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

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  $\eta$  are given in Table 2.1.

**Table 2.1**

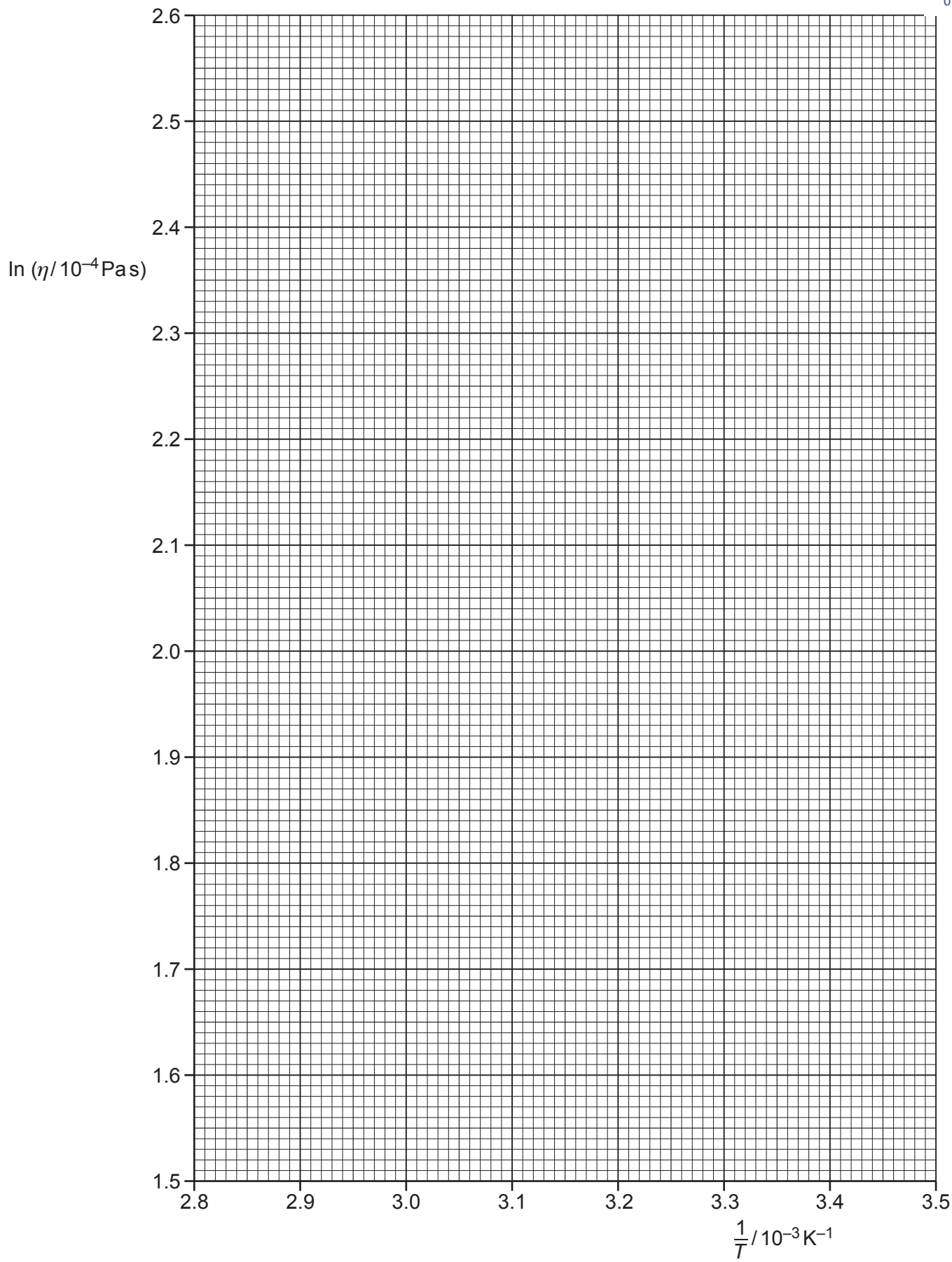
$T/K$	$\eta/10^{-4}\text{Pas}$	$\frac{1}{T}/10^{-3}\text{K}^{-1}$	$\ln(\eta/10^{-4}\text{Pas})$
292	$12.3 \pm 0.2$	3.42	
303	$9.8 \pm 0.2$	3.30	
311	$8.4 \pm 0.2$	3.22	
323	$6.8 \pm 0.2$	3.10	
335	$5.6 \pm 0.2$	2.99	
346	$4.8 \pm 0.2$	2.89	

Calculate and record values of  $\ln(\eta/10^{-4}\text{Pas})$  in Table 2.1.  
Include the absolute uncertainties in  $\ln(\eta/10^{-4}\text{Pas})$ .

[2]

- (c) (i) Plot a graph of  $\ln(\eta/10^{-4}\text{Pas})$  against  $\frac{1}{T}/10^{-3}\text{K}^{-1}$ .  
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]



- (iv) Determine the  $y$ -intercept of the line of best fit. Do **not** include the absolute uncertainty ... 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:  $k = 1.38 \times 10^{-23} \text{ JK}^{-1}$

$E =$  .....

$H =$  ..... [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.

$\eta =$  ..... Pas [1]

[Total: 15]