Cambridge International AS & A Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

PHYSICS **9702/33**

Paper 3 Advanced Practical Skills 1 **February/March 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.

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

1 In this experiment, you will investigate the properties of a pendulum.

(a) (i)
- Assemble the apparatus as shown in Fig. 1.1 and Fig. 1.2.
- Push the nail through the central hole in the pendulum and then into the plastic tube.
- Secure the tube and nail in the boss, as shown in Fig. 1.1.

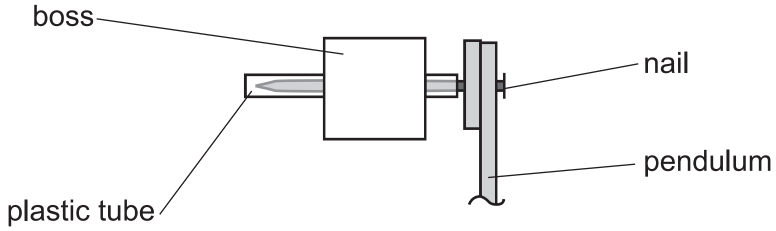

Fig. 1.1

- Ensure that the pendulum swings freely on the nail.

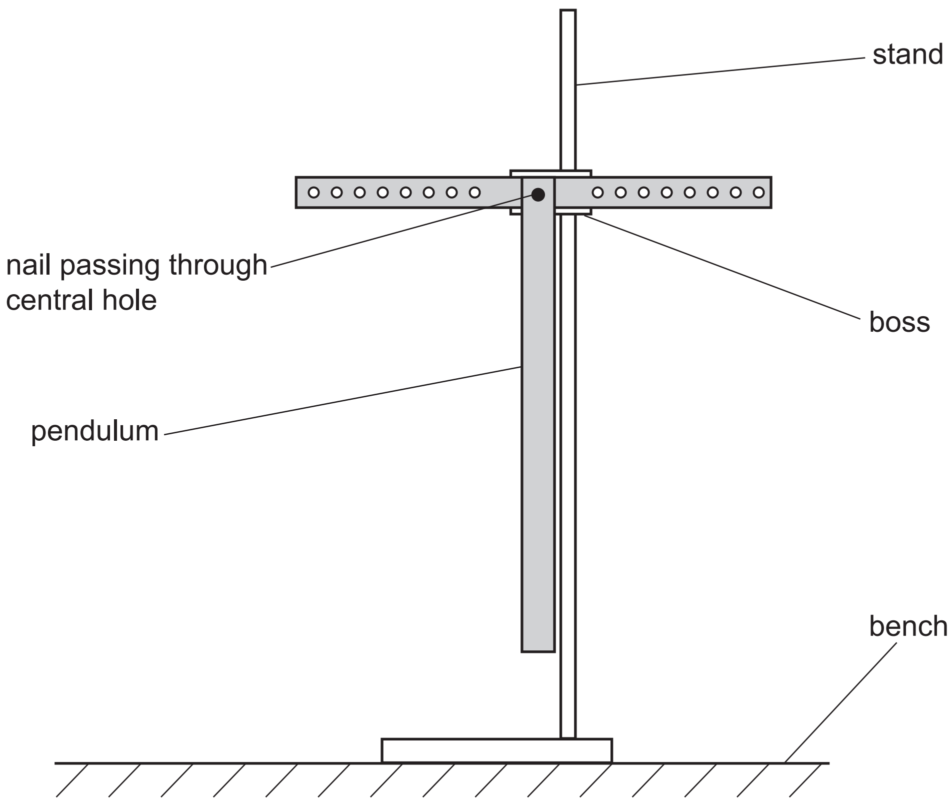

Fig. 1.2

- Attach two 50g slotted masses to the pendulum using the bolts and nuts. Use two holes which are the **same distance** *x* from the nail, as shown in Fig. 1.3.

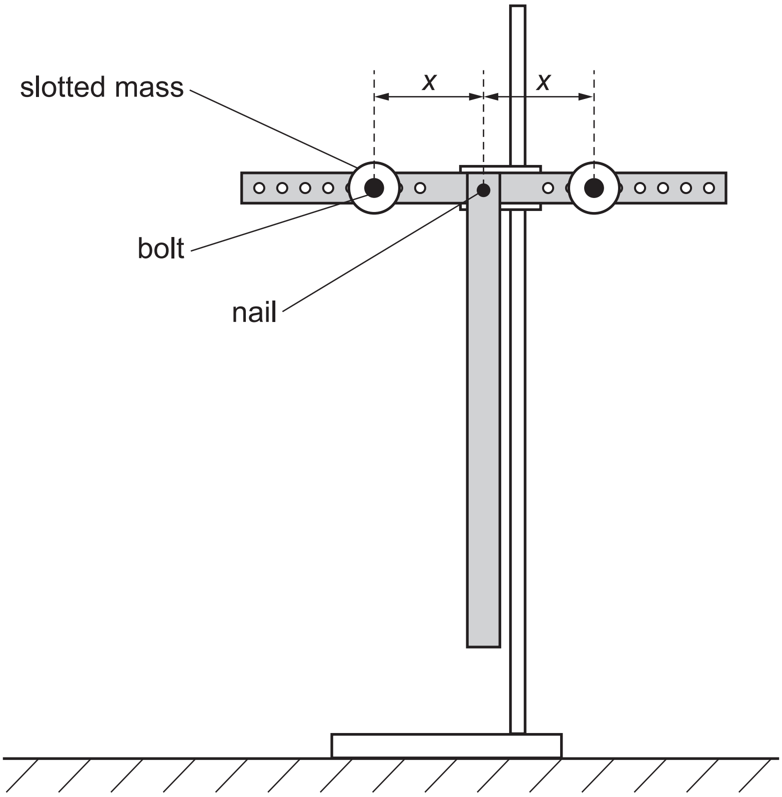

Fig. 1.3

- The distance from the centre of each bolt to the nail is *x*.
- Measure and record *x*.

x = ... [1]

(ii) Push the bottom of the pendulum a short distance to one side and then release it.

Take measurements to determine the period *T* of the oscillations.

T = ... [2]

(b) Vary x by using different holes and measure T.

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

Record your results in a table. Include values of $\sqrt{x^3}$ in your table.

[9]

(c) **(i)** Plot a graph of T on the y-axis against $\sqrt{x^3}$ 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 T and x are related by the equation

$$T = a\sqrt{x^3} + b$$

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]

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

2 In this experiment, you will investigate the frictional forces on a wooden strip.

(a) (i) • You have been provided with two wooden strips. Select the **thicker** strip.

Measure and record its length L.

L = ... cm

• Attach the slotted mass to one of the wider faces of the strip approximately 10 cm from one end using a small piece of adhesive putty, as shown in Fig. 2.1.

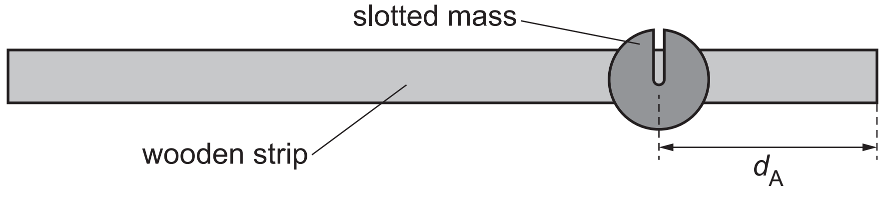

Fig. 2.1

• The distance from the centre of the slotted mass to the nearest end of the strip is d_A, as shown in Fig. 2.1.

Measure and record d_A.

d_A = ... cm
[2]

(ii) You have been provided with a smooth board. Support the board vertically on the bench using the stand, boss and clamp, as shown in Fig. 2.2.

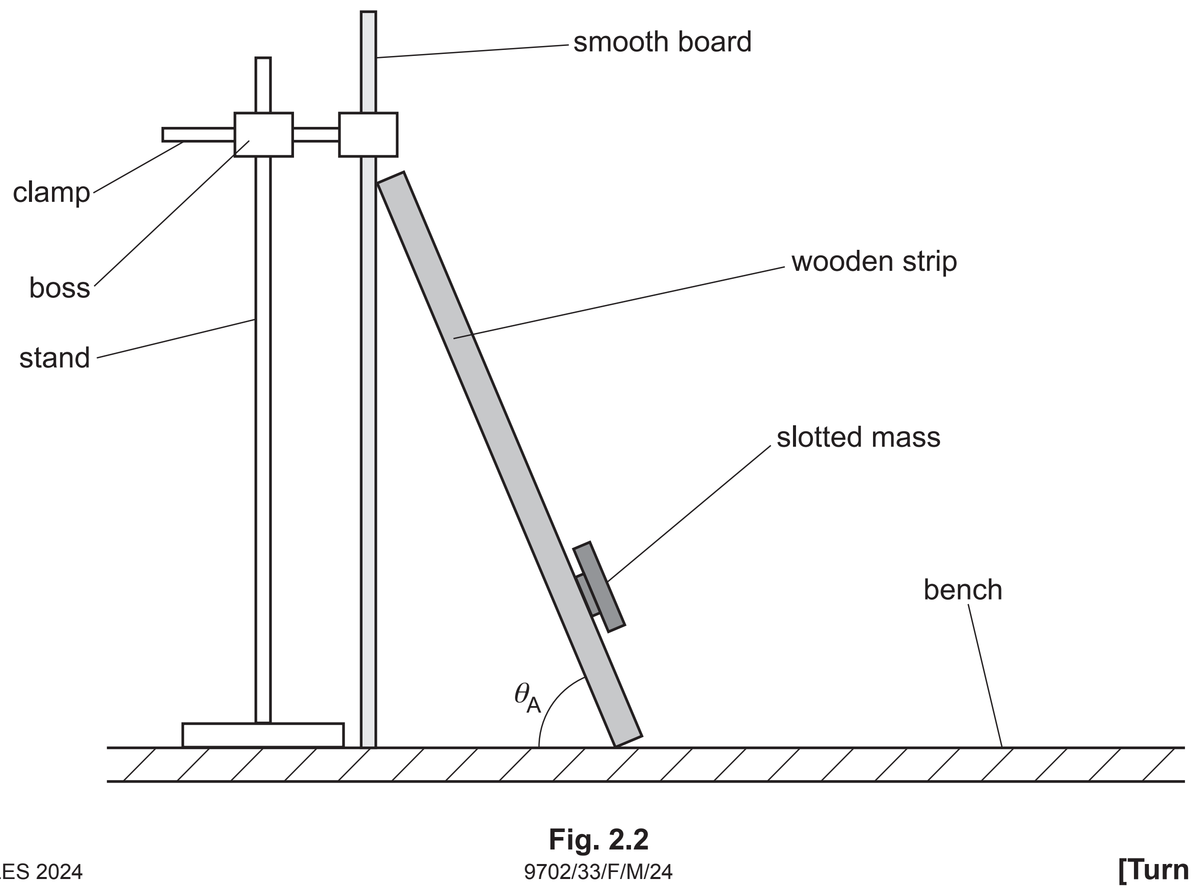

Fig. 2.2

- Lean the strip against the smooth board with the slotted mass nearer the lower end, as shown in Fig. 2.2.
- Move the bottom of the strip away from the smooth board until the strip starts to slip. Gradually push the bottom of the strip back towards the board until it **just** stays in position by itself.
- The angle between the strip and the bench is θ_A, as shown in Fig. 2.2.

  Measure and record θ_A.

θ_A = ...° [2]

(iii) Estimate the percentage uncertainty in your value of θ_A.
Show your working.

percentage uncertainty = ...% [1]

(iv) The mass of the thicker strip is M. The value of M is written on the strip.

- Record M.

M = ... g

- Calculate F_A using

$$F_A = \frac{\frac{M}{2} + \frac{Sd_A}{L}}{(M + S)\tan\theta_A}$$

where S is 100 g.

F_A = ... [1]

(v) • Invert the thicker strip and lean it against the smooth board so that the slotted mass is nearer the upper end as shown in Fig. 2.3.

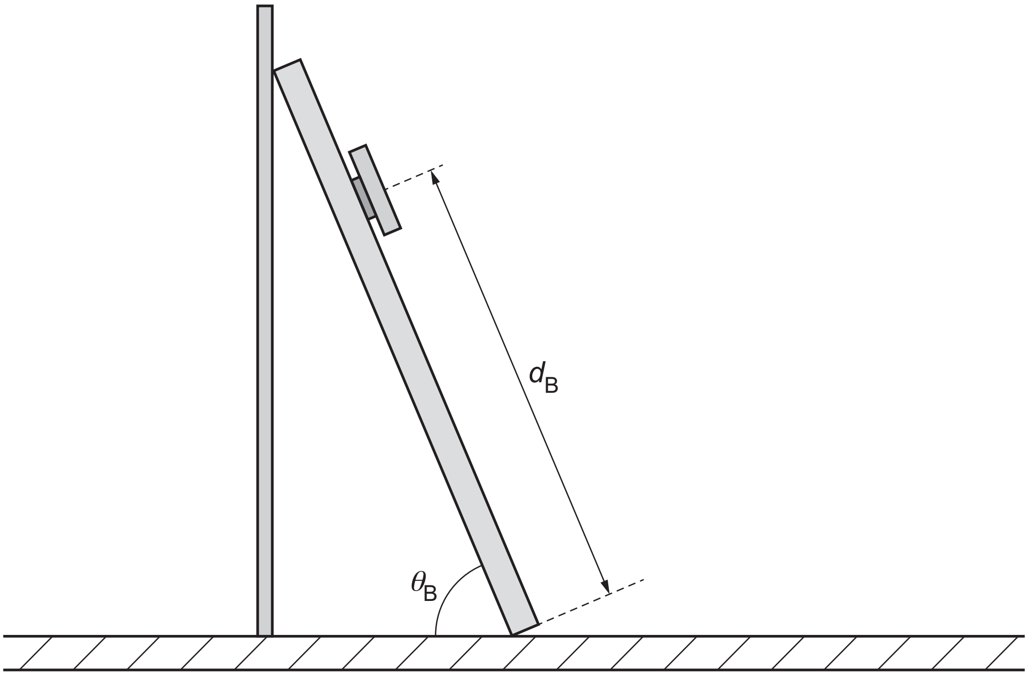

Fig. 2.3

• The distance from the centre of the slotted mass to the lower end of the strip is d_B.

Measure and record d_B.

d_B = ... cm

• Move the bottom of the strip away from the smooth board until the strip starts to slip. Gradually push the bottom of the strip back towards the board until it **just** stays in position by itself.

• The angle between the strip and the bench is θ_B, as shown in Fig. 2.3.

Measure and record θ_B.

θ_B = ... °

• Calculate F_B, using

$$F_B = \frac{\frac{M}{2} + \frac{Sd_B}{L}}{(M + S)\tan\theta_B}.$$

F_B = ...

[1]

(b) Repeat **(a)(i)**, **(a)(ii)**, **(a)(iv)** and **(a)(v)** using the **thinner** wooden strip.

L = ... cm

d_A = ... cm

θ_A = ... °

M = ... g

F_A = ...

d_B = ... cm

θ_B = ... °

F_B = ...

[3]

(c) It is suggested that the relationship between F_A and F_B is

$$k = \frac{F_A}{F_B}$$

where k is a constant.

Using your data, calculate two values of k.

first value of k = ...

second value of k = ...
[1]

(d) 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 **(c)**.

....

....

....

.... [1]

(e) **(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]