Cambridge International AS & A Level

**Cambridge Assessment International Education**
Cambridge International Advanced Subsidiary and Advanced Level

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| CANDIDATE NAME | |

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| CENTRE NUMBER | | CANDIDATE NUMBER | |

*9290265852*

**PHYSICS** **9702/33**

Paper 3 Advanced Practical Skills 1 **October/November 2019**

**2 hours**

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions.

**READ THESE INSTRUCTIONS FIRST**

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **both** questions.
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You are reminded of the need for good English and clear presentation in your answers.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

Additional answer paper and graph paper should be used only if it becomes necessary to do so.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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This document consists of **10** printed pages and **2** blank pages.

DC (ST/CB) 171579/3


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

**1** In this experiment, you will investigate the equilibrium of a metre rule.

**(a)** You have been provided with a metre rule with a 100 g mass attached to it.

- Set up the apparatus as shown in Fig. 1.1.

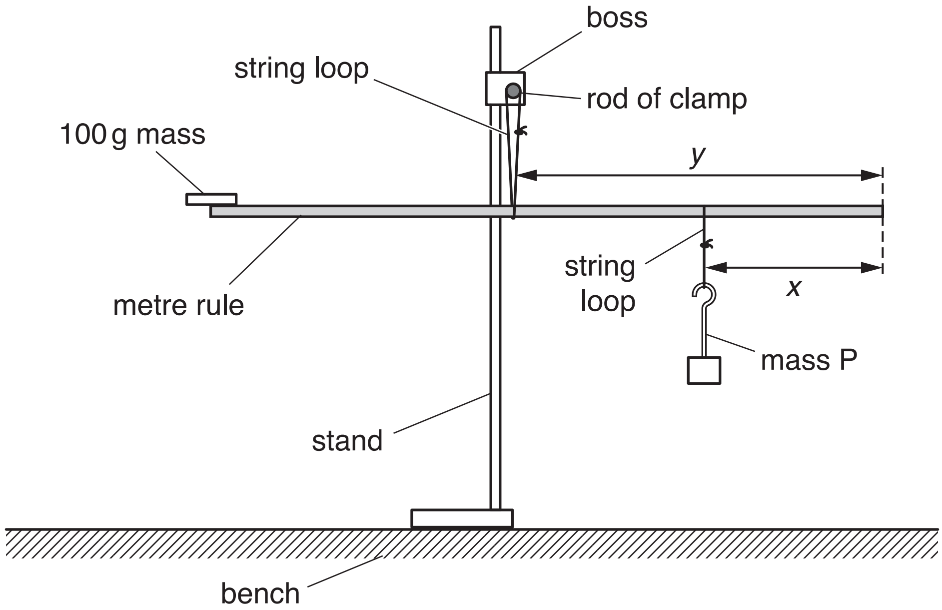


**Fig. 1.1**

The distance between the end of the rule and the string loop from which mass P is suspended is *x*, as shown in Fig. 1.1.

The distance between the same end of the rule and the string loop suspended from the rod of the clamp is *y*.

- Position mass P so that *x* is approximately 30 cm.
- Without changing *x*, adjust the position of the rule until it balances.
- Measure and record *x* and *y*.

*x* = ...............................................................

*y* = ...............................................................
[2]

**(b)** Change $x$. Adjust the position of the rule until it balances. Measure and record $x$ and $y$.

Repeat until you have six sets of values.

Record your results in a table.

[8]

**(c)** **(i)** Plot a graph of $y$ 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]

**(d)** It is suggested that the quantities $y$ and $x$ are related by the equation

$$y = Ax + B$$

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]

**(e)** Theory suggests that

$$A = \frac{2M}{3M + Q}$$

where $M$ is the mass of the metre rule and $Q = 0.100\,\text{kg}$.

Determine a value for $M$.
Give your answer to three significant figures. Include an appropriate unit.

$M$ = ........................................................ [2]

[Total: 20]

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

**2** In this experiment, you will investigate the motion of a magnet connected to some springs.

**(a) (i)** You have been provided with two magnets A and B and three connected springs.

- Use the tape to attach magnet A to the springs as shown in Fig. 2.1.

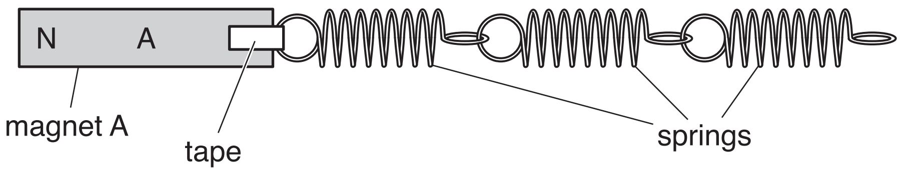


**Fig. 2.1**

- Set up the apparatus as shown in Fig. 2.2, with the N poles of magnets A and B facing each other.

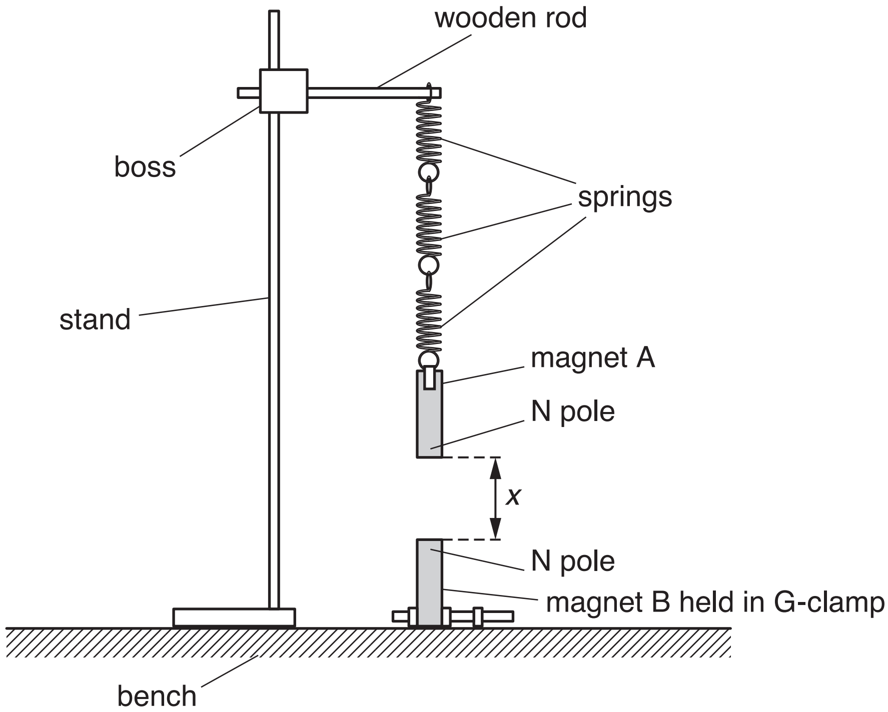


**Fig. 2.2**

- The distance between the magnets is $x$.

  Adjust the height of the wooden rod until $x$ is approximately 7 cm.

- Measure and record $x$.

$x$ = ........................................................ [1]

**(ii)** Estimate the percentage uncertainty in your value of *x*.

percentage uncertainty = ........................................................ [1]

**(b)** **(i)**
- Pull magnet A down through a short distance.
- Release the magnet. The magnet will oscillate.
- Determine the period $T_1$ of these oscillations.

$T_1$ = ..................................................... s [2]

**(ii)**
- Reverse magnet B in the G-clamp so that its S pole is at the top.
- Adjust the position of the wooden rod until *x* has the same value as in **(a)(i)**.
- Determine the period $T_2$ of the oscillations of magnet A.

$T_2$ = ..................................................... s [1]

**(iii)** Calculate $T_2 - T_1$.

$T_2 - T_1$ = ..................................................... s [1]

**(c)**
- Reverse magnet B so that its N pole is at the top.
- Adjust the position of the wooden rod until $x$ is approximately 10 cm.
- Measure and record $x$.

$x$ = ..............................................................

- Repeat **(b)** using this value of $x$.

$T_1$ = ........................................................... s

$T_2$ = ........................................................... s

$T_2 - T_1$ = ........................................................... s
[3]

**(d)** It is suggested that the relationship between $T_1$, $T_2$ and $x$ is

$$T_2 - T_1 = \frac{k}{x^3}$$

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 $k$.

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.................................................................................................................................... [1]

**(iii)** Explain whether your results in **(d)(i)** support the suggested relationship.

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.................................................................................................................................... [1]

**(e)** **(i)** Describe four sources of uncertainty or limitations of the procedure for this experiment.

1. ..............................................................................................................................

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2. ..............................................................................................................................

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3. ..............................................................................................................................

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4. ..............................................................................................................................

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[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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[4]

[Total: 20]

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**PHYSICS** **9702/34**

Paper 3 Advanced Practical Skills 2 **October/November 2019**

**2 hours**

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Additional Materials: As listed in the Confidential Instructions.

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Answer **both** questions.
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**You may not need to use all of the materials provided.**

1 In this experiment, you will investigate the motion of a wooden strip balanced on a curved surface.

**(a)**
- Assemble the apparatus as shown in Fig. 1.1.
- Use pieces of modelling clay to ensure that the beaker is secure and that its axis is horizontal.
- The centre of each mass should be the same distance $x$ from the line at the midpoint of the wooden strip, where $x$ is approximately 15 cm.

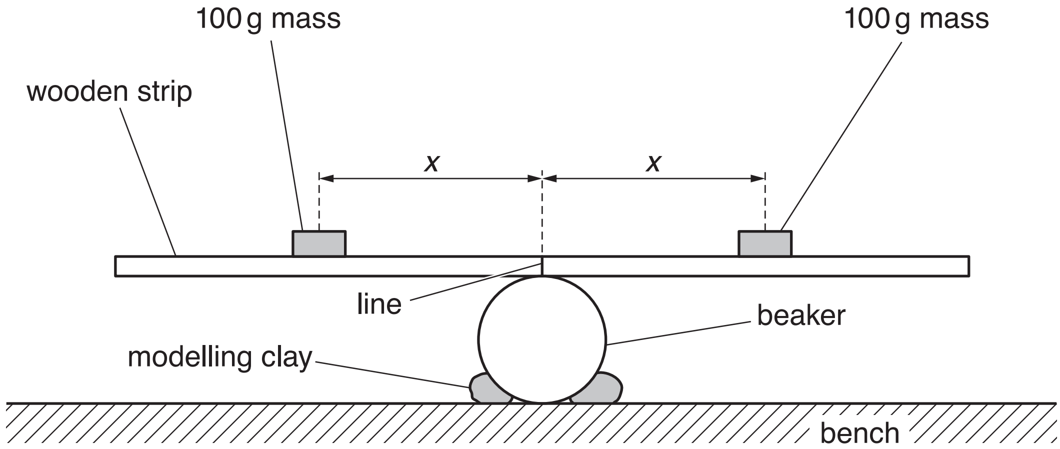


**Fig. 1.1**

- Measure and record $x$.

$x$ = .................................................. cm [1]

**(b)**
- Push one end of the strip down by approximately 2 cm and release it so that it oscillates.
- Take measurements to find the period $T$ of the oscillations.

$T$ = .................................................... s [1]

**(c)** Change $x$ and measure $T$. Repeat until you have six sets of values of $x$ and $T$.

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

[9]

**(d)** **(i)** Plot a graph of $T^2$ on the $y$-axis against $x^2$ 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 $x$ are related by the equation

$$T^2 = ax^2 + b$$

where $a$ and $b$ are constants.

Use your answers in **(d)(iii)** to determine the values of $a$ and $b$.
Give appropriate units.

$a$ = ..............................................................

$b$ = ..............................................................
[2]

**(f)** • Take measurements to find the radius $R$ of the beaker.

$R$ = ..............................................................

• An approximate value for the acceleration of free fall $g$ is given by

$$g = \frac{4\pi^2}{Ra}.$$

Calculate $g$.

$g$ = ..............................................................
[1]

[Total: 20]

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

**2** In this experiment, you will investigate the force needed to pull a cylinder up a step.

**(a)** Measure the thickness *h* of the board, as shown in Fig. 2.1.

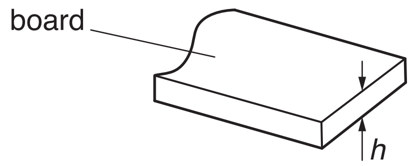


**Fig. 2.1**

*h* = ................................................ mm [1]

**(b)** • Suspend the two **larger** (100 g) slotted masses from the newton meter using the loop of thread, as shown in Fig. 2.2.

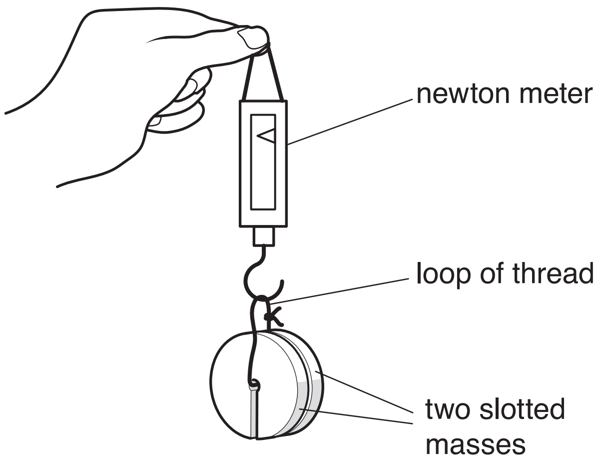


**Fig. 2.2**

• Record the total weight *W* of these masses.

*W* = ................................................ N [1]

**(c)** **(i)** Take measurements to find the radius *r* of one of the larger slotted masses.

*r* = ................................................ mm [1]

**(ii)** The value of $\alpha$ is given by

$$\sin\alpha = \frac{(r - h)}{r}.$$

Calculate $\alpha$.

$\alpha$ = ........................................................ ° [1]

**(iii)** Justify the number of significant figures you have given for your value of $\alpha$.

..............................................................................................................................

..............................................................................................................................

........................................................................................................................ [1]

**(d)**
- Place the board on the bench to make a step. Stand the two larger slotted masses on their edges next to the step with their slots at the top, as shown in Fig. 2.3.
- Attach the loop of thread to the masses and the newton meter, as shown in Fig. 2.3.

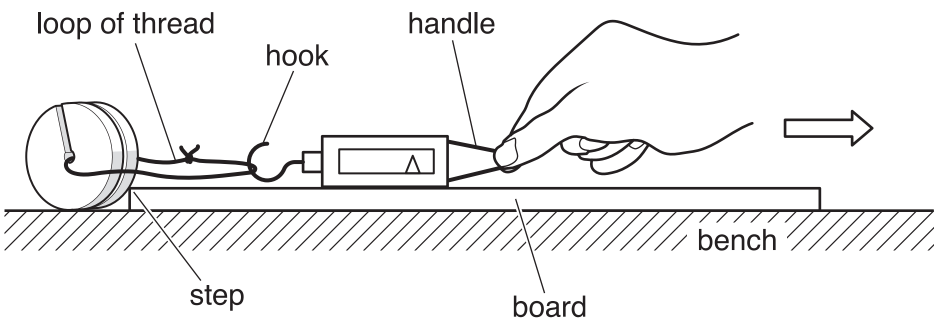


**Fig. 2.3**

- Pull the handle of the newton meter horizontally and at right angles to the step. The force required to just start the slotted masses rolling up the step is $F$.

  Measure and record $F$.

$F$ = ........................................................ [2]

**(e)** Estimate the percentage uncertainty in your value of $F$.

percentage uncertainty = ........................................................ [1]

**(f)** Repeat **(b)**, **(c)(i)**, **(c)(ii)** and **(d)** using the two smaller (50 g) slotted masses.

$W$ = .......................................................... N

$r$ = ...................................................... mm

$\alpha$ = .......................................................... °

$F$ = ..............................................................
[2]

**(g)** It is suggested that the relationship between $F$, $W$ and $\alpha$ is

$$F = \frac{kW}{\tan \alpha}$$

where $k$ is a constant.

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

first value of $k$ = ..............................................................

second value of $k$ = ..............................................................
[1]

**(ii)** Explain whether your results support the suggested relationship.

...............................................................................................................................

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............................................................................................................................... [1]

**(h)** **(i)** Describe four sources of uncertainty or limitations of the procedure for this experiment.

1. ..........................................................................................................................

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4. ..........................................................................................................................

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[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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[4]

[Total: 20]

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*8629017065*

**PHYSICS** **9702/35**

Paper 3 Advanced Practical Skills 1 **October/November 2019**

**2 hours**

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Cambridge Assessment International Education

**[Turn over**

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

1 In this experiment, you will investigate the motion of a pendulum consisting of a chain of paper clips and a sphere of modelling clay.

**(a)** • Set up the apparatus as shown in Fig. 1.1.

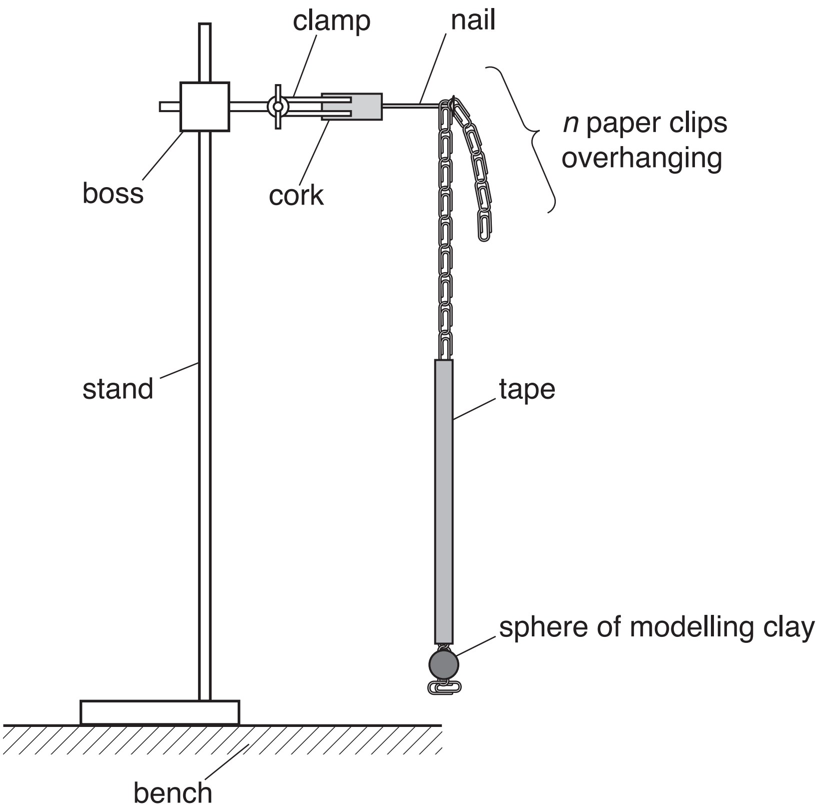


**Fig. 1.1**

- Suspend the chain of paper clips from the nail by one of the clips with *n* clips overhanging.
- Count and record *n*.

$n$ = ..............................................................

- Pull the sphere to the side through a short distance, as shown in Fig. 1.2.

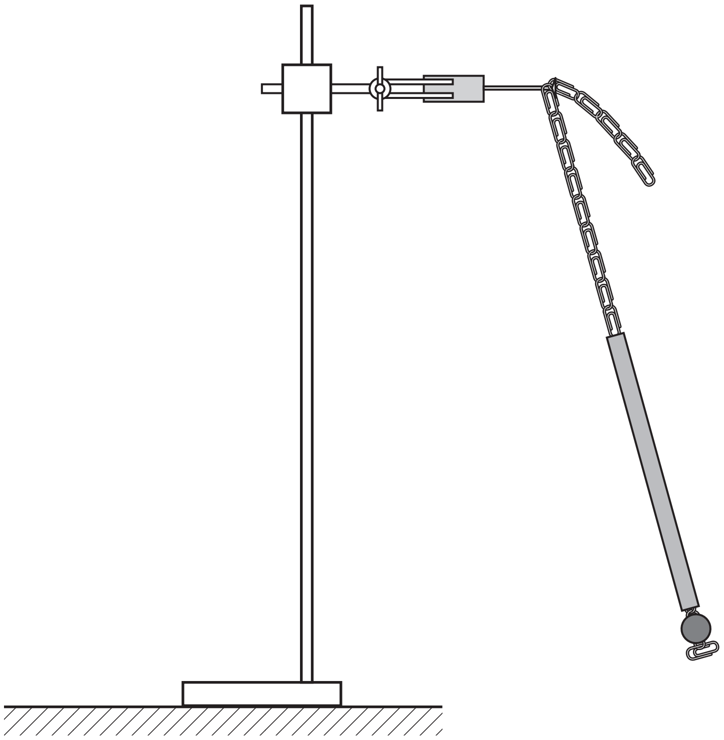

**Fig. 1.2**

- Release the sphere. The sphere will oscillate.

- Determine the period $T$ of these oscillations.

$T$ = ........................................................ [1]

**(b)** Vary $n$ by placing the nail through different clips in the chain. Measure and record $n$ and $T$. Repeat until you have six sets of values.

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

[10]

**(c)** **(i)** Plot a graph of $T^2$ on the $y$-axis against $n$ 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 $n$ are related by the equation

$$T^2 = Pn + Q$$

where $P$ and $Q$ are constants.

Using your answers in **(c)(iii)**, determine the values of $P$ and $Q$.
Give appropriate units.

$P$ = ..............................................................

$Q$ = ..............................................................
[2]

**(e)** Theory suggests that $P$ is proportional to the length of a paper clip and that $Q$ is proportional to the total length of the chain.

The experiment is repeated using a chain consisting of 30 paper clips of the same length as those used in your experiment.

For this experiment, draw a second line on the graph to show the expected results.
Label this line W. [1]

[Total: 20]

 

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

**2** In this experiment, you will investigate how the force of attraction between two bar magnets depends on their separation.

**(a)** **(i)** • Place magnet A on the wooden board as shown in Fig. 2.1.

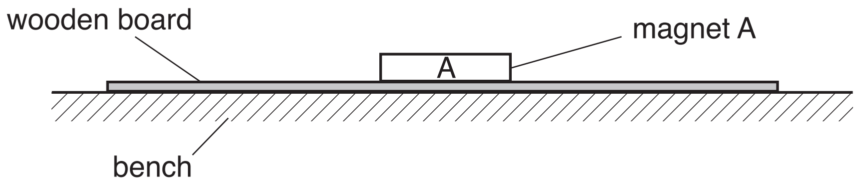


**Fig. 2.1**

• Raise the end of the board until the magnet just starts to move down the board, as shown in Fig. 2.2.

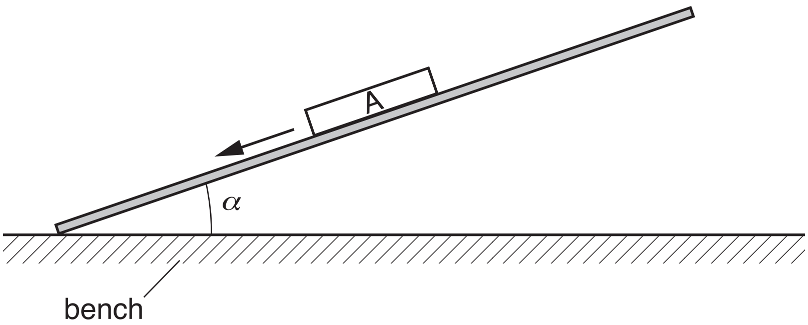


**Fig. 2.2**

• The angle between the bench and the board when the magnet just starts to move is $\alpha$.

Measure and record $\alpha$.

$\alpha$ = ..................................................° [2]

**(ii)** Estimate the percentage uncertainty in your value of $\alpha$.

percentage uncertainty = .................................................. [1]

**(b)** You have been provided with a small block of wood as shown in Fig. 2.3.

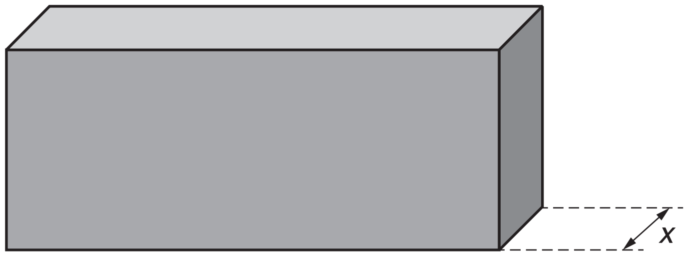


**Fig. 2.3**

The smallest dimension of the block is *x*.

Measure and record *x*.

*x* = ........................................................ [1]

**(c)** • Use some of the adhesive putty to secure the block to the board on the line as shown in Fig. 2.4.

• Use some of the adhesive putty to secure magnet B to the board at a distance *y* from the block, where *y* is approximately 5 mm.

• Place magnet A on the board as shown in Fig. 2.4 so that the magnets are attracting each other.

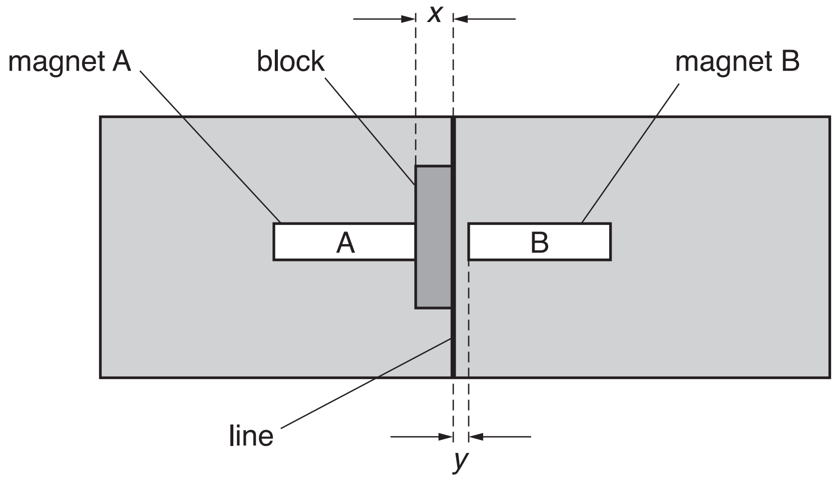


**Fig. 2.4**

- Raise the end of the board until magnet A starts to move down the board.
- The angle at which A just starts to move is $\beta$, as shown in Fig. 2.5. If A does not move down the board for any angle of the board, gradually increase $y$ until it does move.

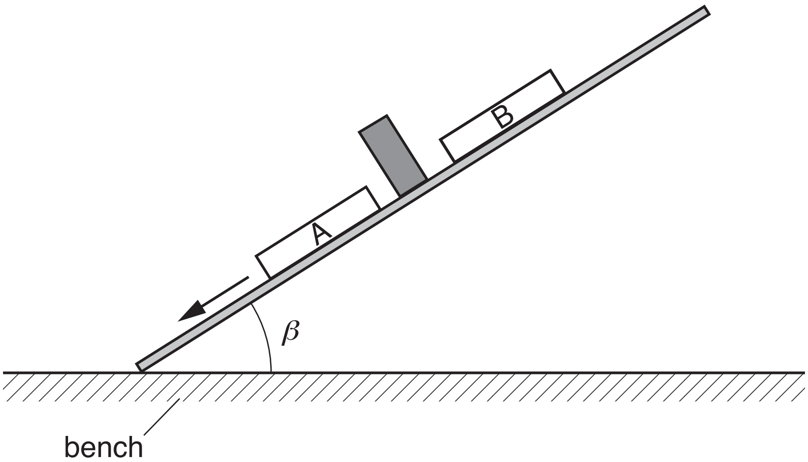


**Fig. 2.5**

- Measure and record $\beta$.

$\beta$ = ........................................................° [1]

**(d) (i)** • Measure and record $y$.

$y$ = ...............................................................

• Calculate $(x + y)^2$.

$(x + y)^2$ = ...............................................................
[1]

**(ii)** Justify the number of significant figures that you have given for your value of $(x + y)^2$.

.......................................................................................................................................

.......................................................................................................................................

....................................................................................................................................... [1]

**(e)** • Remove the block from the board.

• Measure and record the dimension of the block shown in Fig. 2.6.


**Fig. 2.6**

$x$ = ..............................................................

• Calculate $(x + y)^2$ using your value of $y$ in **(d)(i)**.

$(x + y)^2$ = ..............................................................

• Place and secure the block on the board as shown in Fig. 2.7.
**Do not move B**.

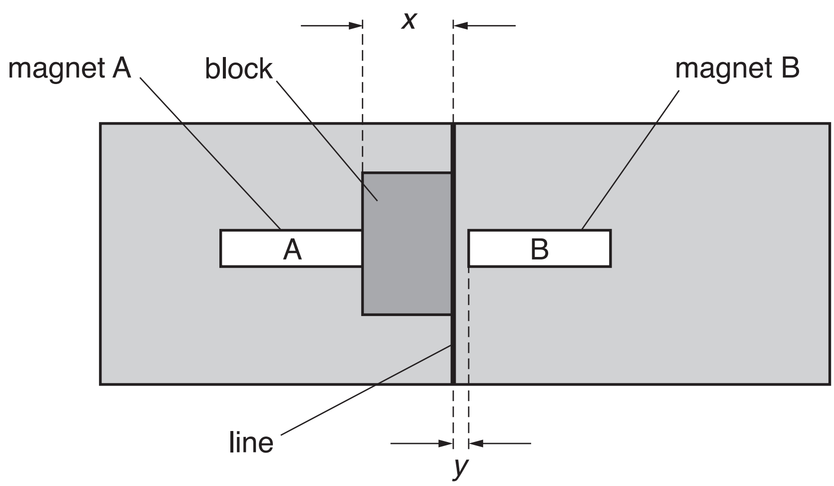


**Fig. 2.7**

• Determine $\beta$.

$\beta$ = .............................................................. °
[3]

**(f)** It is suggested that the relationship between $\beta$, $\alpha$, $x$ and $y$ is

$$(\sin \beta - \sin \alpha) = \frac{k}{(x + y)^2}$$

where $k$ is a constant.

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

first value of $k$ = ..............................................................

second value of $k$ = ..............................................................
[1]

**(ii)** Explain whether your results support the suggested relationship.

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............................................................................................................................. [1]

**(g)** **(i)** Describe four sources of uncertainty or limitations of the procedure for this experiment.

1. ..........................................................................................................................

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4. ..........................................................................................................................

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[4]

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

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[4]

[Total: 20]

Cambridge International AS & A Level

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*3854102650*

**PHYSICS** **9702/36**

Paper 3 Advanced Practical Skills 2 **October/November 2019**

**2 hours**

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**[Turn over**

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1 In this experiment, you will investigate the equilibrium of a loaded wooden strip.

(a) (i)
- Balance the wooden strip on the prism.
- Use the pencil to make a small line on the side of the wooden strip where it touches the prism, as shown in Fig. 1.1.

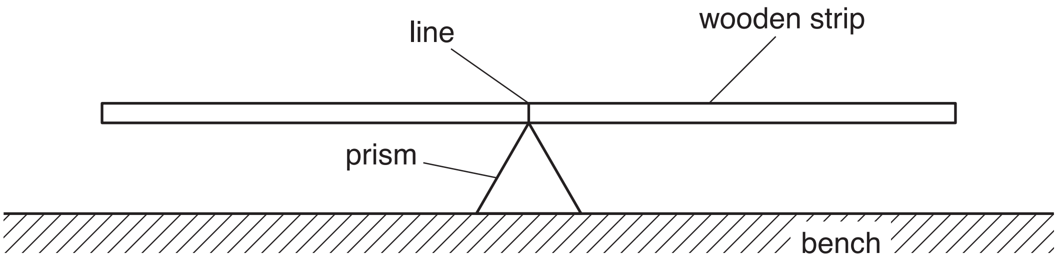


**Fig. 1.1**

- Roll the piece of modelling clay into a uniform cylinder of approximate length 20 cm and place it on the wooden strip with one end above the line, as shown in Fig. 1.2.
- Place the mass on the wooden strip and adjust the position of the mass until the strip balances, as shown in Fig. 1.2.

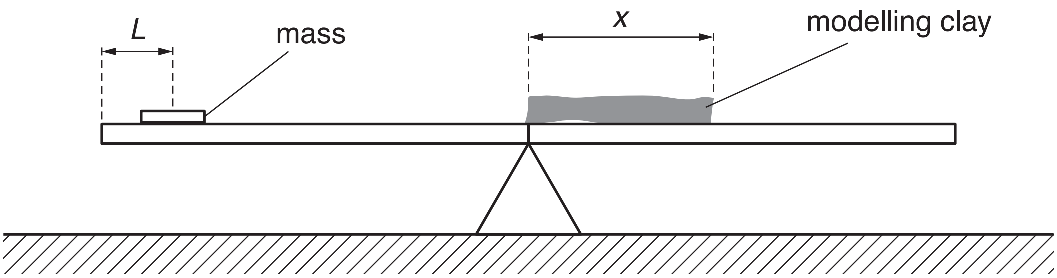


**Fig. 1.2** (not to scale)

- The length of the cylinder of modelling clay is $x$, as shown in Fig. 1.2.

  Measure and record $x$.

$x$ = .................................................. cm [1]

(ii) The distance between the centre of the mass and the end of the wooden strip is $L$, as shown in Fig. 1.2.

Measure and record $L$.

$L$ = .................................................. cm [1]

 

**(b)** • Reduce *x* by cutting off and removing approximately 1 cm of the cylinder of modelling clay at the end furthest from the line, as shown in Fig. 1.3. Adjust the position of the mass until the wooden strip is balanced.

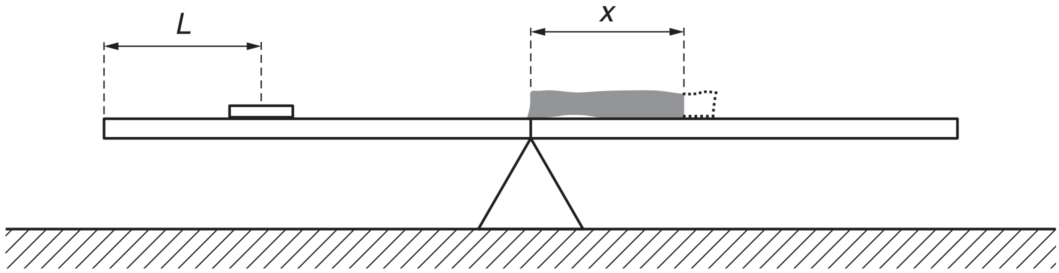


**Fig. 1.3** (not to scale)

• Measure and record the new values of *x* and *L*.

*x* = ........................................................... cm

*L* = ........................................................... cm
[1]

**(c)** Continue to reduce $x$ until you have six sets of values of $x$ and $L$. You may include your previous results.

Record your results in a table. Include values of $x^2$ in the table.

[9]

**(d)** **(i)** Plot a graph of $L$ on the $y$-axis against $x^2$ 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 $L$ and $x$ are related by the equation

$$L = ax^2 + b$$

where $a$ and $b$ are constants.

Use your answers in **(d)(iii)** to 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 expansion of a wire heated by an electric current.

(a) • The apparatus is partly assembled as shown in Fig. 2.1.

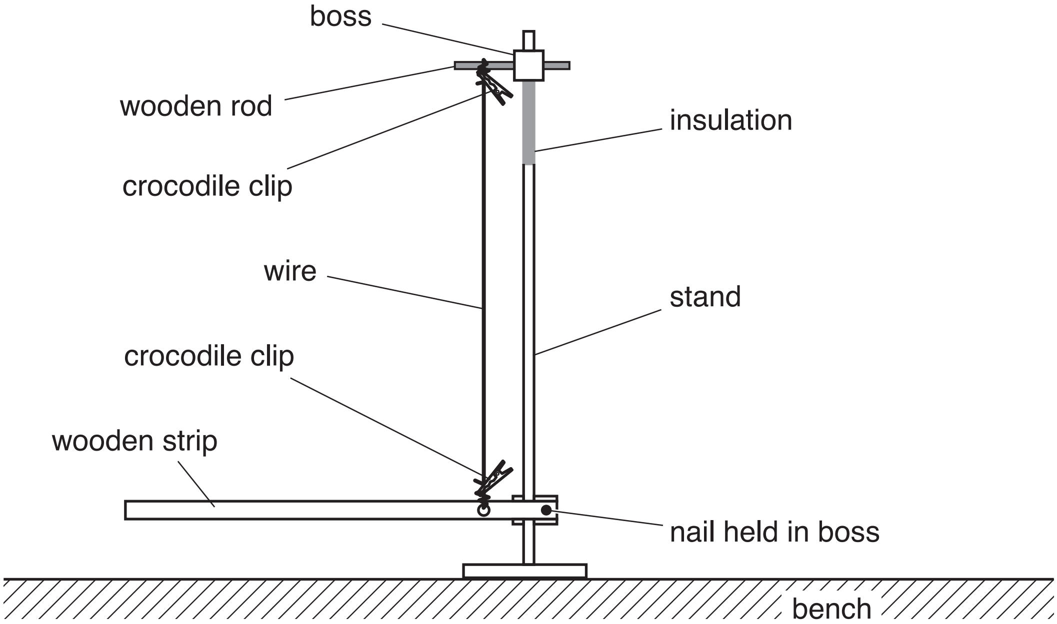


**Fig. 2.1**

Assemble the circuit shown in Fig. 2.2 **with the switch open** and the power supply set to its minimum voltage.

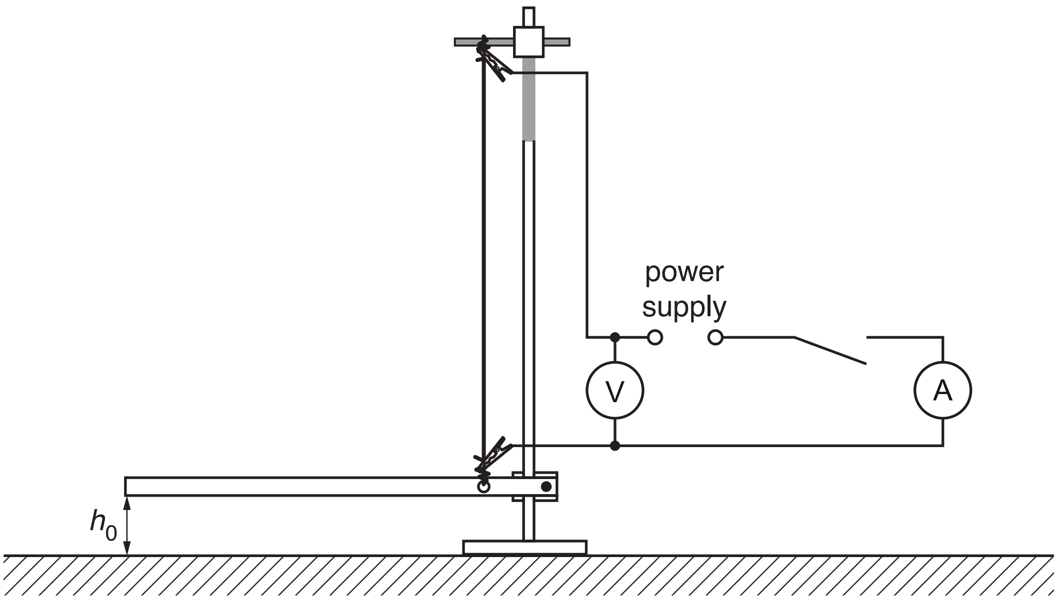


**Fig. 2.2**

• The height of the end of the wooden strip above the bench is $h_0$, as shown in Fig. 2.2.

Measure and record $h_0$.

$h_0$ = .................................................. mm [1]

**(b)** **(i)**
- When the switch is closed, the wire will get hot. **Do not touch the wire.**
- Close the switch and adjust the power supply until the ammeter reading $I$ is between 0.40 A and 0.50 A.
- Measure and record $I$ and the voltmeter reading $V$.

$I$ = ........................................................... A

$V$ = ........................................................... V [2]

**(ii)** The wire expands and this causes the wooden strip to move.

- The height of the end of the wooden strip above the bench is now $h$.

  Measure and record $h$.

$h$ = ........................................................ mm

- Open the switch.

[1]

**(iii)** Calculate the change in height $\Delta h$, where $\Delta h = h_0 - h$.

$\Delta h$ = ................................................. mm [1]

**(c)** Estimate the percentage uncertainty in your value of $\Delta h$.

percentage uncertainty = ........................................................ [1]

**(d)** • Write down the value, in kelvin, of the room temperature $T_0$ given on the card.

$T_0$ = ........................................................... K

• Calculate the temperature $T$ of the wire using the relationship

$$T = T_0 + \alpha \Delta h$$

where $\alpha = 11.8\,\mathrm{K\,mm^{-1}}$.

$T$ = ...................................................... K [1]

**(e)** Repeat **(b)** and **(d)** with the ammeter reading between 0.90 A and 1.00 A.

$I$ = ........................................................... A

$V$ = ........................................................... V

$h$ = ........................................................ mm

$\Delta h$ = ........................................................ mm

$T$ = ........................................................... K
[2]

**(f)** It is suggested that the relationship between $I$, $V$, $T$ and $T_0$ is

$$IV\beta = (T^4 - T_0^4)$$

where $\beta$ is a constant.

**(i)** Using your data, calculate two values of $\beta$.

first value of $\beta$ = ..............................................................

second value of $\beta$ = ..............................................................
[1]

**(ii)** Justify the number of significant figures you have given for your values of $\beta$.

..........................................................................................................................

..........................................................................................................................

.................................................................................................................... [1]

**(iii)** Explain whether your results in **(f)(i)** support the suggested relationship.

..........................................................................................................................

..........................................................................................................................

.................................................................................................................... [1]

**(g)** **(i)** Describe four sources of uncertainty or limitations of the procedure for this experiment.

1. ..........................................................................................................................

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2. ..........................................................................................................................

..........................................................................................................................

3. ..........................................................................................................................

..........................................................................................................................

4. ..........................................................................................................................

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[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. ..........................................................................................................................

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3. ..........................................................................................................................

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4. ..........................................................................................................................

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[4]

[Total: 20]

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