

Cambridge International AS & A Level

ET PEC	CANDIDATE NAME	
	CENTRE NUMBER	CANDIDATE NUMBER

PHYSICS

Paper 3 Advanced Practical Skills 2

9702/36

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 [].

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Total	

[Turn over



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

2

- 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.

3

- 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 =

• 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 .

4

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 <i>y</i> -axis against <i>x</i> on the <i>x</i> -axis.	[3]
(ii)	Draw the straight line of best fit.	[1]
(iii)	Determine the gradient and v-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

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

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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.

- (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.

ρ = 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 5mm above the cross at the centre of the circle, as shown in Fig. 2.1.



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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*.



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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*.

ρ =cm

• Using this knot, repeat (c).

T =

Φ =° [3]





.



10

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

 $T^2=kp\cos{\varPhi}$

where k is a constant.

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

		first value of $k = \dots$	
		second value of <i>k</i> =	
]	1]
	(ii)	Justify the number of significant figures that you have given for your values of <i>k</i> .	
		[1]
(f)	It is	suggested that the percentage uncertainty in the values of k is 15%.	
	Usi	ng 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.

11

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

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

[Total: 20]



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