Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

PHYSICS **9702/33**

Paper 3 Advanced Practical Skills 1 **October/November 2020**

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.
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- 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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1	
2	
Total	

This document has **12** pages. Blank pages are indicated.

[Turn over

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) Using the calipers, determine the diameter of one of the masses.

diameter = ... cm [2]

(b) ● Set up the apparatus as shown in Fig. 1.1, with the scale on the metre rule facing upwards.

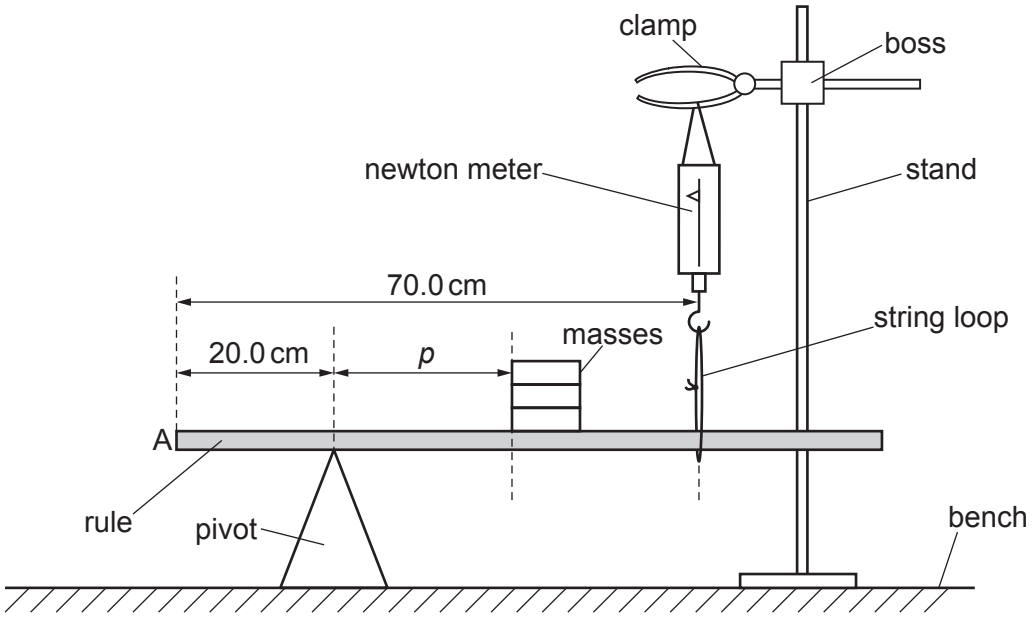


Fig. 1.1 (not to scale)

- Adjust the apparatus until the pivot is 20.0 cm from end A of the rule and the string loop is 70.0 cm from end A of the rule.
  The pivot and string loop should remain at these positions throughout the experiment.

- Place the three masses with the edge of the bottom mass approximately 37 cm from end A of the rule.

- Adjust the stand until the newton meter and string are perpendicular to the bench.

- Adjust the boss and the clamp until the rule is parallel to the bench.

- The distance from the pivot to the edge of the mass is *p*, as shown in Fig. 1.1.

  Measure and record *p*.

p = ... cm

- Measure and record the newton meter reading *F*.

F = ... N
[1]

(c) ● Using your value of diameter from **(a)**, calculate the radius r of a mass.

r = ... cm

● Vary p in the range 5.0 cm ≤ p ≤ 45.0 cm and determine six sets of readings of p and F. For each value of p, adjust the boss and clamp until the rule is parallel to the bench.

Record your values in a table. Include values of (p + r) in your table.

[8]

(d) **(i)** Plot a graph of F on the y-axis against (p + r) on the x-axis. [3]

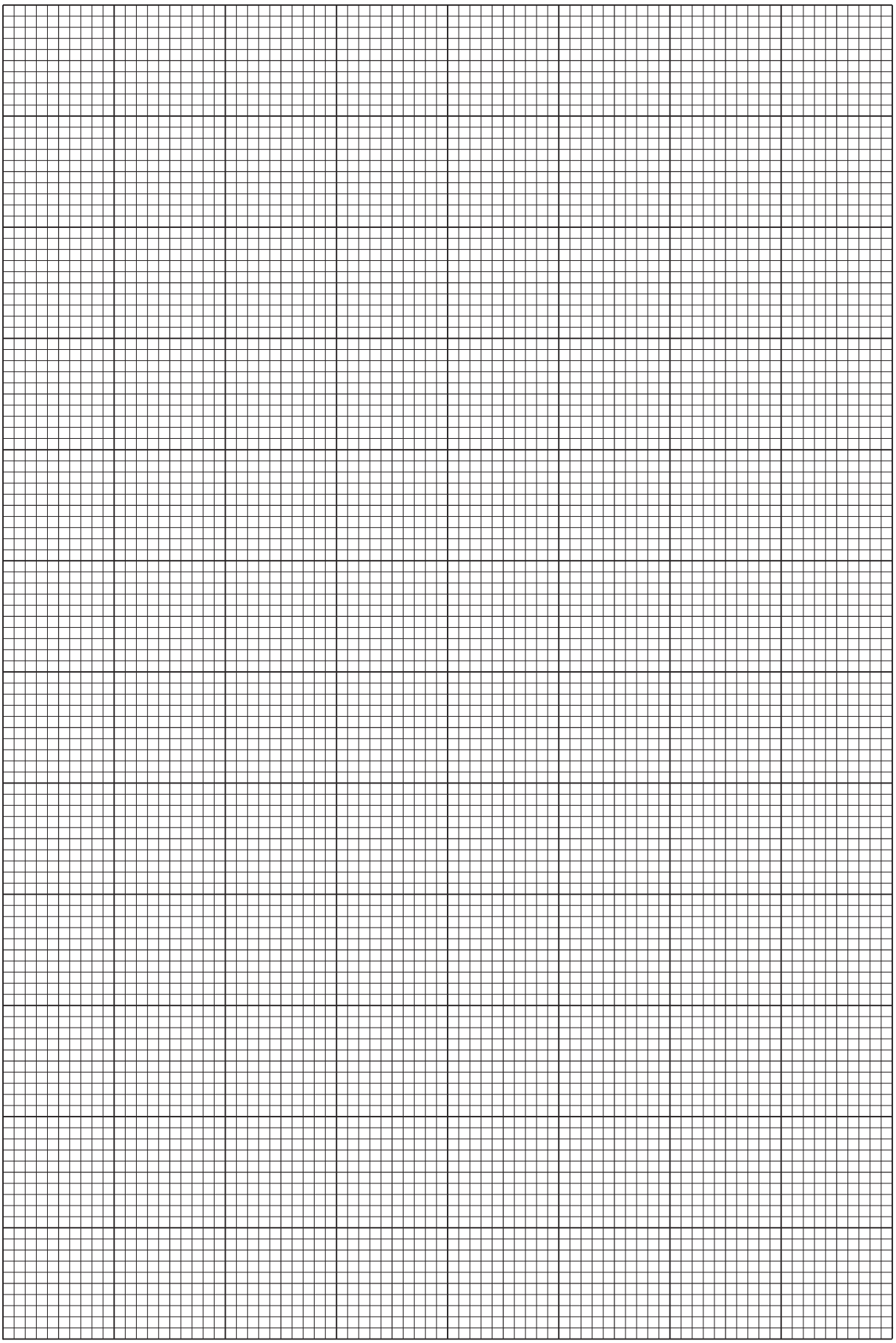
(ii) Draw the straight line of best fit. [1]

(iii) Determine the gradient and y-intercept of this line.

gradient = ...

y-intercept = ...

[2]



(e) It is suggested that the quantities F and p are related by the equation

$$F = \frac{W}{Q}(p + r) + \frac{S}{Q}$$

where $W = 3.00\,\text{N}$ and Q and S are constants.

Using your answers to **(d)(iii)**, determine values for Q and S.
Give appropriate units.

Q = ...

S = ...
[3]

[Total: 20]

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

2 In this experiment, you will investigate the oscillations of a square shape.

(a) (i)
- Bend the wire to form a square shape so that the length L of each side is approximately 12 cm, as shown in Fig. 2.1.

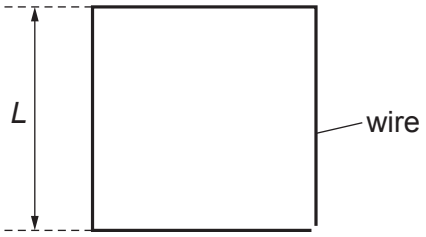


Fig. 2.1

- Use the wire cutters to remove any excess wire.
- Measure and record L.

L = ... cm [1]

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

percentage uncertainty = ... [1]

(b) (i)

- Place the cork in the clamp and attach the clamp to the stand using the boss.
- Hang the wire square from the pin as shown in Fig. 2.2.

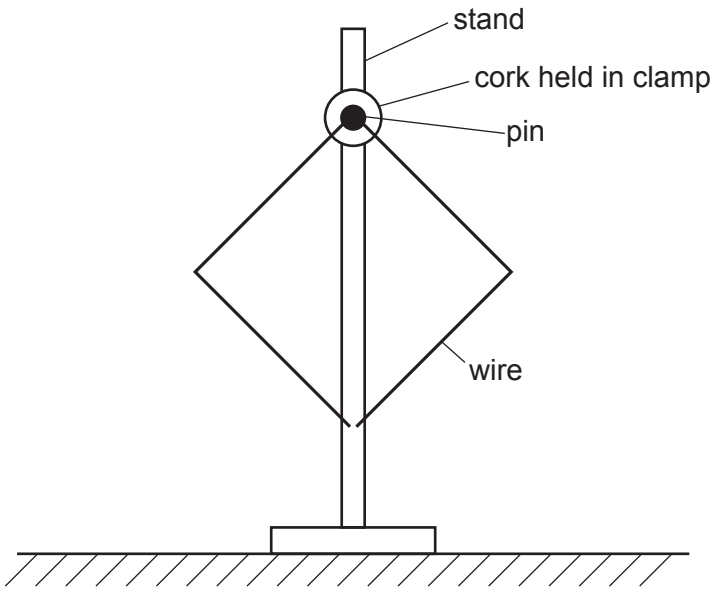


Fig. 2.2

- Gently displace the wire square and release it so that it oscillates as shown in Fig. 2.3.

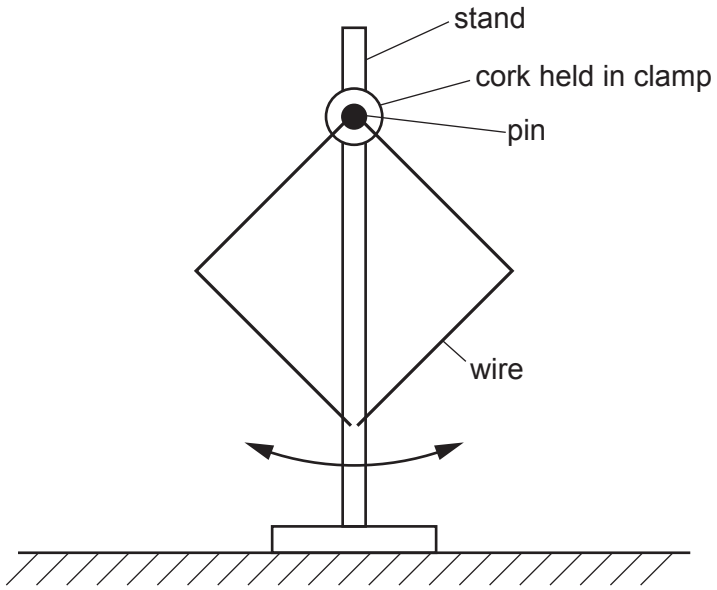


Fig. 2.3

- Determine the period T of the oscillations.

T = ... s [3]

(ii) Calculate T^2.

T^2 = ... s^2 [1]

(iii) Justify the number of significant figures you have given for your value of T^2.

.....

.....

..... [1]

(c)
- Remove the wire square from the pin.
- Form a new square shape from the wire so that L is approximately 6 cm.
- Use the wire cutters to remove the excess wire.
- Measure and record L.

L = ... cm

- Repeat **(b)(i)** and **(b)(ii)**.

T = ... s

T^2 = ... s^2 [2]

(d) It is suggested that the relationship between T and L is

$$T^2 = \frac{L}{k}$$

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.

.....

.....

.....

..... [1]

(e) An approximate value for the acceleration of free fall g is given by

$$g = 46.5k.$$

Use your second value of k to calculate a value for g.

g = ... $m\,s^{-2}$ [1]

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

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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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

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PHYSICS **9702/34**

Paper 3 Advanced Practical Skills 2 **October/November 2020**

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.
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- 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.
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For Examiner's Use	
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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 with a chain attached.

(a)
- Attach the boss to the stand at a height of approximately 60 cm above the bench.
- Assemble the apparatus as shown in Fig. 1.1 with the nail held securely in the boss.
- Attach one end of the chain of paper clips to the string loop and allow the other end of the chain to rest on the bench.
- Attach the piece of adhesive putty to the metre rule approximately 40 cm from the nail.

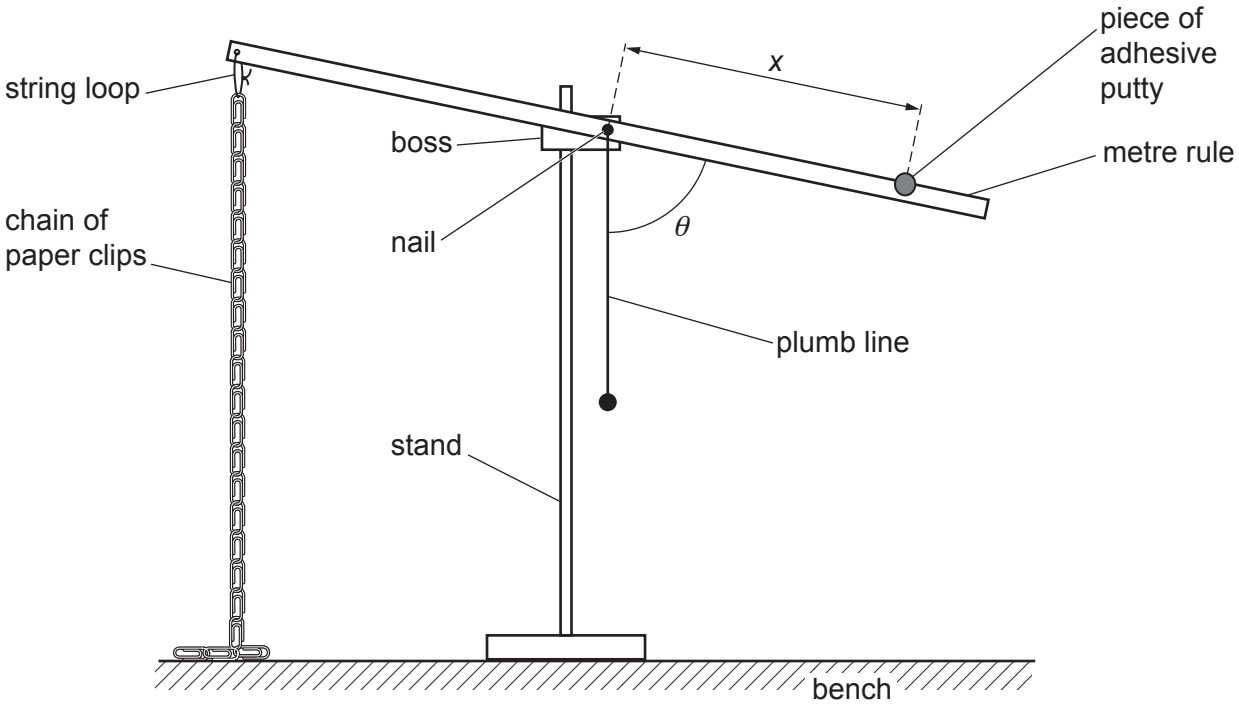


Fig. 1.1

- Measure and record the distance x between the nail and the centre of the piece of adhesive putty, as shown in Fig. 1.1.

x = ... cm [1]

(b) Measure and record the angle θ between the metre rule and the plumb line, as shown in Fig. 1.1.

θ = ... ° [1]

(c) Vary x and measure θ until you have six sets of values of x and θ.
Do not use values of x less than 15 cm.

Record your results in a table. Include values of $\cos\theta$ in your table.

[10]

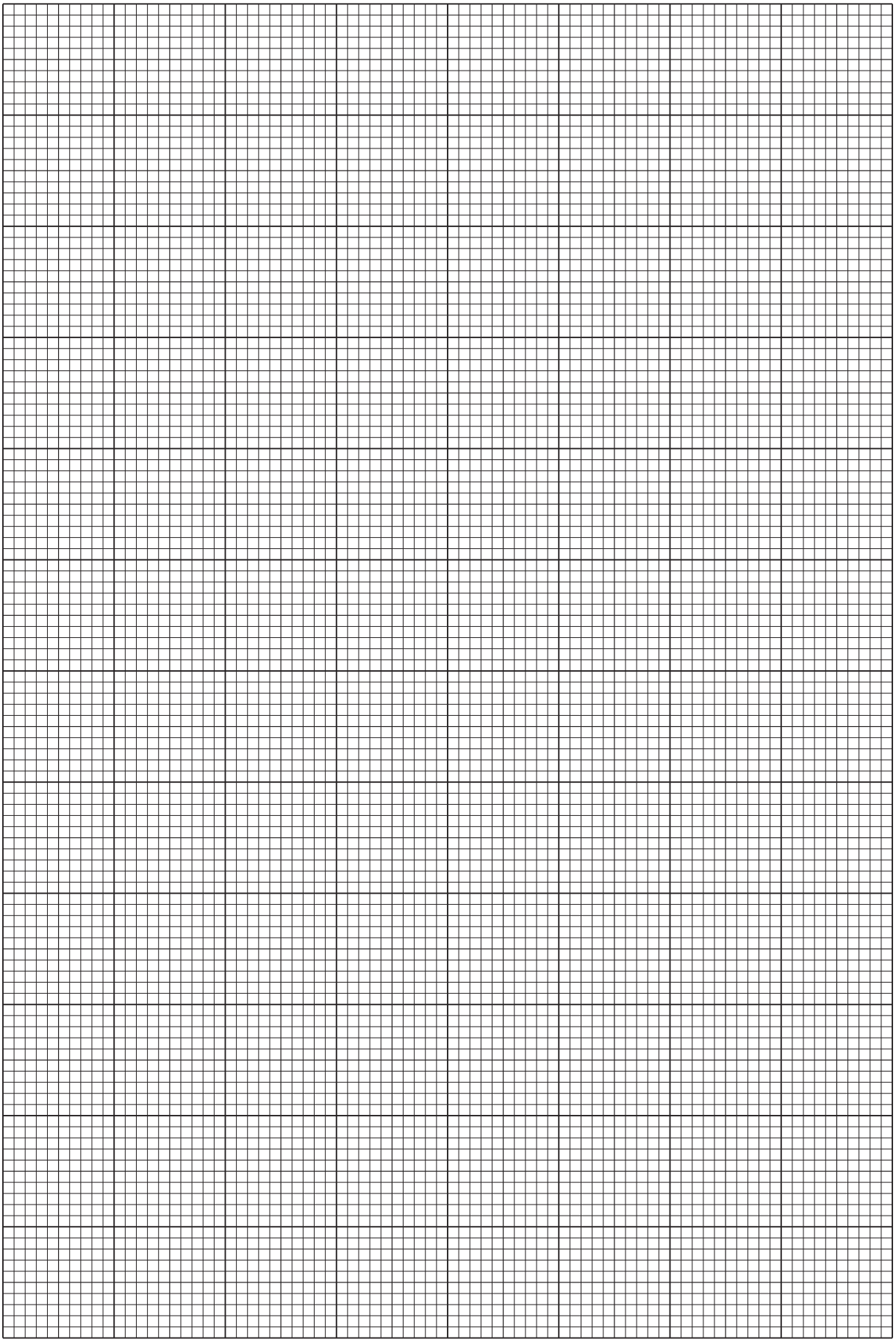
(d) **(i)** Plot a graph of $\cos\theta$ on the y-axis against x on the x-axis. [3]

(ii) Draw the straight line of best fit. [1]

(iii) Determine the gradient and y-intercept of this line.

gradient = ...

y-intercept = ...
[2]



(e) It is suggested that the quantities θ and x are related by the equation

$$\cos\theta = ax + b$$

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 motion of a roller on an inclined surface.

(a) You are provided with a roller made from a bolt and two washers, as shown in Fig. 2.1.

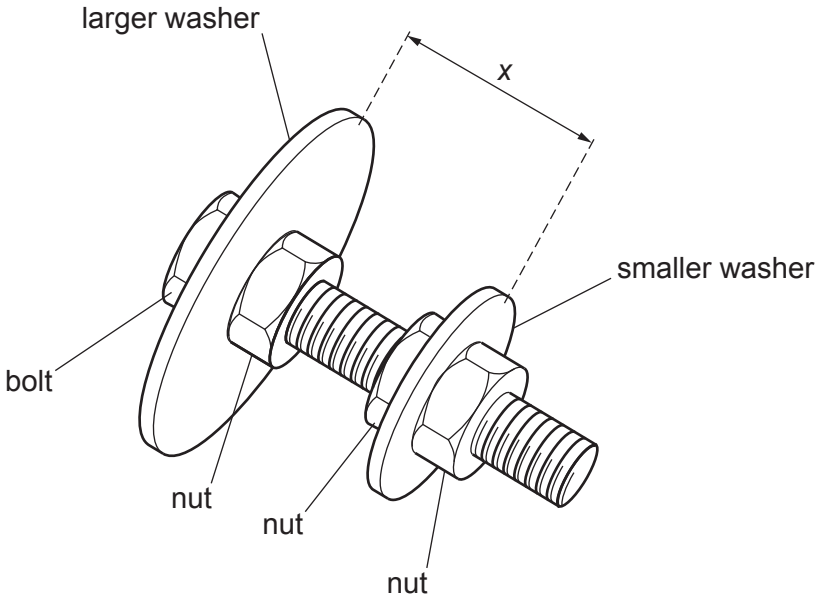


Fig. 2.1

(i) Measure and record the distance x between the two lower faces of the washers, as shown in Fig. 2.1.

x = ... [1]

(ii) Measure and record the diameter D of the larger washer and the diameter d of the smaller washer.

D = ...

d = ...
[1]

(iii) Calculate L, where

$$L = \frac{xD}{(D-d)}.$$

L = ... [1]

(iv) Justify the number of significant figures you have given for your value of L.

.....

.....

..... [1]

(b) • Place the flat board on the bench and support the board with the wooden block so that the board is at an angle θ of approximately 10° to the bench, as shown in Fig. 2.2.

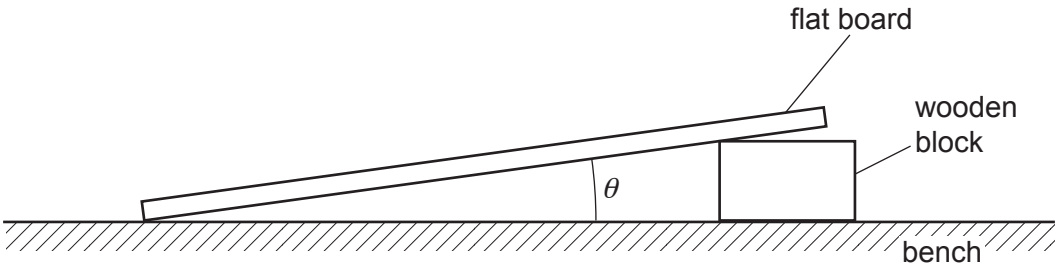


Fig. 2.2

• Measure and record θ.

θ = ... °

(i) • Place the roller on the board as shown in Fig. 2.3 and wait until it is stationary.

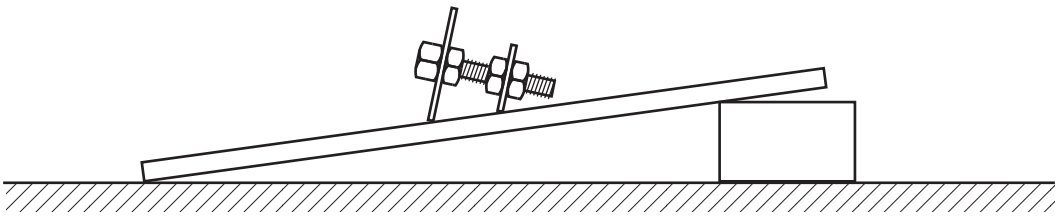


Fig. 2.3

• Push the roller to one side and release it. The roller will oscillate.

• Take measurements to find the period T of the oscillations.

T = ... s [2]

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

percentage uncertainty = ... [1]

(c)
- Use the spanners to loosen the two nuts either side of the smaller washer.
- Move these nuts and the smaller washer along the bolt until x is as large as possible. Use the spanners to tighten the nuts.
- Repeat **(a)(i)**, **(a)(iii)** and **(b)(i)**.

x = ...

L = ...

T = ... s
[2]

(d) It is suggested that the relationship between T, L and x is

$$kT^2 = L - \frac{x}{2}$$

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 in **(d)(i)** support the suggested relationship.

.....

.....

..... [1]

(e) An approximate value for the acceleration of free fall g is given by

$$g = \frac{4\pi^2 k}{\sin\theta}.$$

Use your second value of k and your value of θ from **(b)** to determine g.

g = ... $m\,s^{-2}$ [1]

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

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]

Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0150880739

PHYSICS **9702/35**

Paper 3 Advanced Practical Skills 1 **October/November 2020**

2 hours

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Total	

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[Turn over

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

1 In this experiment, you will investigate combinations of resistors in an electrical circuit.

Fig. 1.1 shows how resistors of resistance 68.0 Ω can be arranged to give different values of total resistance *R*.

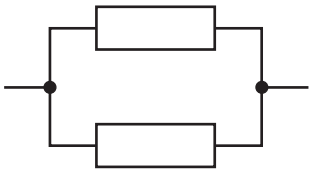
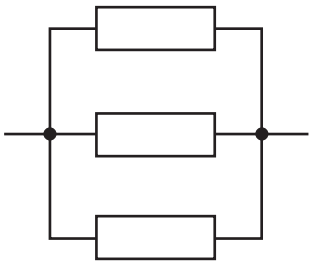
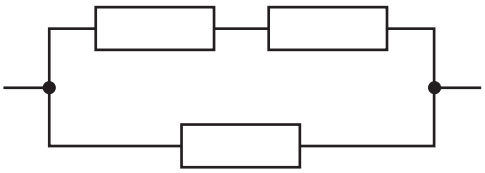
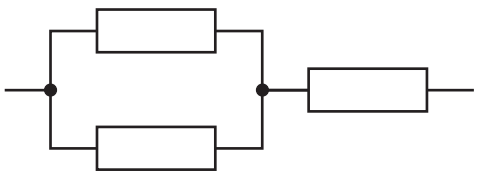
resistor arrangement	R / Ω
	68.0
	136
	204
	34.0
	22.7
	45.3
	102

Fig. 1.1

(a) ● Set up the circuit as shown in Fig. 1.2 with a resistor of resistance 68.0 Ω between F and G.

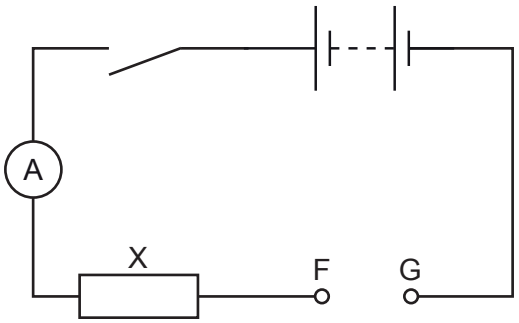


Fig. 1.2

● Record the total resistance *R* between F and G.

R = ... Ω

● Close the switch.

● Record the ammeter reading *I*.

I = ...

● Open the switch.

[1]

(b) Use six different arrangements of the 68.0 Ω resistors to provide six different total resistances between F and G.

For each arrangement, record R and I in a table. Include values of $\frac{1}{I}$ in your table.

[10]

(c) **(i)** Plot a graph of $\frac{1}{I}$ on the *y*-axis against R on the *x*-axis. [3]

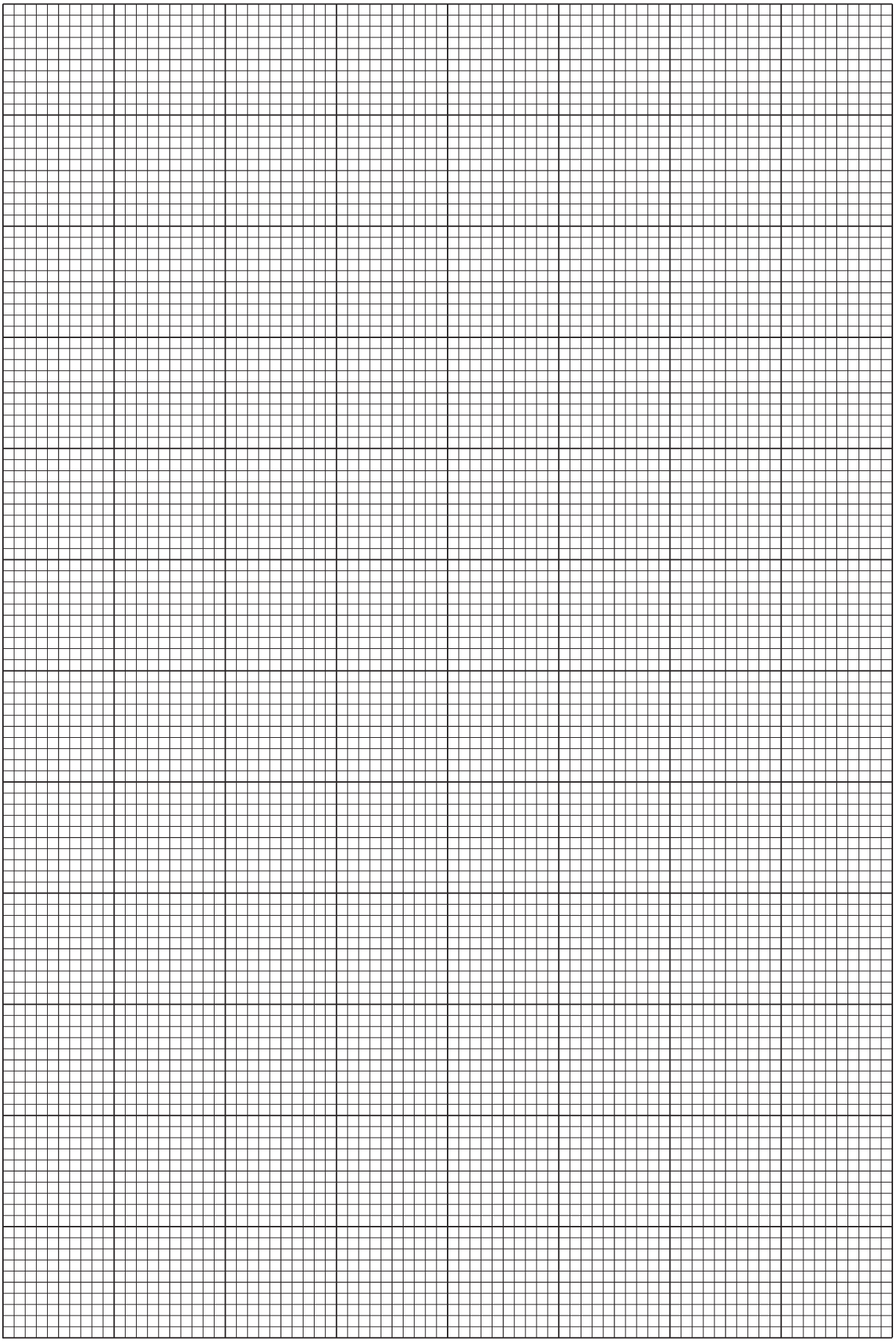
(ii) Draw the straight line of best fit. [1]

(iii) Determine the gradient and *y*-intercept of this line.

gradient = ...

y-intercept = ...

[2]



(d) It is suggested that the quantities I and R are related by the equation

$$\frac{1}{I} = \frac{R}{E} + \frac{X}{E}$$

where E is the electromotive force (e.m.f.) of the power supply and X is the resistance of resistor X.

Using your answers to **(c)(iii)**, determine values for E and X.
Give appropriate units.

E = ...

X = ...
[3]

[Total: 20]

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

2 In this experiment, you will investigate the equilibrium of an L-shaped card.

(a) (i) The dimensions p, q and w of the card are shown in Fig. 2.1.

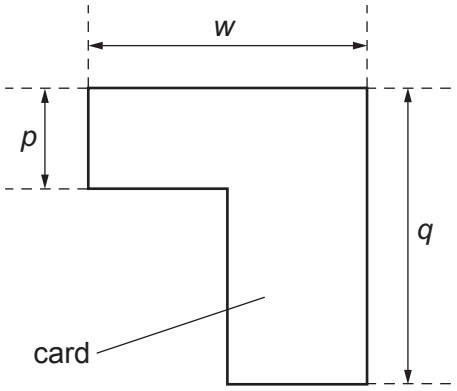


Fig. 2.1 (not to scale)

Measure and record lengths p, q and w.

p = ... cm

q = ... cm

w = ... cm
[2]

(ii) Calculate $\frac{2q}{p+q}$.

$\frac{2q}{p+q}$ = ... [1]

(b) (i) ● Set up the apparatus as shown in Fig. 2.2.

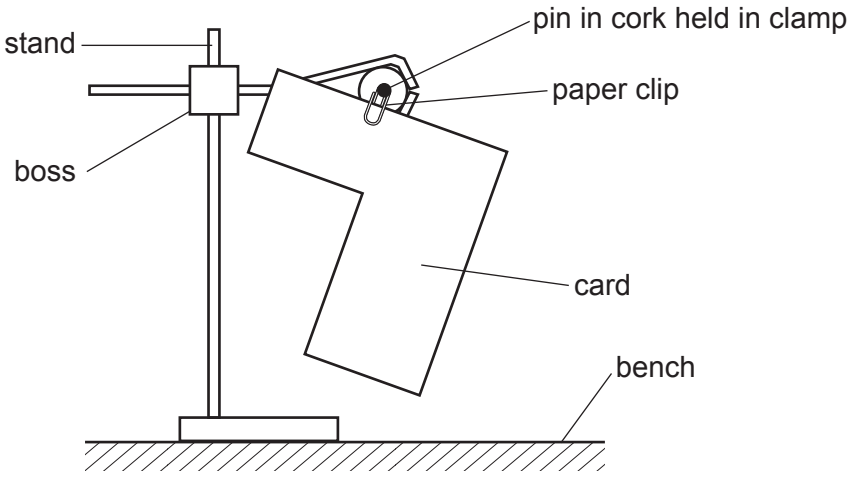


Fig. 2.2 (not to scale)

● Adjust the position of the paper clip so that the top edge of the card is horizontal, as shown in Fig. 2.3.

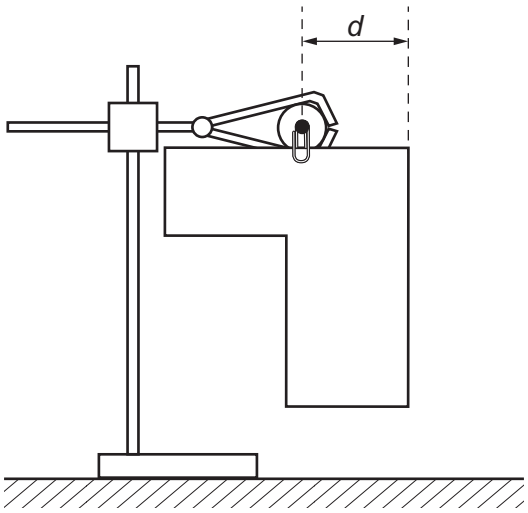


Fig. 2.3 (not to scale)

● The distance *d* is the distance from the centre of the paper clip to the right-hand edge of the card when the top edge of the card is horizontal.

● Measure and record *d*.

d = ... cm [1]

(ii) Estimate the percentage uncertainty in d. Show your working.

percentage uncertainty = ... [1]

(iii) Calculate $(w - d)$.

$(w - d)$ = ... cm [1]

(c) (i) Explain how you would accurately reduce q to half of its original value.

.....

.....

..... [1]

(ii)
- Remove the card from the paper clip.
- Cut the card so that q is half of its original value.
- Measure and record the new value of q.

q = ... cm

- Calculate $\frac{2q}{p + q}$.

$\frac{2q}{p + q}$ = ...
[1]

(iii) Repeat **(b)(i)** and **(b)(iii)**.

d = ... cm

$(w - d)$ = ... cm
[2]

(d) It is suggested that the relationship between d and q is

$$(w - d) = k\left[1 + \left(\frac{2q}{p + q}\right)\right]$$

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.

.....

.....

.....

..... [1]

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

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. .....

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[4]

[Total: 20]

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Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

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PHYSICS **9702/36**

Paper 3 Advanced Practical Skills 2 **October/November 2020**

2 hours

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[Turn over

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1 In this experiment, you will investigate an electrical circuit.

(a) ● Connect any one of the eight resistors labelled with values in the component holder.

● Assemble the circuit shown in Fig. 1.1.

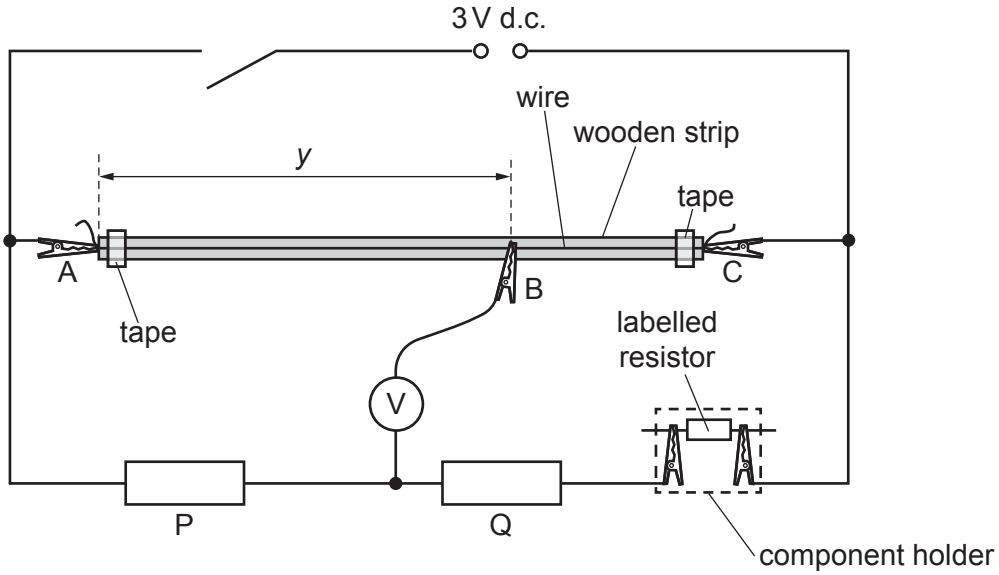


Fig. 1.1

● Record the resistance *R* of the labelled resistor in the component holder.

R = ... Ω

● Close the switch. The voltmeter reading will be non-zero.

● A, B and C are crocodile clips.

Adjust the position of B on the wire until the voltmeter reading is as close as possible to zero.

● The distance between A and B is *y*, as shown in Fig. 1.1.

Measure and record *y*.

y = ... cm

● Open the switch.

[1]

(b) Change the labelled resistor and determine the value of y. Repeat until you have six sets of values of R and y.

Record your results in a table. Include values of $\frac{1}{y}$ in your table.

[9]

(c) **(i)** Plot a graph of $\frac{1}{y}$ on the y-axis against R on the x-axis. [3]

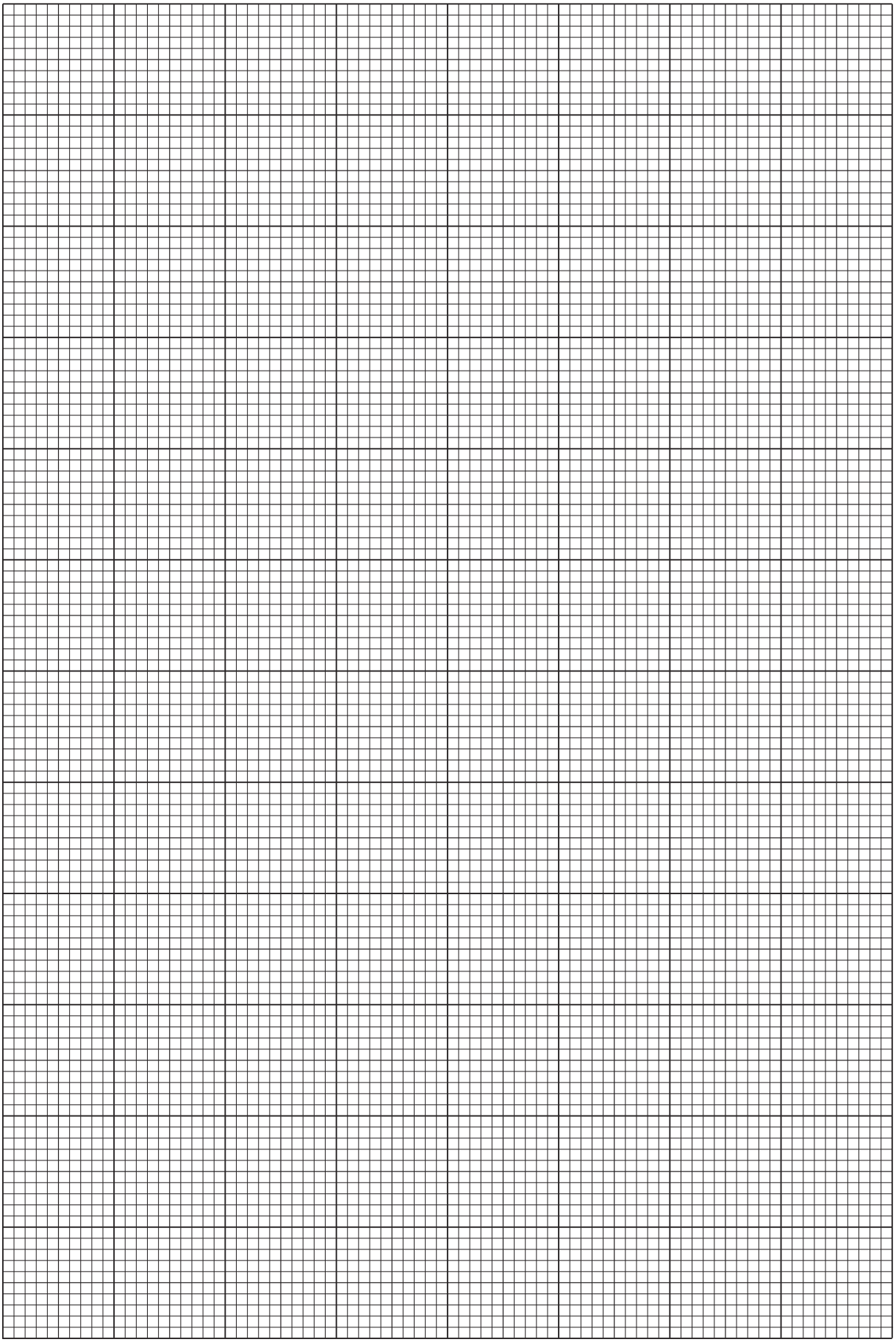
(ii) Draw the straight line of best fit. [1]

(iii) Determine the gradient and y-intercept of this line.

gradient = ...

y-intercept = ...

[2]



(d) It is suggested that the quantities y and R are related by the equation

$$\frac{1}{y} = aR + b$$

where a and b are constants.

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

a = ...

b = ...
[2]

(e) **(i)** Measure and record the length W of the wire between the crocodile clips A and C.

W = ... cm [1]

(ii) The resistor P has resistance P.

Calculate the value of P using the relationship

$$a = \frac{1}{PW}.$$

P = ... Ω [1]

[Total: 20]

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

2 In this experiment, you will investigate an oscillating system.

You have access to a roll of strong adhesive tape. Cut off a piece of tape of approximate length 40 cm. The exact length is not important.

(a) ● You have been provided with two plastic rulers.
Bend one of the rulers so that the distance L between its ends is approximately 29 cm.
Use the adhesive tape to fix it in this shape, as shown in Fig. 2.1.

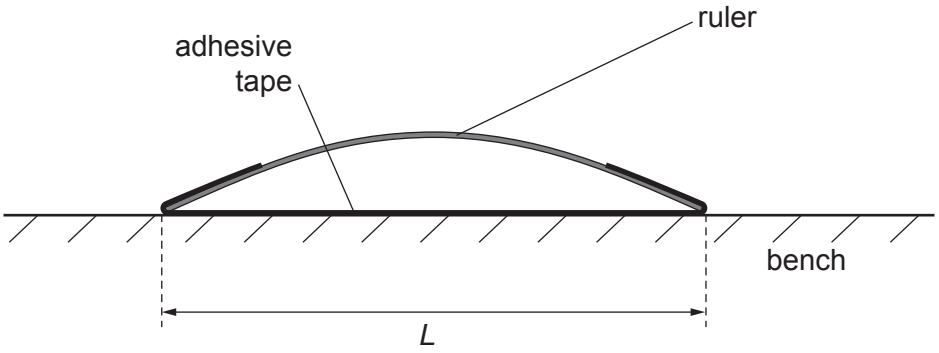


Fig. 2.1

● Measure and record the length L and the height H of the bent ruler, as shown in Fig. 2.2.

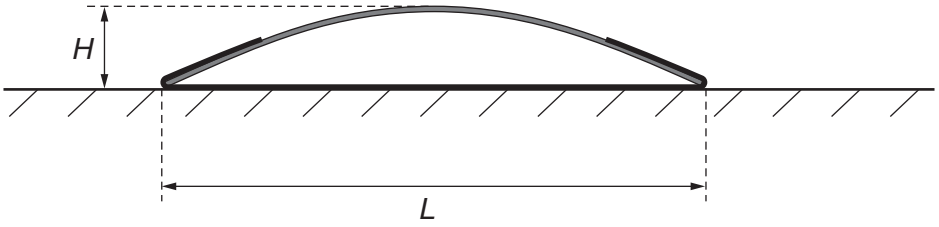


Fig. 2.2

L = ... cm

H = ... cm
[2]

(b) Estimate the percentage uncertainty in your value of H. Show your working.

percentage uncertainty = ... [1]

(c) ● Balance the wooden strip on top of the ruler, as shown in Fig. 2.3.

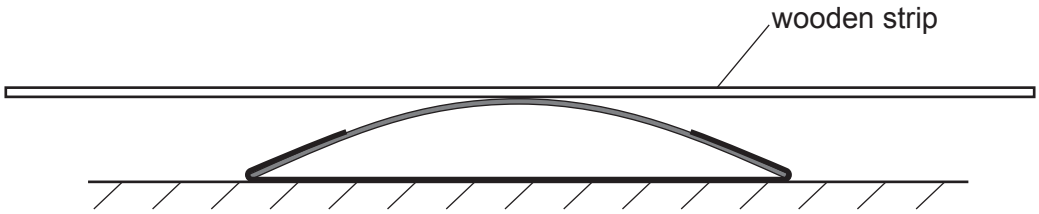


Fig. 2.3

● Push one end of the strip down a short distance and release it so that it oscillates.

● Determine the period T of the oscillations.

T = ... s [2]

(d) **(i)** Repeat **(a)** using a length L of approximately 27 cm.

L = ... cm

H = ... cm
[1]

(ii) Repeat **(c)**.

T = ... s [2]

(e) It is suggested that the relationship between T, L and H is

$$T^2L^2 = kH$$

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 you have given for your values of k.

.....

.....

..... [1]

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

.....

.....

..... [1]

(f) The length S of the wooden strip is 91 cm.

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

$$3gk = \pi^4 S^2.$$

Use your second value of k to calculate g.
Give an appropriate unit.

g = ... [1]

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

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]