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Cambridge Assessment International Education

# Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*4526355485*

**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 | |

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**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.

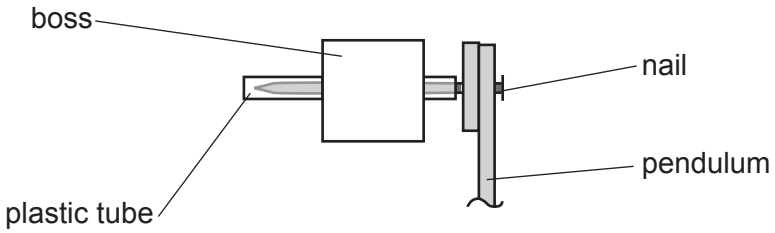



**Fig. 1.1**

- Ensure that the pendulum swings freely on the nail.

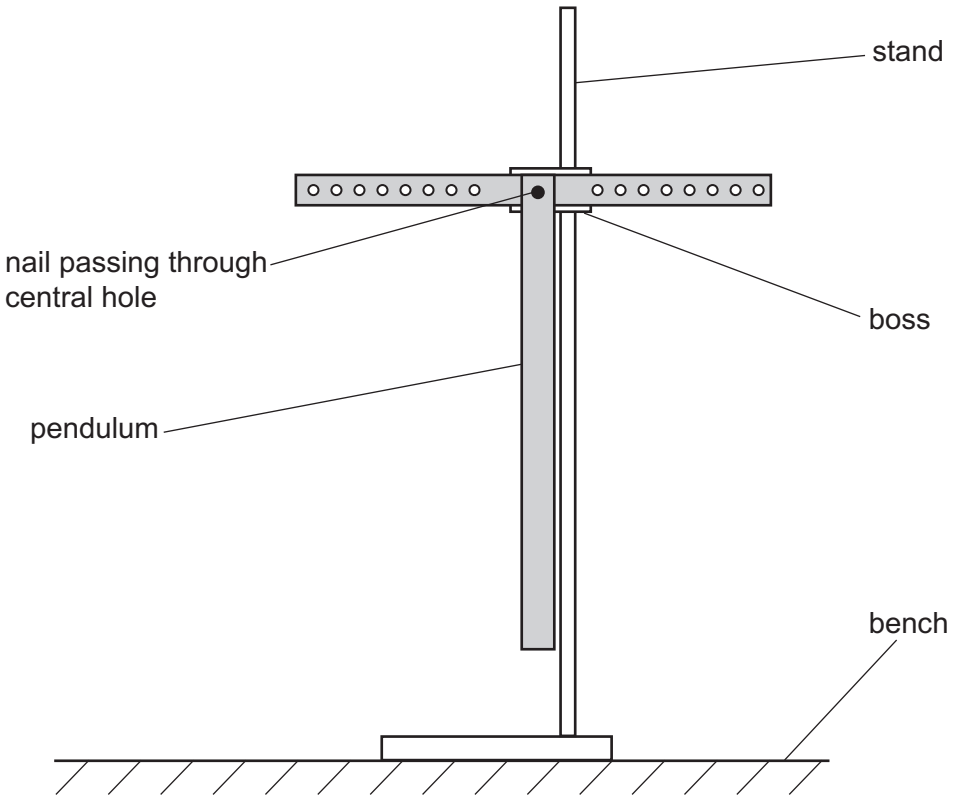



**Fig. 1.2**

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- 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.

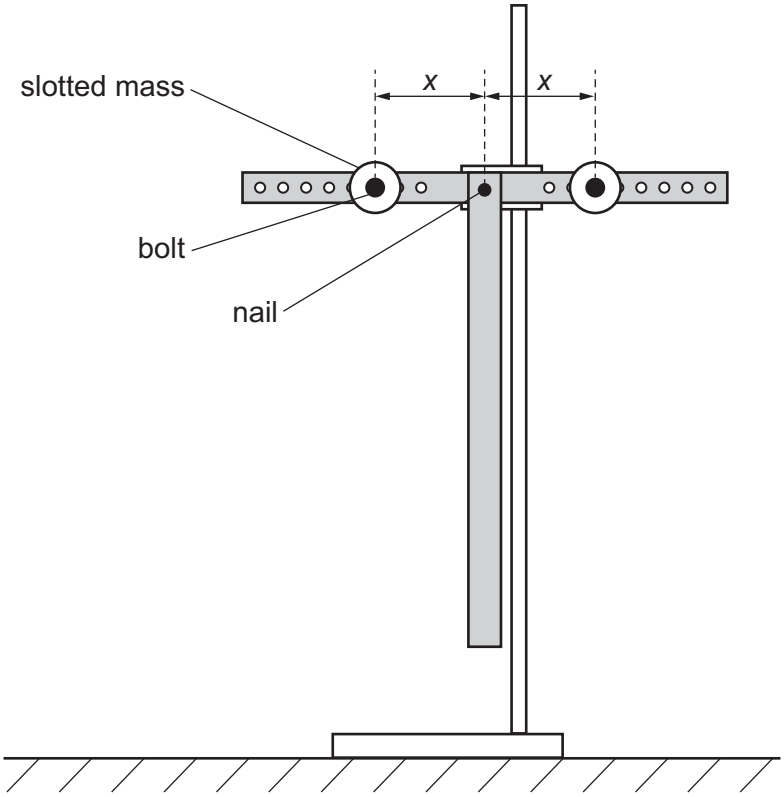



**Fig. 1.3**

- 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]

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**(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 = .....

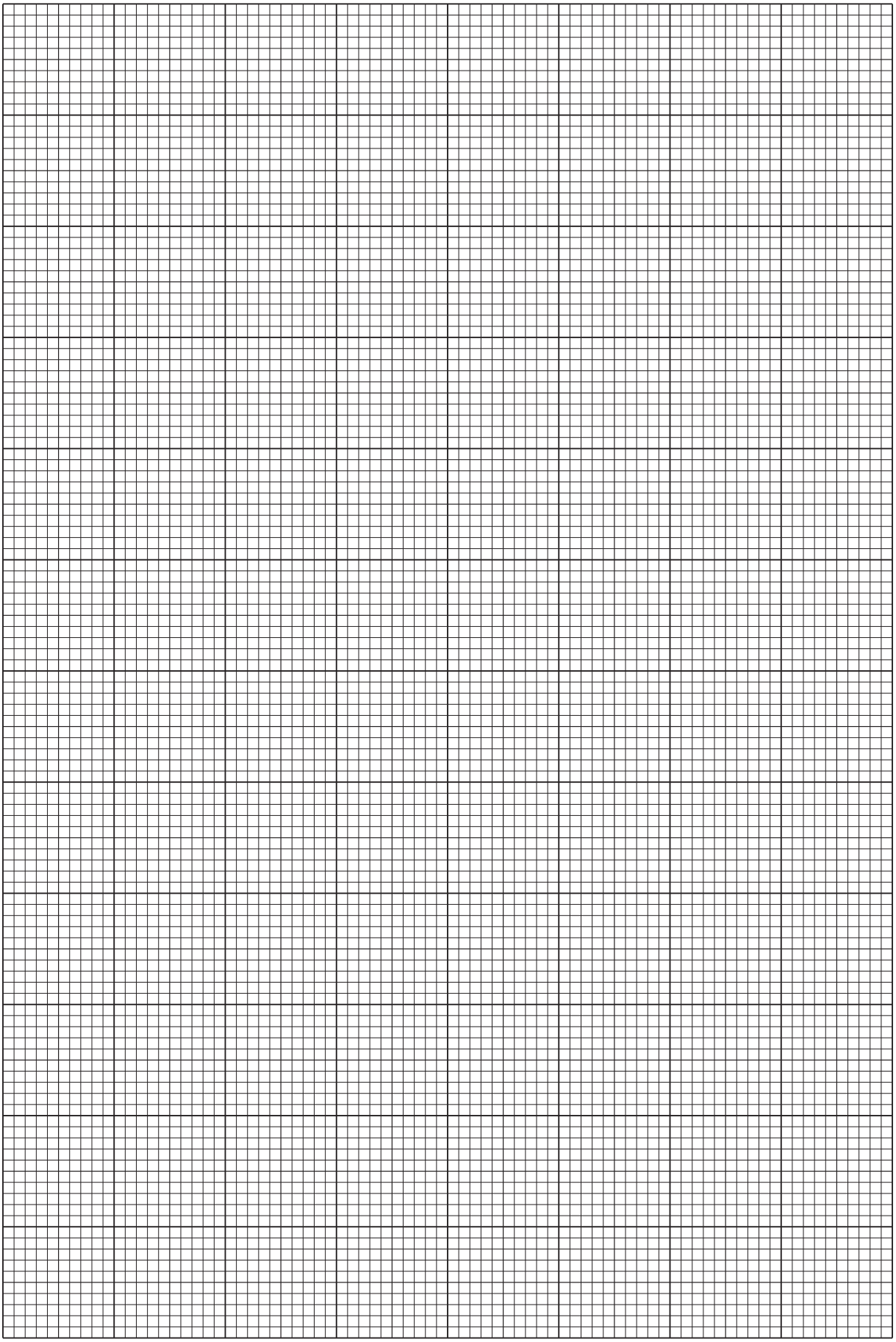
$y$-intercept = .....

[2]

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**(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]

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**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.

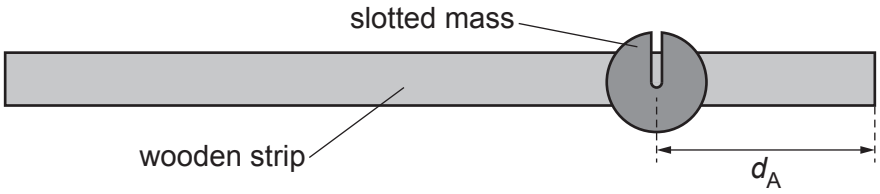



**Fig. 2.1**

• 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.

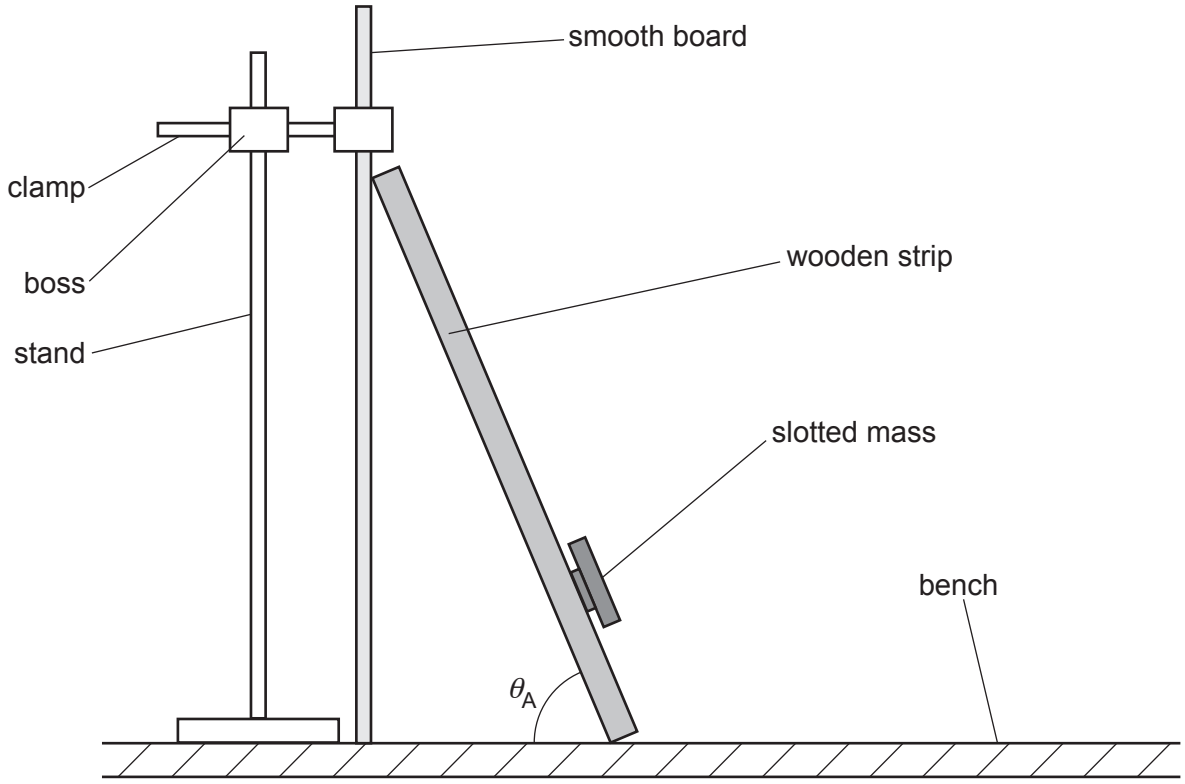



**Fig. 2.2**

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- 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 $\theta_A$, as shown in Fig. 2.2.

  Measure and record $\theta_A$.

$\theta_A$ = .....° [2]

**(iii)** Estimate the percentage uncertainty in your value of $\theta_A$.
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]

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**(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.

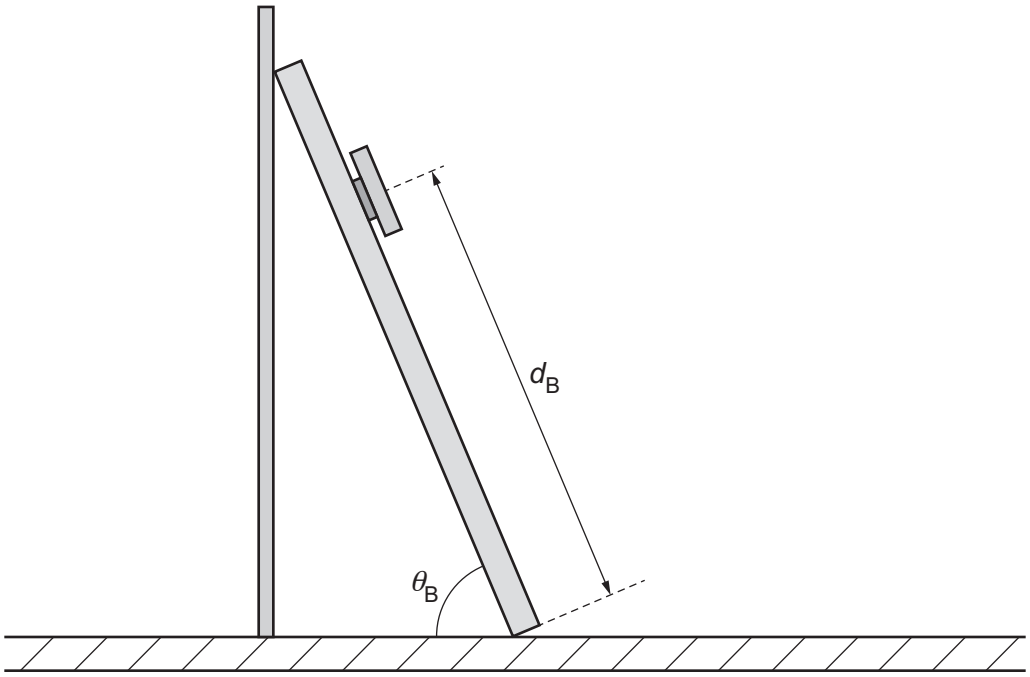



**Fig. 2.3**

• 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 $\theta_B$, as shown in Fig. 2.3.

Measure and record $\theta_B$.

$\theta_B$ = ..... °

• Calculate $F_B$, using

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

$F_B$ = .....
[1]

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

$L$ = ..... cm

$d_A$ = ..... cm

$\theta_A$ = ..... °

$M$ = ..... g

$F_A$ = .....

$d_B$ = ..... cm

$\theta_B$ = ..... °

$F_B$ = .....
[3]

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**(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]

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**(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]

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