



Cambridge International AS & A Level

CANDIDATE
NAME
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PHYSICS

9702/36

Paper 3 Advanced Practical Skills 2

October/November 2024

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

1	
2	
Total	

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 equilibrium position of a suspended cardboard sheet.
 - (a) You are provided with a flat sheet of cardboard with a hole through it and two lines drawn near two of the edges.
 - Assemble the apparatus as shown in Fig. 1.1 with the bottom edge of the cardboard approximately 5 cm above the bench. Check that the cardboard swings freely on the knitting needle.

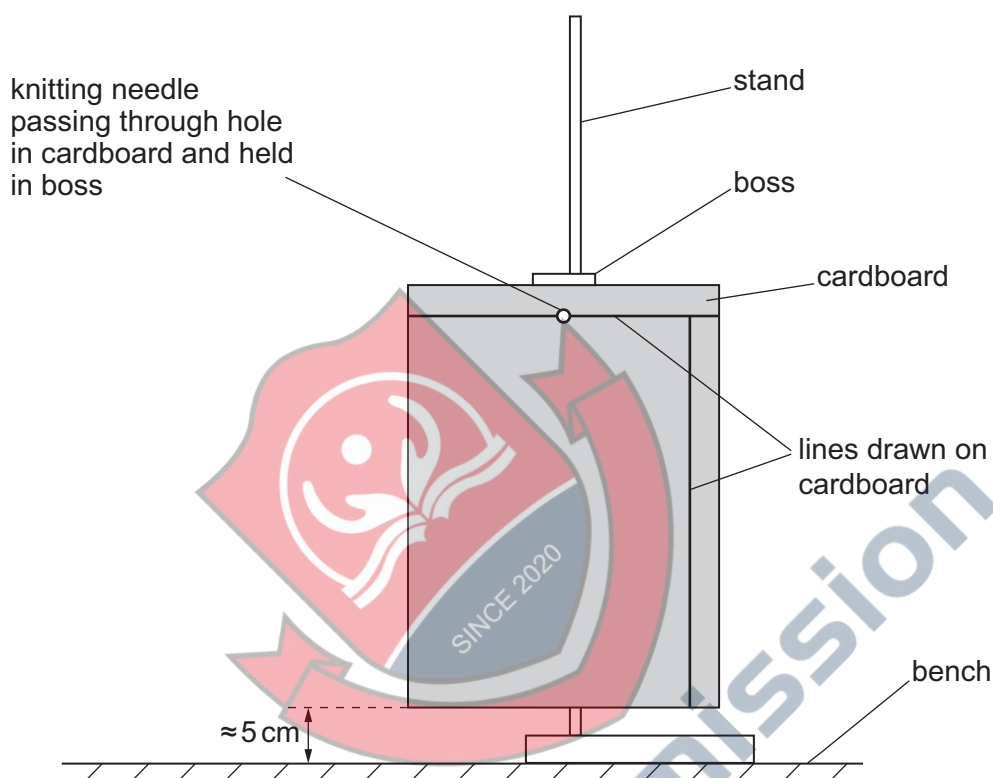
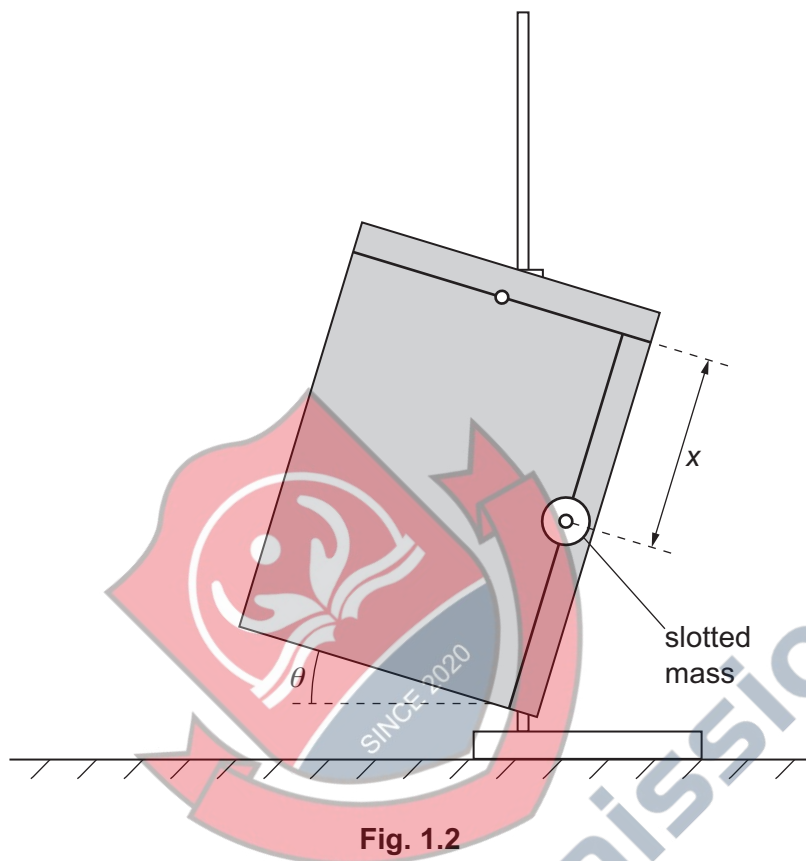


Fig. 1.1



- Use the sharp pencil to make a hole through the cardboard approximately half-way along the longer line.
- Pass the bolt through the slotted mass and then through the hole in the cardboard, as shown in Fig. 1.2.
- Secure the bolt using the nut.



- The distance between the centre of the slotted mass and the intersection of the two lines is x , as shown in Fig. 1.2.

Measure and record x .

$x = \dots\dots\dots$

- The angle between the bottom edge of the cardboard and the horizontal is θ , as shown in Fig. 1.2.

Use the wooden block and the protractor to measure θ .

$\theta = \dots\dots\dots^\circ$
[2]





- (b) Use the pencil to make another hole through the longer line and move the slotted mass and bolt to the new hole. Measure x and θ .

Repeat until you have six sets of values of x and θ .

Record your results in a table. Include values of $\frac{1}{\tan \theta}$ in your table.



- (c) (i) Plot a graph of $\frac{1}{\tan \theta}$ on the y -axis against x on the x -axis. [10]

- (ii) Draw the straight line of best fit. [3]

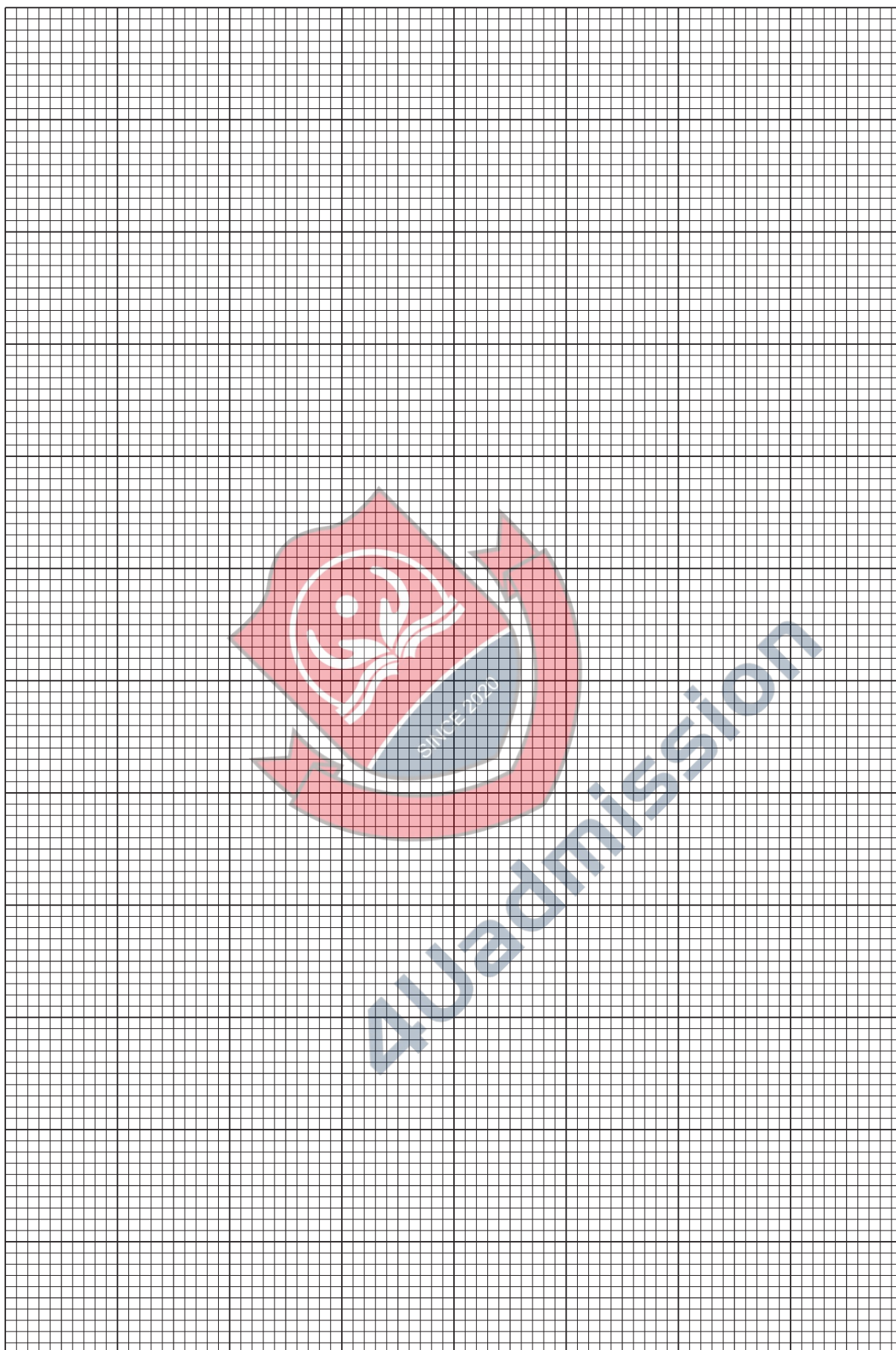
- (iii) Determine the gradient and y -intercept of this line. [1]

gradient =

y -intercept =

[2]







(d) It is suggested that the quantities θ and x are related by the equation

$$\frac{1}{\tan \theta} = ax + b$$

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]

[Total: 20]



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

2 In this experiment, you will investigate the motion of a conical pendulum.

- (a)
- Set the compasses to a radius of approximately 9 cm and then use them to draw a circle on the sheet of paper.
 - Mark the centre of the circle with a cross.
 - Measure and record the diameter D of the circle.

$D = \dots\dots\dots$ cm [1]

(b) (i) You are provided with a pendulum bob with a length of string attached.

- Tie a knot in the string approximately 19 cm from the top of the bob.
- Measure and record the distance p from the knot to the **centre** of the bob.

$p = \dots\dots\dots$ cm [1]

(ii) Estimate the percentage uncertainty in your value of p . Show your working.

percentage uncertainty = $\dots\dots\dots$ % [1]





- (c) (i) • Place the paper with the circle on the bench.
- Holding the knot, suspend the bob approximately 5 mm above the cross at the centre of the circle, as shown in Fig. 2.1.

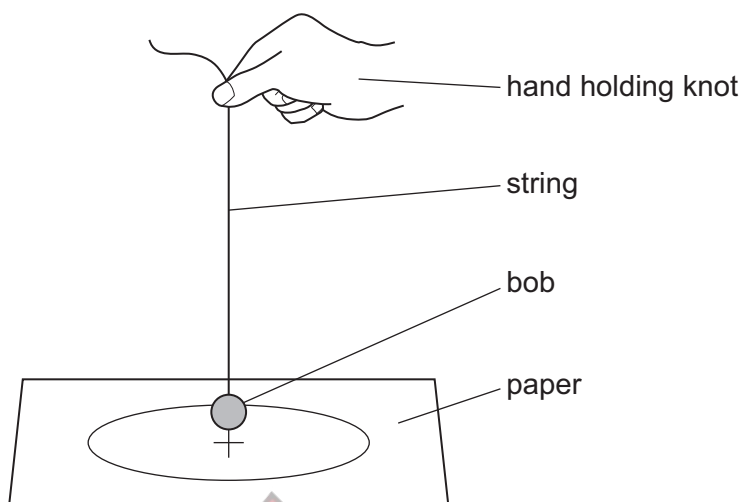


Fig. 2.1

- Move the knot in small, slow circles so that the bob starts to move in a circle.
- Adjust the movement of the knot until the bob moves just above the circle on the paper, as shown in Fig. 2.2.

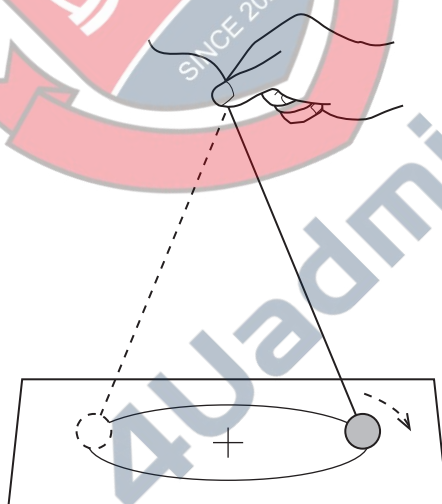


Fig. 2.2

- The period T of the rotation of the bob is the time the bob takes to travel through one complete circle.

When this motion is steady, take measurements to determine T .

$T = \dots\dots\dots$ [2]



- (ii) The angle between the string and the vertical when the bob follows this circular path is ϕ , where ϕ is given by

$$\sin \phi = \frac{D}{2p}.$$

Calculate ϕ .

$$\phi = \dots\dots\dots^\circ \quad [1]$$

- (d) • Tie a knot in the string approximately 13 cm from the top of the bob.
- Using this knot, measure and record p .

$$p = \dots\dots\dots \text{cm}$$

- Using this knot, repeat (c).

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

$$\phi = \dots\dots\dots^\circ \quad [3]$$





- (e) It is suggested that the relationship between T , p and Φ is

$$T^2 = k p \cos \Phi$$

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]

- (f) It is suggested that the percentage uncertainty in the values of k is 15%.

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

.....

 [1]



- (g) (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

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2

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3

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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

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2

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3

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4

.....

[4]

[Total: 20]





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