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CANDIDATE NAME

CENTRE NUMBER

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5980946253

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.

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[Turn over

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.

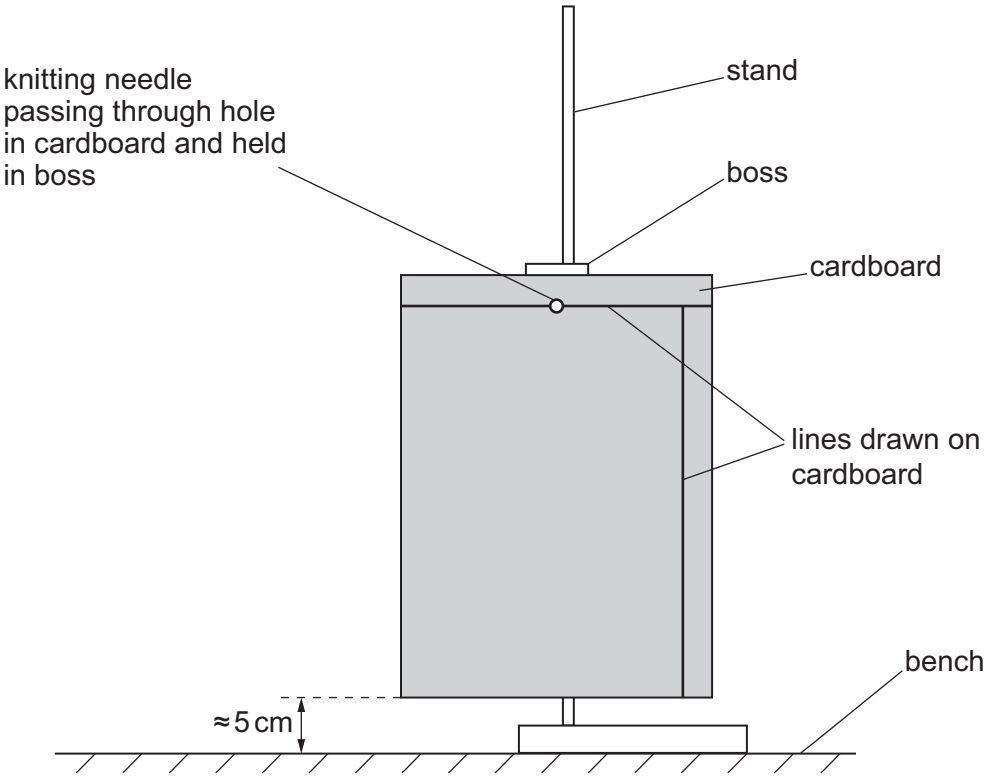


Fig. 1.1

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- 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.

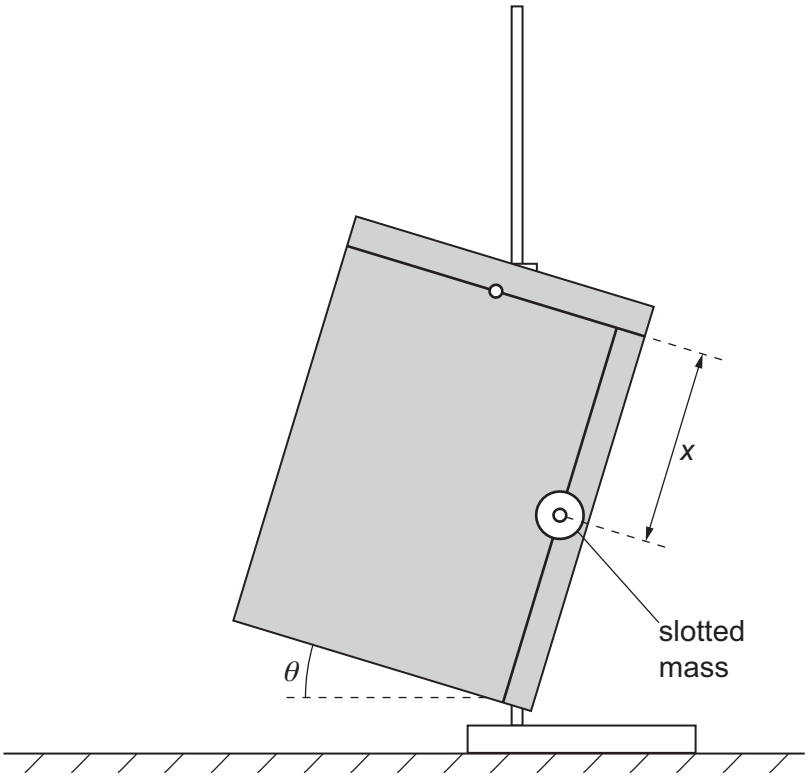


Fig. 1.2

- 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 = ...

- 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.

  θ = ... °

[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]

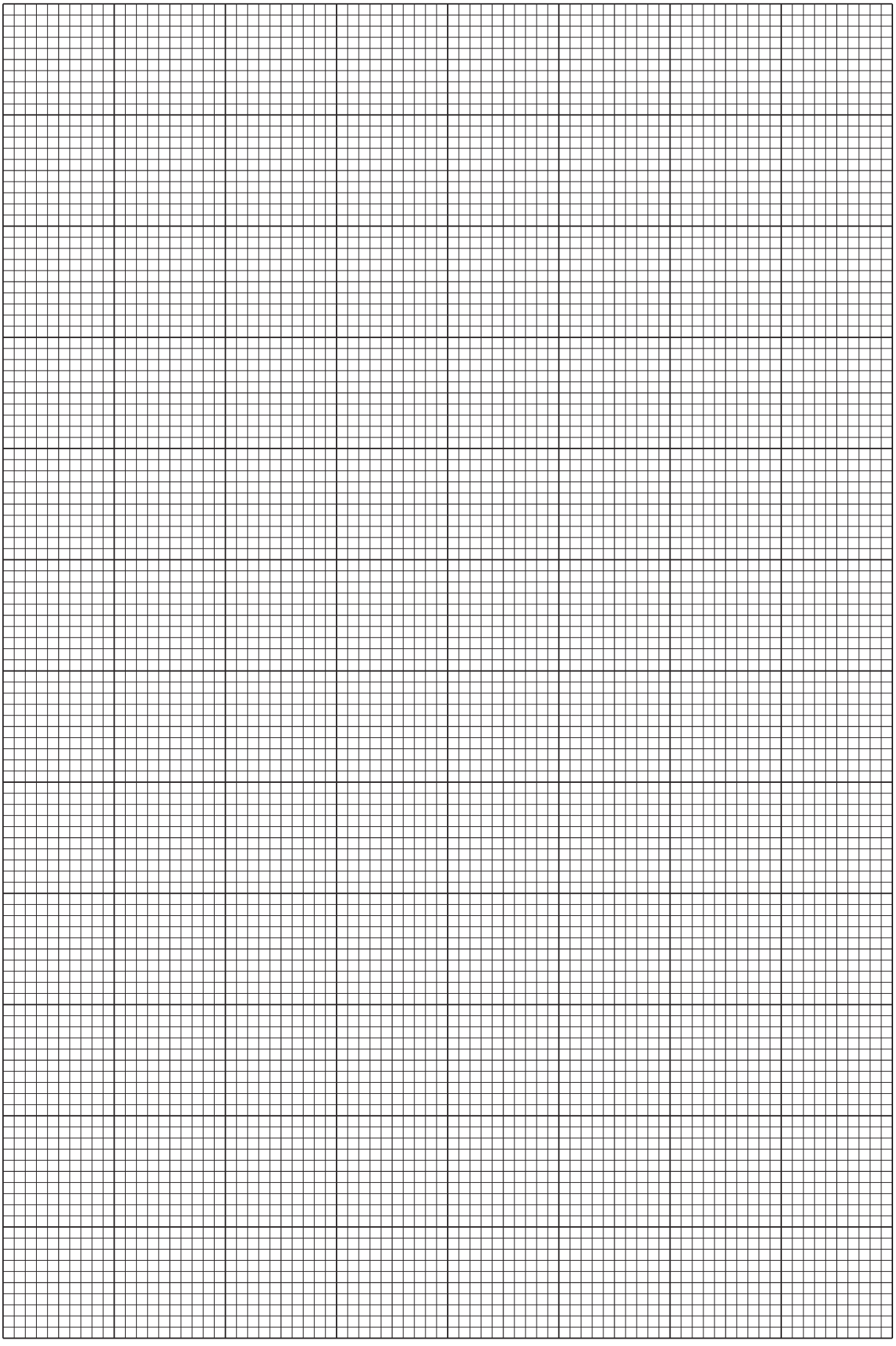
(iii) Determine the gradient and y-intercept of this line.

gradient = ...

y-intercept = ...

[2]

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(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 = ... 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 = ... cm [1]

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

percentage uncertainty = ...% [1]

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(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.

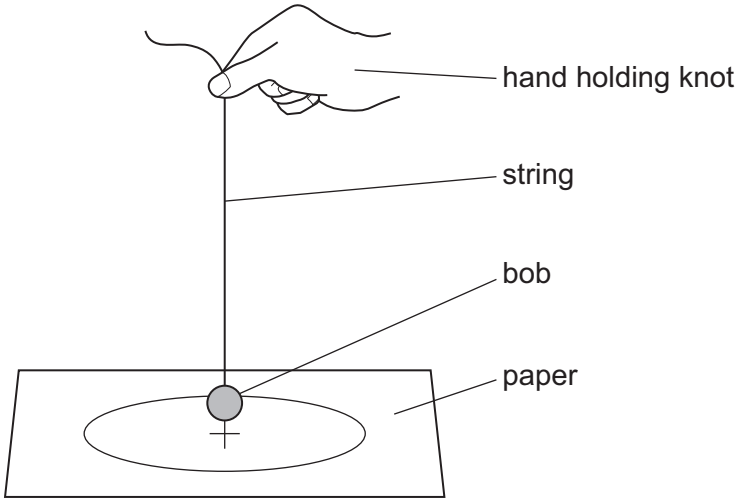


Fig. 2.1

• 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.

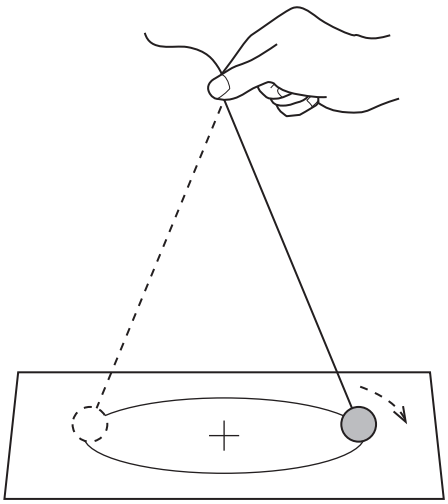


Fig. 2.2

• 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 = ... [2]

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(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.

Φ = ...° [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 = ... cm

• Using this knot, repeat **(c)**.

T = ...

Φ = ... °
[3]

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

$$T^2 = kp\cos\Phi$$

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]

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(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 .....

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2 .....

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3 .....

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4 .....

.....

[4]

[Total: 20]

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