Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME						
CENTRE NUMBER						
CANDIDATE NUMBER						

8777719096

PHYSICS **9702/31**

Paper 3 Advanced Practical Skills 1 **October/November 2022**

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.

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[Turn over

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

1 In this experiment, you will investigate oscillations of card shapes.

(a) You have been provided with a circular card of radius 10.0 cm.

- Draw a circle on the card of radius 9.0 cm, as shown in Fig. 1.1.

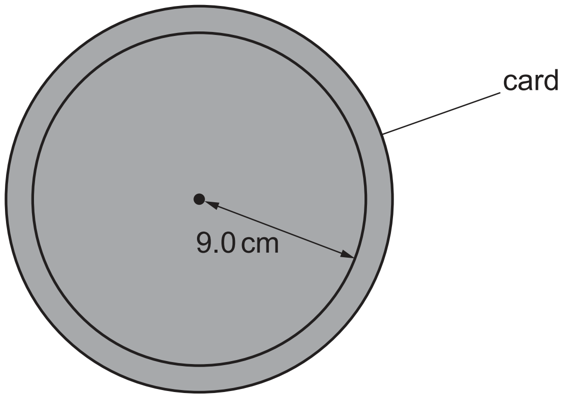

Fig. 1.1 (not to scale)

- Fold the card in half. Cut carefully along the line, as shown in Fig. 1.2, and keep both parts of the card.

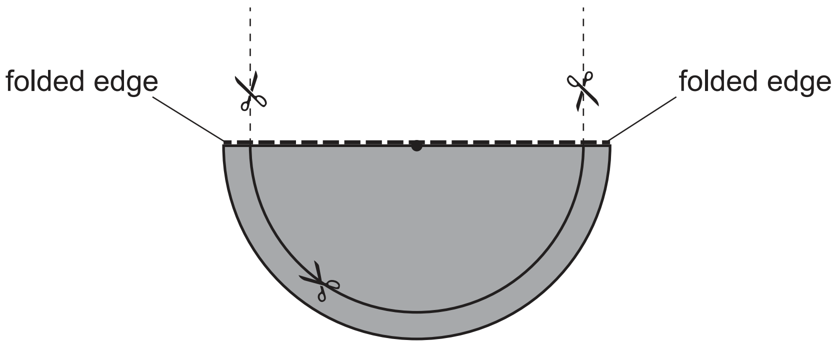

Fig. 1.2 (not to scale)

- The distance between the centre of one side of the card shape and the centre of the other side is *d*, as shown in Fig. 1.3.

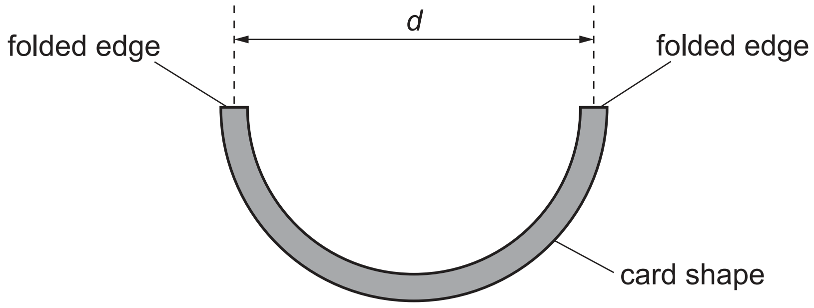

Fig. 1.3

Measure and record *d*.

d = ... [1]

(b)
- Stand the card shape on the bench.
- Adjust the loops of card until the distance between the points where the loops touch the bench is approximately 3 cm, as shown in Fig. 1.4.

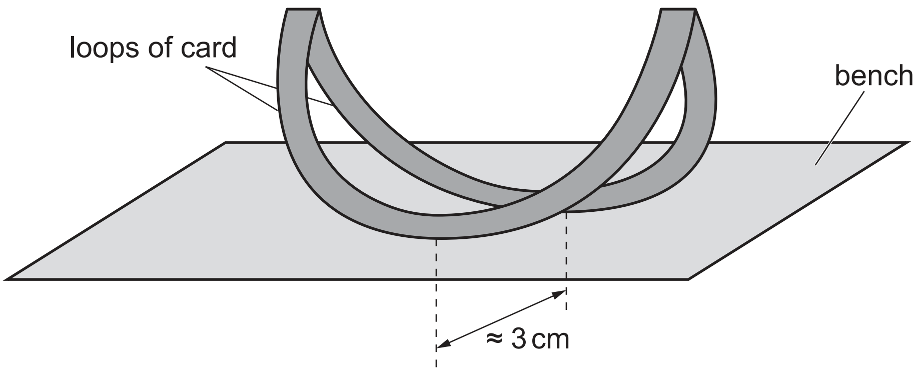

Fig. 1.4

- Gently press down one side of the card shape through a short distance. Release the card shape so that it oscillates.
- Determine the period *T* of these oscillations.

T = ... [2]

(c) Use the remaining card to cut out shapes of smaller radius, each with the same width of 1.0 cm.
For each card shape, measure *d* and repeat **(b)**. Repeat until you have five sets of values of *d* and *T*.

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

[8]

(d) (i) Plot a graph of T^2 on the *y*-axis against *d* 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]

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

$$T^2 = Ad + B$$

where A and B are constants.

Using your answers in **(d)(iii)**, determine the values of A and B.
Give appropriate units.

A = ...

B = ...
[2]

(f) Theory suggests that

$$A = \frac{2\pi^2}{g}$$

where g is the acceleration of free fall.

Use your value of A in **(e)** to determine a value for g.
Give an appropriate unit.

g = ... [1]

[Total: 20]

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

2 In this experiment, you will investigate the collision of two pendulums.

(a) **(i)**
- Mould the two pieces of modelling clay onto the ends of the **shorter** strings to make two pendulums, as shown in Fig. 2.1.

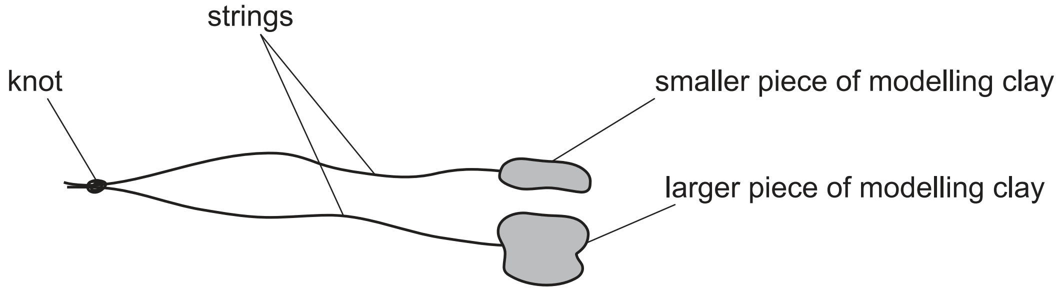

Fig. 2.1

- Set up the apparatus as shown in Fig. 2.2.

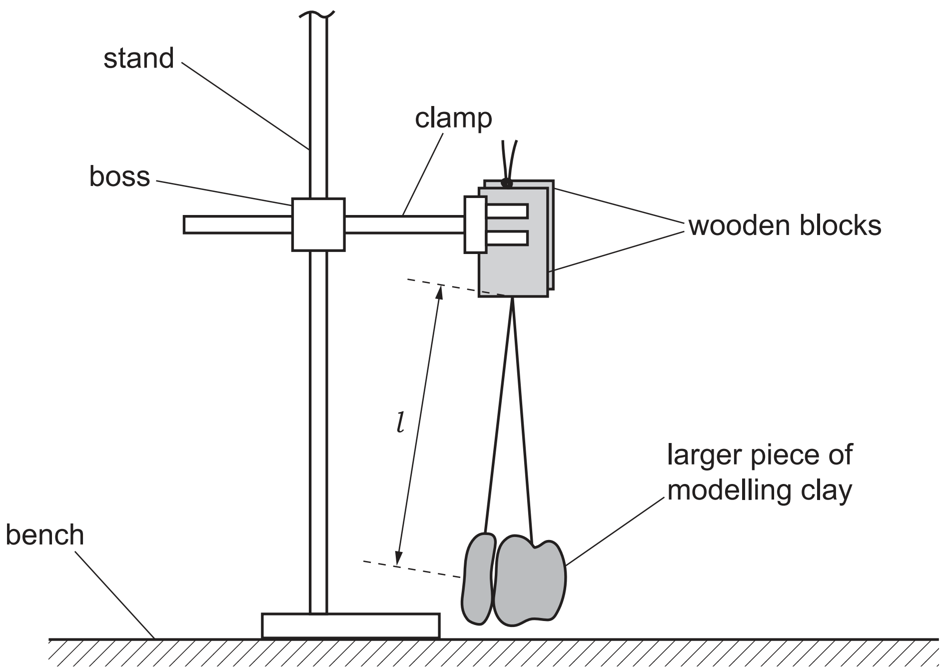

Fig. 2.2

- Adjust the modelling clay until the lengths of the pendulums are the same.
- The distance between the bottom of the wooden blocks and the centre of the smaller piece of modelling clay is l, as shown in Fig. 2.2.

  Measure and record l.

l = ... [1]

(ii) • Hold the larger pendulum a short distance away from the smaller pendulum, as shown in Fig. 2.3.

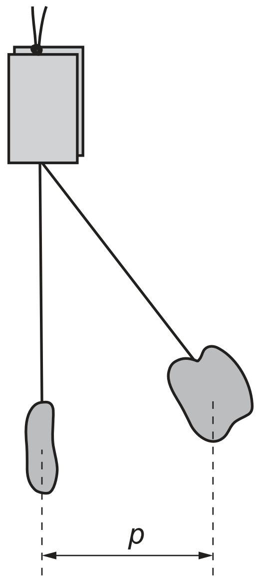

Fig. 2.3

• The horizontal distance between the centres of the pendulums is p.

• Hold the larger pendulum so that p is approximately 12 cm.

• Measure and record p.

p = ... [1]

(iii) Calculate R where

$$R = \sqrt{\left(1 - \frac{p^2}{l^2}\right)}.$$

R = ... [1]

(b) Justify the number of significant figures that you have given for your value of R.

....

....

.... [1]

(c) (i) • Hold the larger pendulum so the horizontal distance between the centres of the pendulums is *p*.

• Release the larger pendulum so that the pendulums collide.

• After colliding, the maximum angle between the vertical and the string of the **smaller** pendulum is θ, as shown in Fig. 2.4.

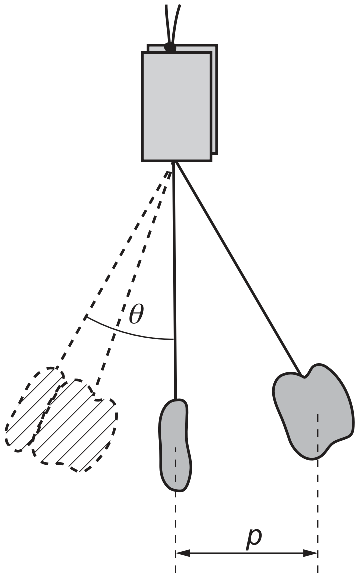

Fig. 2.4

Measure and record θ.

θ = ... ° [2]

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

percentage uncertainty = ... % [1]

(d) • Remove the modelling clay from the strings.

• Repeat **(a)** and **(c)(i)** using the **longer** strings.

l = ...

p = ...

R = ...

θ = ... °
[3]

(e) It is suggested that the relationship between θ and R is

$$k(1 - \cos\theta) = 1 - R$$

where k is a constant.

Using your data, calculate two values of k.

first value of k = ...

second value of k = ...
[1]

(f) It is suggested that the percentage uncertainty in the values of k is 10%.

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]