



# Cambridge International AS & A Level

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## PHYSICS

9702/34

Paper 3 Advanced Practical Skills 2

May/June 2023

2 hours

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

## 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 will be allowed to work with the apparatus for a maximum of 1 hour for each question.
- You should record all your observations in the spaces provided in the question paper as soon as these observations are made.
- You may use a calculator.
- You should show all your working and use appropriate units.

## INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

| For Examiner's Use |  |
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| 1                  |  |
| 2                  |  |
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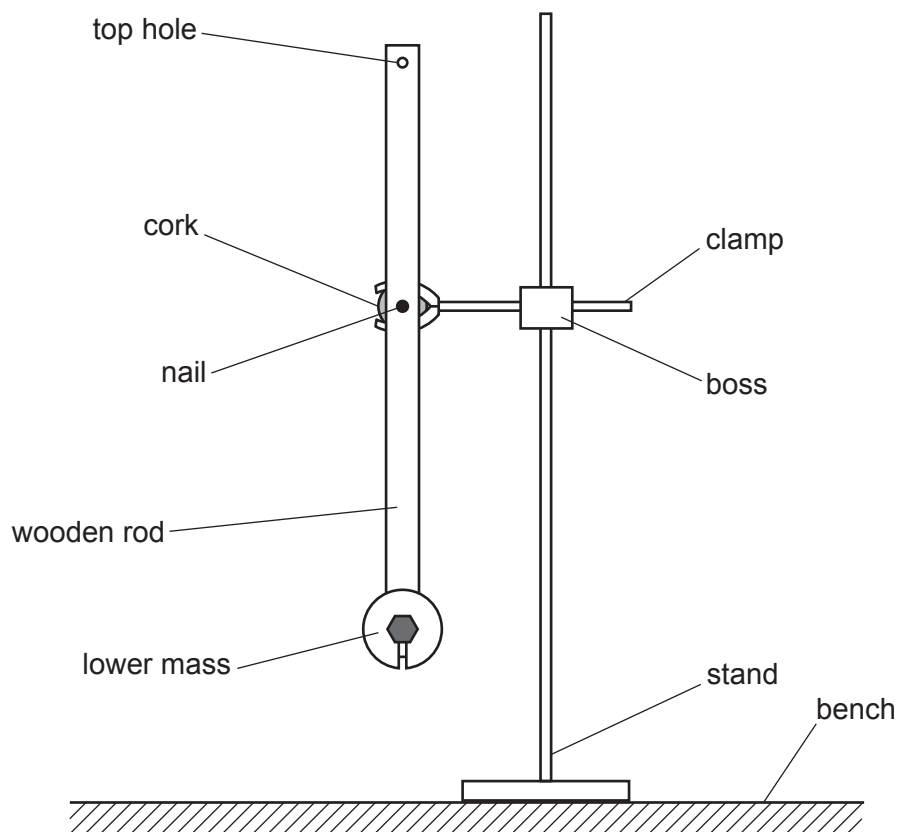
This document has **12** pages. Any blank pages are indicated.



**You may not need to use all of the materials provided.**

**1** In this experiment, you will investigate the oscillations of a pendulum.

- (a) • Assemble the apparatus as shown in Fig. 1.1 with the nail held securely in the cork. Check that the wooden rod can swing freely.



**Fig. 1.1**

- You have been provided with one 50 g and four 10 g slotted masses. Use the bolt and nut to attach some of the 10 g slotted masses to the top hole.
- Record the total mass  $M$  of the slotted masses that are attached to the top hole.

$M = \dots\dots\dots$

- Push the bottom of the wooden rod a small distance to one side.
- Release the wooden rod so that it oscillates.
- Take measurements to determine the period  $T$  of the oscillations.

$T = \dots\dots\dots$

[3]

- (b) Change  $M$  and determine  $T$ . Repeat until you have six sets of values of  $M$  and  $T$ . Do **not** change the lower mass.

Record your results in a table. Include values of  $M^2$  and  $T^2$  in your table.

[9]

- (c) (i) Plot a graph of  $T^2$  on the  $y$ -axis against  $M^2$  on the  $x$ -axis.

[3]

- (ii) Draw the straight line of best fit.

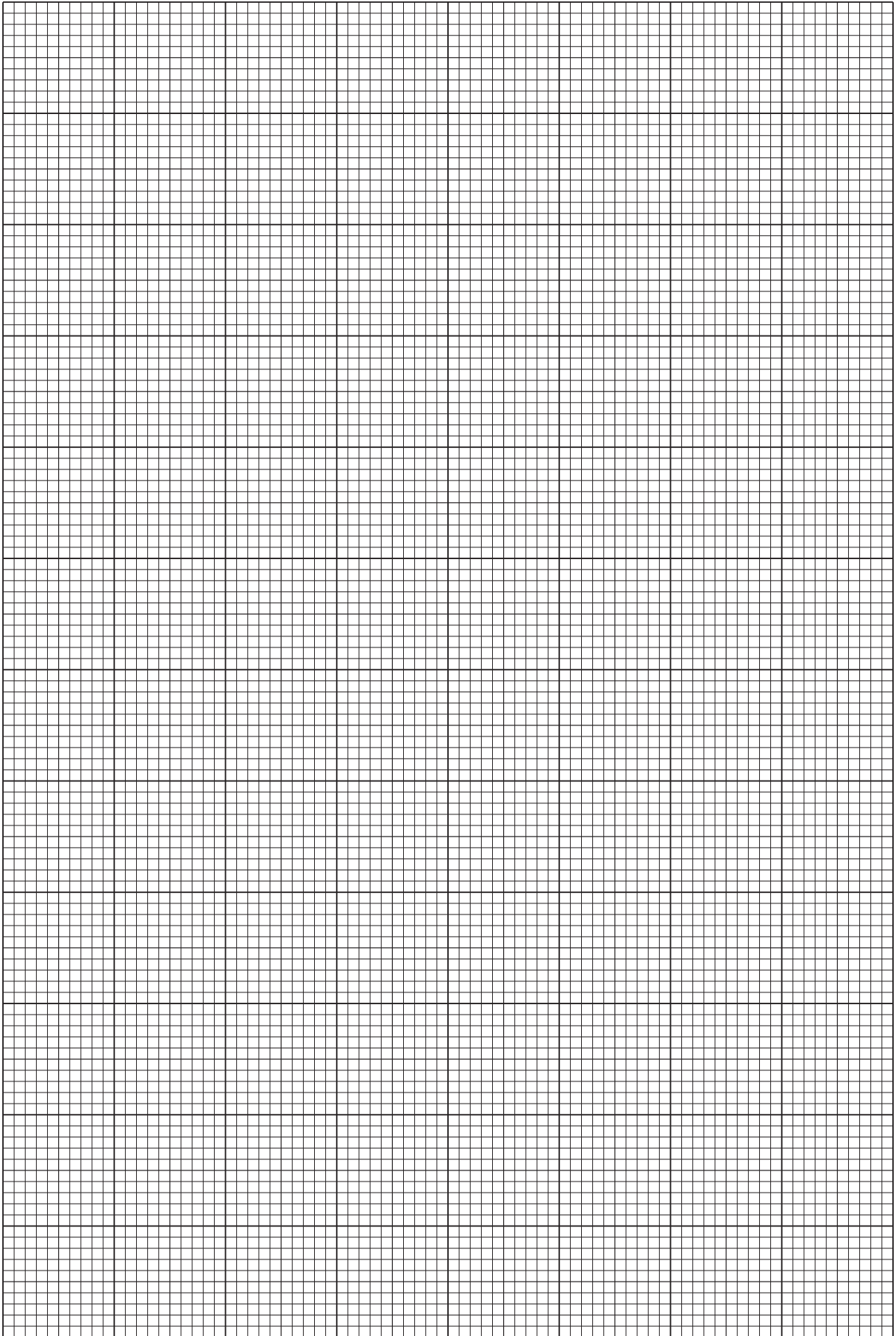
[1]

- (iii) Determine the gradient and  $y$ -intercept of this line.

gradient = .....

$y$ -intercept = .....

[2]



(d) It is suggested that the quantities  $T$  and  $M$  are related by the equation

$$T^2 = aM^2 + b$$

where  $a$  and  $b$  are constants.

Using your answers in (c)(iii), determine the values of  $a$  and  $b$ .  
Give appropriate units.

$a =$  .....

$b =$  .....

[2]

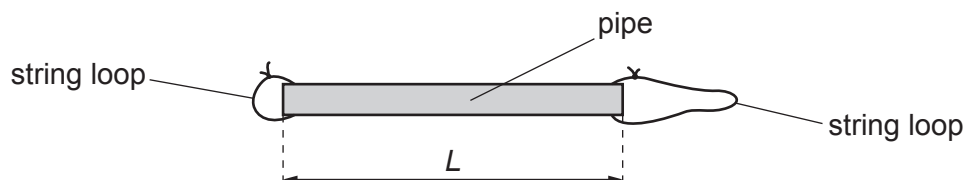
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**You may not need to use all of the materials provided.**

**2** In this experiment, you will investigate the thermal expansion of plastic.

**(a)** You have been provided with two plastic pipes. Each pipe has a string loop attached at each end, as shown in Fig. 2.1.



**Fig. 2.1**

- Measure and record the length  $L$  of the **longer** pipe, as shown in Fig. 2.1.

$L =$  .....

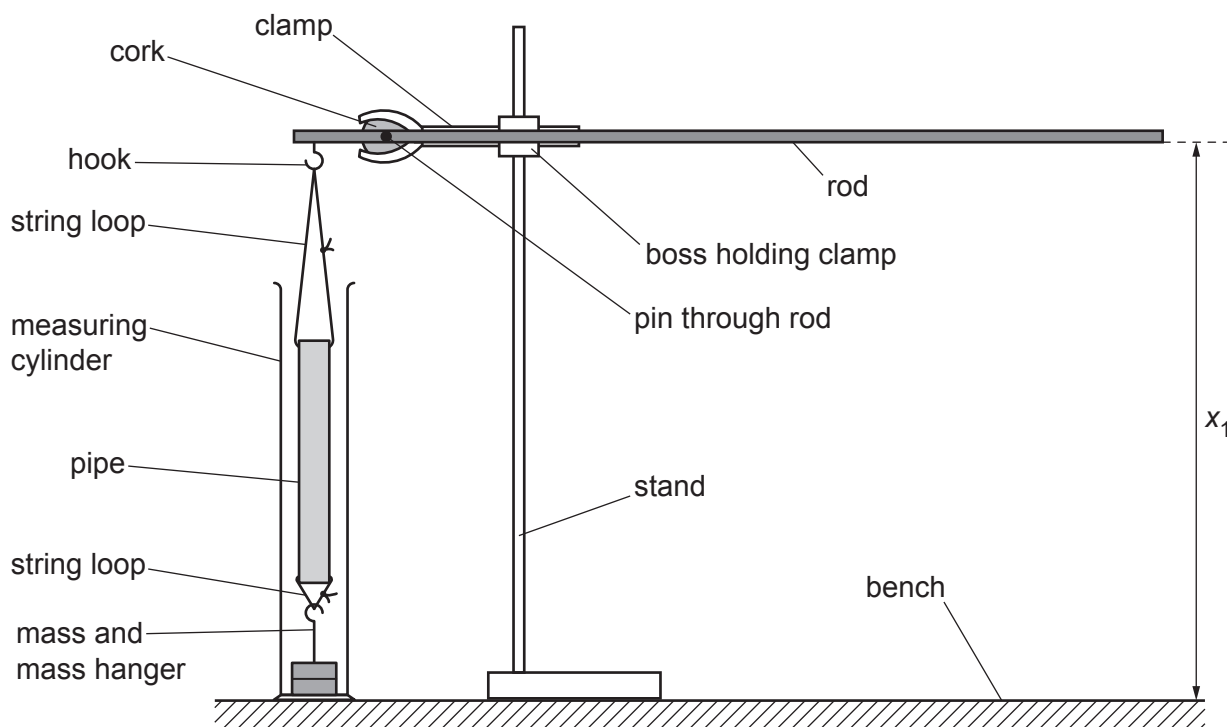
- Place the thermometer on the bench. Record the room temperature  $T_0$ .

$T_0 =$  .....

[2]

**(b) (i)** You have been provided with a wooden rod supported by a pin.

- Using the longer pipe, assemble the apparatus as shown in Fig. 2.2.



**Fig. 2.2**

- Adjust the apparatus so that the rod is parallel to the bench and the mass hanger rests on the bottom of the measuring cylinder.
- Measure and record the height  $x_1$  of the end of the rod above the bench, as shown in Fig. 2.2.

$$x_1 = \dots\dots\dots [1]$$

- (ii)
- Slowly pour boiling water into the measuring cylinder until it covers the pipe.
  - Place the thermometer in the water. Record the temperature  $T$ .

$$T = \dots\dots\dots$$

- Remove the thermometer from the water.
- The expansion of the pipe causes the end of the rod to move down. Measure the new height  $x_2$  of the end of the rod above the bench.

$$x_2 = \dots\dots\dots$$

- Carefully remove the pipe and mass hanger (the masses will be very hot) and pour the hot water into the sink.

[2]

- (iii) Calculate  $(x_1 - x_2)$ .

$$(x_1 - x_2) = \dots\dots\dots [1]$$

- (iv) Estimate the percentage uncertainty in your value of  $(x_1 - x_2)$ . Show your working.

$$\text{percentage uncertainty} = \dots\dots\dots \% [1]$$

- (c) • Measure and record the length  $L$  of the **shorter** pipe.

$$L = \dots\dots\dots$$

- Repeat (b)(i), (b)(ii) and (b)(iii) using the shorter pipe.

$$x_1 = \dots\dots\dots$$

$$T = \dots\dots\dots$$

$$x_2 = \dots\dots\dots$$

$$(x_1 - x_2) = \dots\dots\dots$$

[2]

- (d) It is suggested that the relationship between  $x_1$ ,  $x_2$ ,  $L$ ,  $T$  and  $T_0$  is

$$k(x_1 - x_2) = L(T - T_0)$$

where  $k$  is a constant.

- (i) Using your data, calculate two values of  $k$ .

first value of  $k$  = .....

second value of  $k$  = .....

[1]

- (ii) Justify the number of significant figures that you have given for your values of  $k$ .

.....  
 .....  
 ..... [1]

- (e) It is suggested that the percentage uncertainty in the values of  $k$  is 20%.

Using this uncertainty, explain whether your results support the relationship in (d).

.....  
 .....  
 .....  
 ..... [1]

- (f) (i) Describe **four** sources of uncertainty or limitations of the procedure for this experiment.

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

.....

[4]

- (ii) Describe **four** improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

.....

[4]

[Total: 20]

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