



Cambridge International AS & A Level

CANDIDATE
NAME



CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

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.

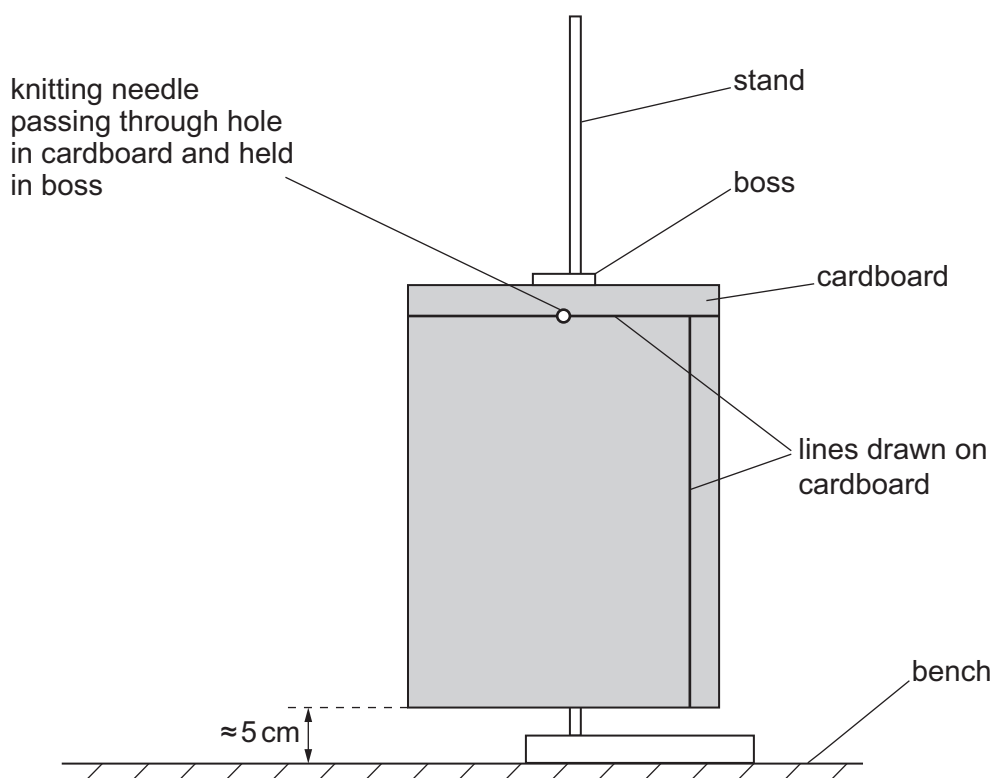


Fig. 1.1



- 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.

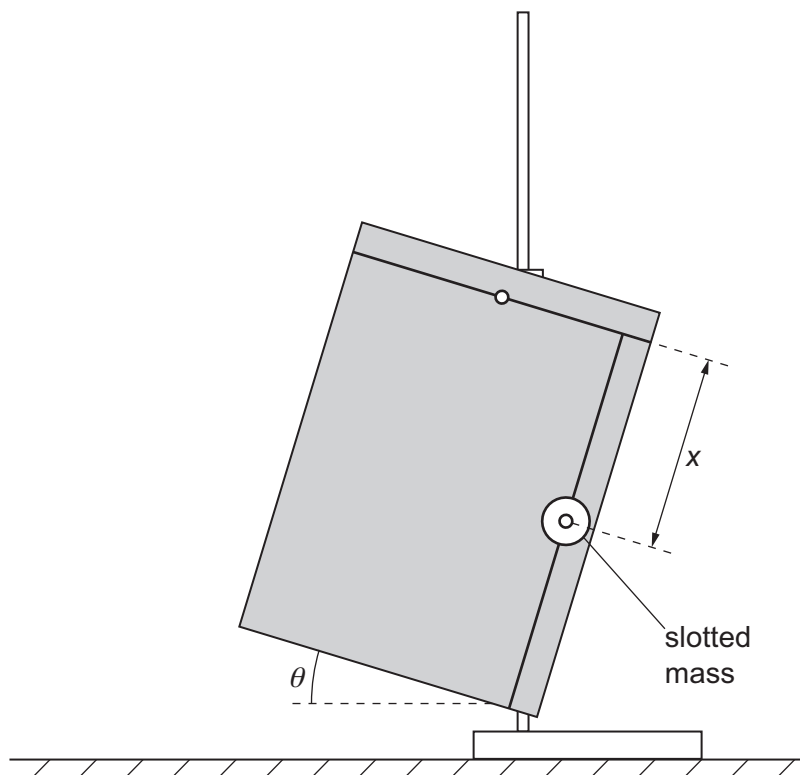


Fig. 1.2

- 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.

[10]

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

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN





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.

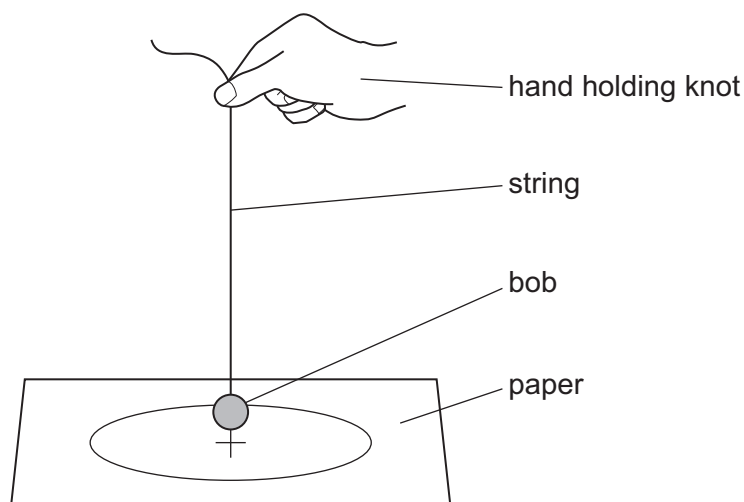


Fig. 2.1

- 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.

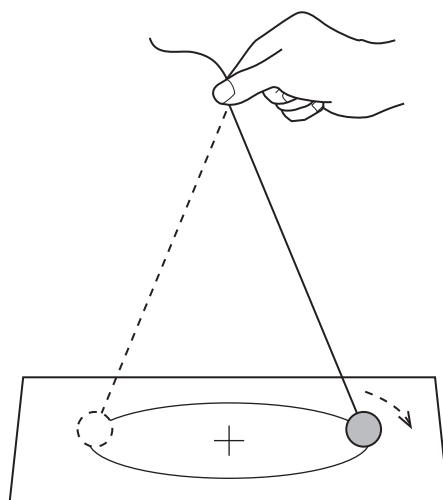


Fig. 2.2

- 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

.....

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]





Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.

