Cambridge Assessment International Education

Interactive

Interactive Example Candidate Responses
Paper 3 (May/June 2016), Question 1
Cambridge International AS & A Level Physics 9702

Version 1.0

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

1 In this experiment, you will investigate a wooden strip acted on by several forces.

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

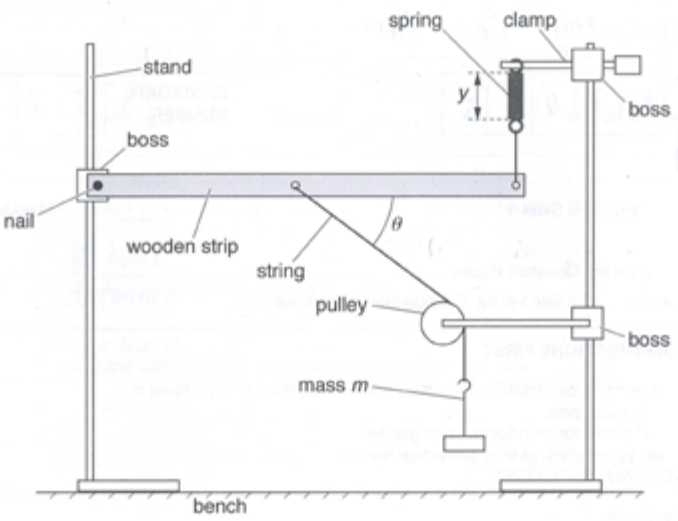


Fig. 1.1

The mass m should be 100 g.

The angle θ between the wooden strip and the string should be approximately 45°.

(ii) Adjust the apparatus so that the spring is vertical and the wooden strip is parallel to the bench.

(b) (i) Record the mass m.

m = 100 g

(ii) Measure and record the length y of the coiled part of the spring.

y_1	y_2	$\langle y \rangle$
4.50	4.50	4.50

y = 4.50 cm [1]

(iii) Measure and record θ.

θ_1	θ_2	$\langle \theta \rangle$
66.0°	68.0°	67.0°

θ = 67.0° [1]

Your Mark

1(b)(ii) ☐

1(b)(iii) ☐

1(d) ☐

1(e)(i) ☐

1(e)(ii) ☐

1(e)(iii) ☐

1(f) ☐

Q1	Mark scheme
(b)(ii)	Value for y with unit in range 2.0 ≤ y ≤ 8.0 cm.
(b)(iii)	Raw values of θ to the nearest degree. Value of θ in the range 40° to 50°.

EXAMINER COMMENTS

MARK SCHEME

(c) (i) Add 100 g to the mass hanger.

(ii) Adjust the height of the boss holding the nail until the wooden strip is parallel to the bench.

(iii) Measure and record m, y and θ.

y_1	y_2	$\langle y \rangle$
5.70	5.70	5.70

θ_1	θ_2	$\langle \theta \rangle$
58.0°	59.0°	59.0°

$m =$ 100 g

$y =$ 5.70 cm

$\theta =$ 59.0°

Select page

HIGH | MIDDLE | LOW

	Your Mark
1(b)(ii)	
1(b)(iii)	
1(d)	
1(e)(i)	
1(e)(ii)	
1(e)(iii)	
1(f)	

Q1	Mark scheme
(b)(ii)	Value for y with unit in range 2.0 ≤ y ≤ 8.0 cm.
(b)(iii)	Raw values of θ to the nearest degree. Value of θ in the range 40° to 50°.

EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH | MIDDLE | LOW

(d) Change m and repeat **(c)(ii)** and **(c)(iii)** until you have six sets of values of m, y and θ.

You may include values of m and θ from **(b)** and **(c)**.

Include values of $m \sin\theta$ in your table.

m/g	y/cm			θ/°			
	y_1	y_2	$\langle y \rangle$	θ_1	θ_2	$\langle \theta \rangle$	$m \sin\theta$/g
100	4.50	4.50	4.50	66.0	68.0	67.0	92.1
200	5.70	5.70	5.70	58.0	59.0	59.0	171.
250	6.50	6.50	6.50	60.0	62.0	61.0	219
300	7.20	7.20	7.20	57.0	59.0	58.0	254
350	7.90	8.00	8.00	56.0	56.0	56.0	290
450	9.30	9.40	9.40.	54.0	55.0	55.0	369

[10]

(e) (i) Plot a graph of y on the y-axis against $m \sin\theta$ 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 : $\frac{7.2 - 5.7}{369 - 171} = \frac{1}{132} = 7.58 \times 10^{-3}$ cm g^{-1}

c, y-intercept : $y = mx + c$

$3.5 = 50(7.58 \times 10^{-3}) + c$

$c = 3.12$ cm

gradient = 7.58×10^{-3} cm g^{-1}

y-intercept = 3.12 cm

[2]

Your Mark

1(b)(ii) ☐

1(b)(iii) ☐

1(d) ☐

1(e)(i) ☐

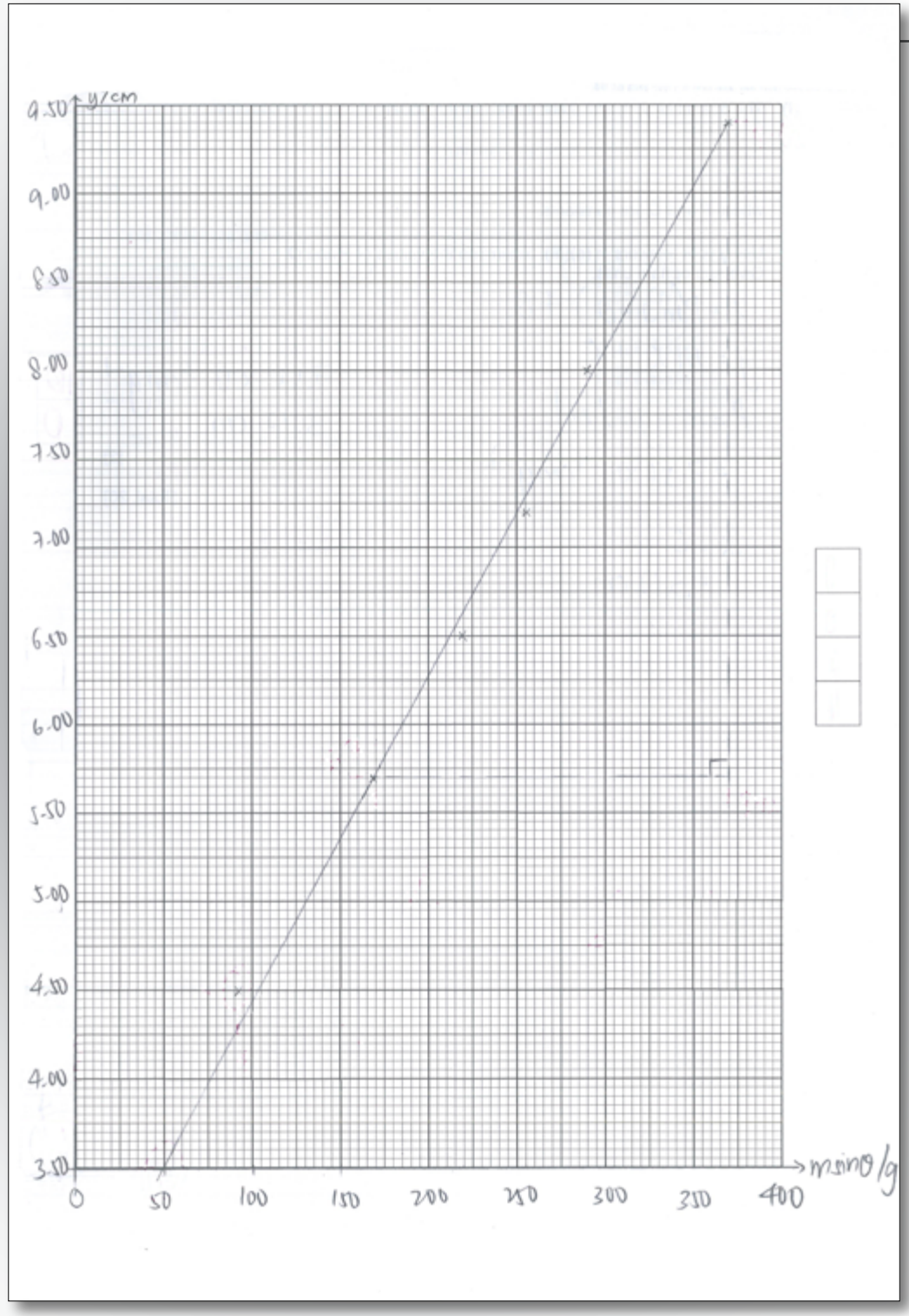
1(e)(ii) ☐

1(e)(iii) ☐

1(f) ☐

Q1	Mark scheme
(d)	Six sets of readings of m, y and θ with correct trend scores 5 marks, five sets scores 4 marks etc. [5] Help from supervisor –1. **Range:** [1] Range of values to include m ≤ 150 g and m ≥ 400 g. **Column headings:** [1] Each column heading must contain a quantity and a unit where appropriate. The unit must conform to accepted scientific convention, e.g. $m \sin\theta$ / g or θ (°). **Consistency:** [1] All values of y must be given to the nearest mm only. Significant figures: [1] Every value of $m \sin\theta$ must be given to 2 or 3 s.f. **Calculation:** [1] Values of $m \sin\theta$ calculated correctly to the number of s.f. given by the candidate **[5]**
(e)(i)	**Axes:** [1] Sensible scales must be used. Awkward scales (e.g. 3:10) are not allowed. Scales must be chosen so that the plotted points occupy at least half the graph grid in both x and y directions. Scales must be labelled with the quantity that is being plotted. Scale markings should be no more than three large squares apart. **Plotting of points:** [1] All observations must be plotted. Diameter of plotted points must be ≤ half a small square (no "blobs"). Plotted points must be accurate to half a small square. **Quality:** [1] All points in the table (at least 5) must be plotted on the grid for this mark to be awarded. All points must be within ±0.25 cm in the y direction of a straight line. **[3]**

EXAMINER COMMENTS | MARK SCHEME



Select page

HIGH | MIDDLE | LOW

	Your Mark
1(b)(ii)	
1(b)(iii)	
1(d)	
1(e)(i)	
1(e)(ii)	
1(e)(iii)	
1(f)	

Q1	Mark scheme
(e)(ii)	**Line of best fit:** **[1]** Judge by balance of all points on the grid about the candidate's line (at least 5 points). There must be an even distribution of points either side of the line along the full length. Allow one anomalous point only if clearly indicated by the candidate. Lines must not be kinked or thicker than half a square
(e)(iii)	**Gradient:** [1] The hypotenuse of the triangle must be greater than half of the length of the drawn line. The method of calculation must be correct. Both read-offs must be accurate to half a small square in both the x and y directions. **y-intercept:** [1] Either: Correct read-off from a point on the line and substituted into $y = mx + c$. Read-offs must be accurate to half a small square in both x and y directions. **Or:** Intercept read off directly from the graph (accurate to half a small square). **[2]**

EXAMINER COMMENTS

MARK SCHEME

(f) The quantities y, m and θ are related by the equation

$$y = Pm\sin\theta + Q$$

where P and Q are constants.

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

$y = P(m\sin\theta) + Q$

$y = mx + c$

$P = m = \text{gradient}$

$= 7.58 \times 10^{-3}\,\text{cm g}^{-1}$

$Q = c$

$= 3.12\,\text{cm}$

$P =$ $7.58 \times 10^{-3}\,\text{cm g}^{-1}$

$Q =$ $3.12\,\text{cm}$

[2]

[Total: 20]

Select page

HIGH | MIDDLE | LOW

	Your Mark
1(b)(ii)	
1(b)(iii)	
1(d)	
1(e)(i)	
1(e)(ii)	
1(e)(iii)	
1(f)	

Q1	Mark scheme
(f)	Value of P = candidate's gradient and value of Q = candidate's intercept. [1] Do not allow fractions. Unit for P correct (m kg^{-1} **or** cm kg^{-1} **or** mm kg^{-1} **or** m g^{-1} **or** cm g^{-1} **or** mm g^{-1}) and consistent with value. Unit for Q correct (m or cm or mm) and consistent with value. [1] **[2]** **[total: 20]**

EXAMINER COMMENTS

MARK SCHEME

Select page

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

1 In this experiment, you will investigate a wooden strip acted on by several forces.

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

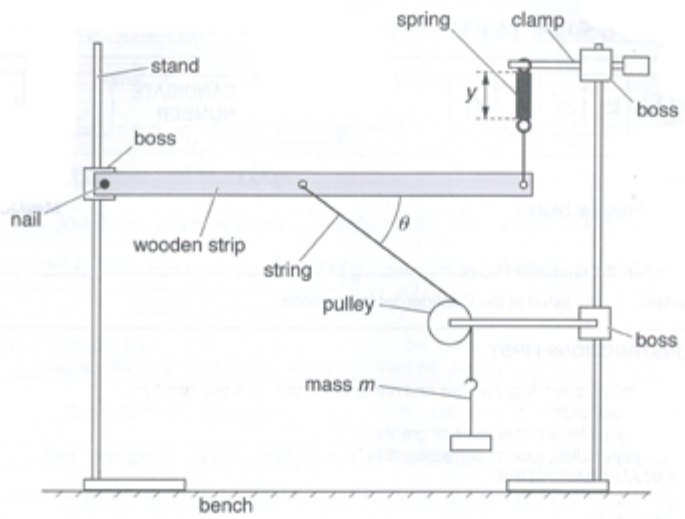

Fig. 1.1

The mass m should be 100 g.

The angle θ between the wooden strip and the string should be approximately 45°.

(ii) Adjust the apparatus so that the spring is vertical and the wooden strip is parallel to the bench.

(b) (i) Record the mass m.

m = 100 g

(ii) Measure and record the length y of the coiled part of the spring.

y = 0.035 m [1]

(iii) Measure and record θ.

θ = 45° [1]

	Your Mark
1(b)(ii)	
1(b)(iii)	
1(d)	
1(e)(i)	
1(e)(ii)	
1(e)(iii)	
1(f)	

Q1	Mark scheme
(b)(ii)	Value for y with unit in range 2.0 ≤ y ≤ 8.0 cm.
(b)(iii)	Raw values of θ to the nearest degree. Value of θ in the range 40° to 50°.

EXAMINER COMMENTS

MARK SCHEME

(c) (i) Add 100 g to the mass hanger.

(ii) Adjust the height of the boss holding the nail until the wooden strip is parallel to the bench.

(iii) Measure and record m, y and θ.

$m =$ 200 g

$y =$ 0.045m

$\theta =$ 40.4°

Select page

HIGH | MIDDLE | LOW

	Your Mark
1(b)(ii)	
1(b)(iii)	
1(d)	
1(e)(i)	
1(e)(ii)	
1(e)(iii)	
1(f)	

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EXAMINER COMMENTS

MARK SCHEME

(d) Change m and repeat **(c)(ii)** and **(c)(iii)** until you have six sets of values of m, y and θ.

You may include your values from **(b)** and **(c)**.

Include values of $m \sin\theta$ in your table.

m/g	y/cm	θ/°	m sin θ
100	3.5	45.0	70.70
150	3.8	44.0	104.2
200	4.5	40.4	129.6
250	4.8	38.0	153.9
300	5.4	41.0	196.8
350	6.0	39.0	220.3

[10]

(e) (i) Plot a graph of y on the y-axis against $m \sin\theta$ on the x-axis. [3]

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

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

$m = \frac{6.0 - 3.5}{220.3 - 70.7}$

$= 0.017$

$\frac{220.3 - 70.7}{8} = 187$

$\frac{6 - 3.5}{10} = 0.25$

$y = mx + c$

$6 = 0.017(220.3) + c$

$c = 2.3$

gradient = 0.017

y-intercept = 2.3

[2]

	Your Mark
1(b)(ii)	
1(b)(iii)	
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1(e)(ii)	
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Q1	Mark scheme
(d)	Six sets of readings of m, y and θ with correct trend scores 5 marks, five sets scores 4 marks etc. [5] Help from supervisor –1. **Range:** [1] Range of values to include m ≤ 150 g and m ≥ 400 g. **Column headings:** [1] Each column heading must contain a quantity and a unit where appropriate. The unit must conform to accepted scientific convention, e.g. m sin θ / g or θ (°). **Consistency:** [1] All values of y must be given to the nearest mm only. Significant figures: [1] Every value of m sin θ must be given to 2 or 3 s.f. **Calculation:** [1] Values of m sin θ calculated correctly to the number of s.f. given by the candidate **[5]**
(e)(i)	**Axes:** [1] Sensible scales must be used. Awkward scales (e.g. 3:10) are not allowed. Scales must be chosen so that the plotted points occupy at least half the graph grid in both x and y directions. Scales must be labelled with the quantity that is being plotted. Scale markings should be no more than three large squares apart. **Plotting of points:** [1] All observations must be plotted. Diameter of plotted points must be ≤ half a small square (no "blobs"). Plotted points must be accurate to half a small square. **Quality:** [1] All points in the table (at least 5) must be plotted on the grid for this mark to be awarded. All points must be within ±0.25 cm in the y direction of a straight line. **[3]**

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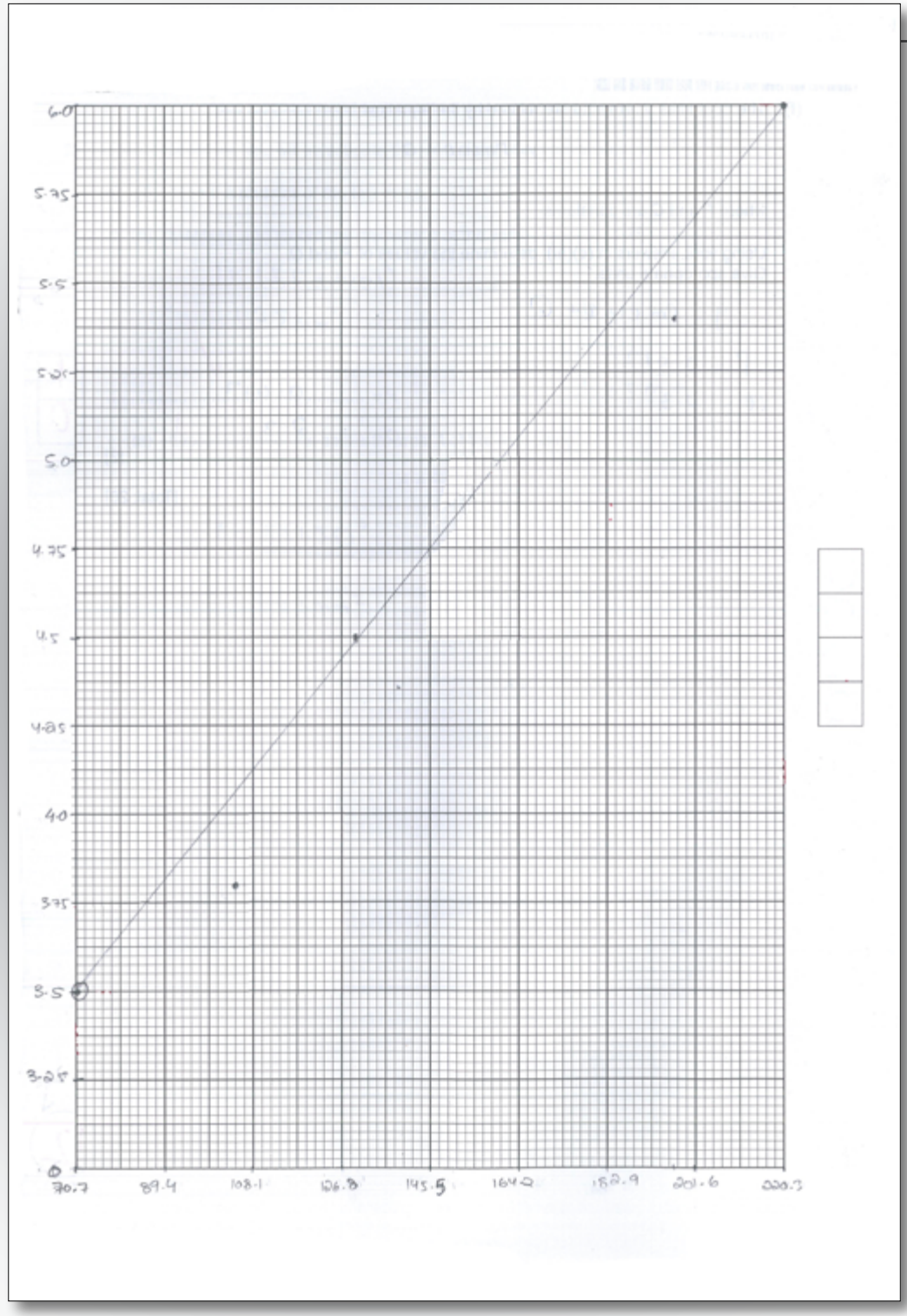

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HIGH | MIDDLE | LOW

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1(b)(ii)	
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EXAMINER COMMENTS

MARK SCHEME

(f) The quantities y, m and θ are related by the equation

$$y = Pm\sin\theta + Q$$

where P and Q are constants.

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

$y = Pm\sin\theta + Q$

$P = 0.017$

$Q = 2.3$

$P =$ 0.017

$Q =$ 2.3

[2]

[Total: 20]

Select page

HIGH | MIDDLE | LOW

	Your Mark
1(b)(ii)	
1(b)(iii)	
1(d)	
1(e)(i)	
1(e)(ii)	
1(e)(iii)	
1(f)	

Q1	Mark scheme
(f)	Value of P = candidate's gradient and value of Q = candidate's intercept. [1] Do not allow fractions. Unit for P correct (m kg^{-1} **or** cm kg^{-1} **or** mm kg^{-1} **or** m g^{-1} **or** cm g^{-1} **or** mm g^{-1}) and consistent with value. Unit for Q correct (m or cm or mm) and consistent with value. [1] **[2]** **[total: 20]**

EXAMINER COMMENTS

MARK SCHEME

Select page

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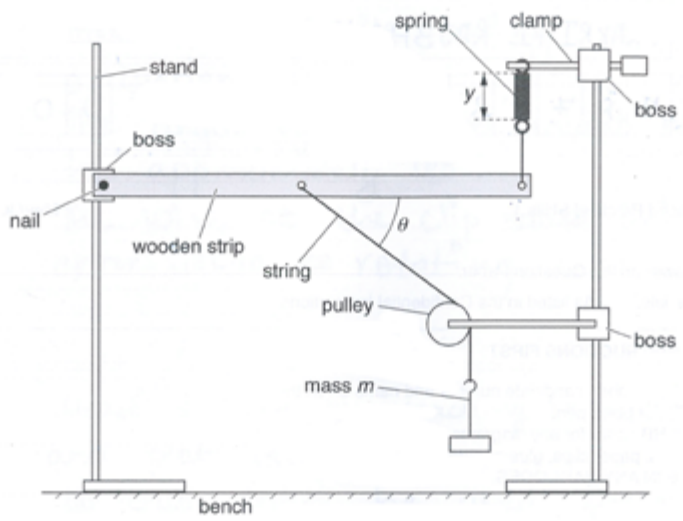

Fig. 1.1

The mass m should be 100 g.

The angle θ between the wooden strip and the string should be approximately 45°.

(ii) Adjust the apparatus so that the spring is vertical and the wooden strip is parallel to the bench.

(b) (i) Record the mass m.

$m =$ 100g. .....

(ii) Measure and record the length y of the coiled part of the spring.

$y = \frac{4.2 + 4.0 + 4.3}{3}$

$y =$ 4.2cm ..... [1]

(iii) Measure and record θ.

$\theta =$ 45° ..... [1]

	Your Mark
1(b)(ii)	
1(b)(iii)	
1(d)	
1(e)(i)	
1(e)(ii)	
1(e)(iii)	
1(f)	

Q1	Mark scheme
(b)(ii)	Value for y with unit in range 2.0 ≤ y ≤ 8.0 cm.
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EXAMINER COMMENTS

MARK SCHEME

(c) (i) Add 100 g to the mass hanger.

(ii) Adjust the height of the boss holding the nail until the wooden strip is parallel to the bench.

(iii) Measure and record m, y and θ.

$m =$ 200 g.

$y = \frac{4.8 + 4.9 + 5.0}{3}$

$y =$ 4.9 cm.

$\theta =$ 55°

Select page

HIGH | MIDDLE | LOW

	Your Mark
1(b)(ii)	
1(b)(iii)	
1(d)	
1(e)(i)	
1(e)(ii)	
1(e)(iii)	
1(f)	

Q1	Mark scheme
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EXAMINER COMMENTS

MARK SCHEME

(d) Change m and repeat **(c)(ii)** and **(c)(iii)** until you have six sets of values of m, y and θ.

You may include your values from **(b)** and **(c)**.

Include values of $m \sin\theta$ in your table.

S.No	m/g	y/cm	θ/°	m sin θ/g cm
1	~~100~~ 100	4·2	45	70·7
2	~~100~~ 150	4·6	50	114·9
3	~~250~~ 200	4·9	55	163·8
4	~~250~~ 250	6·0	60	216·5
5	~~350~~ 300	7·0	65	271·9
6	~~350~~ 350	7·8	70	328·9

[10]

(e) (i) Plot a graph of y on the y-axis against $m \sin\theta$ on the x-axis. [3]

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

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

Taking (80, 3·5) and (356, 8·2)

$\text{gradient} = \frac{\Delta y}{\Delta x} = \frac{8·2 - 3·5}{356 - 80} = 0·0170$

Taking (80, 3·5)

$y = mx + c$.

$3·5 = 0·0170 \times 80 + c$

$c = 2·14$

gradient = 0·0170.

y-intercept = 2·14.

[2]

	Your Mark
1(b)(ii)	
1(b)(iii)	
1(d)	
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1(e)(ii)	
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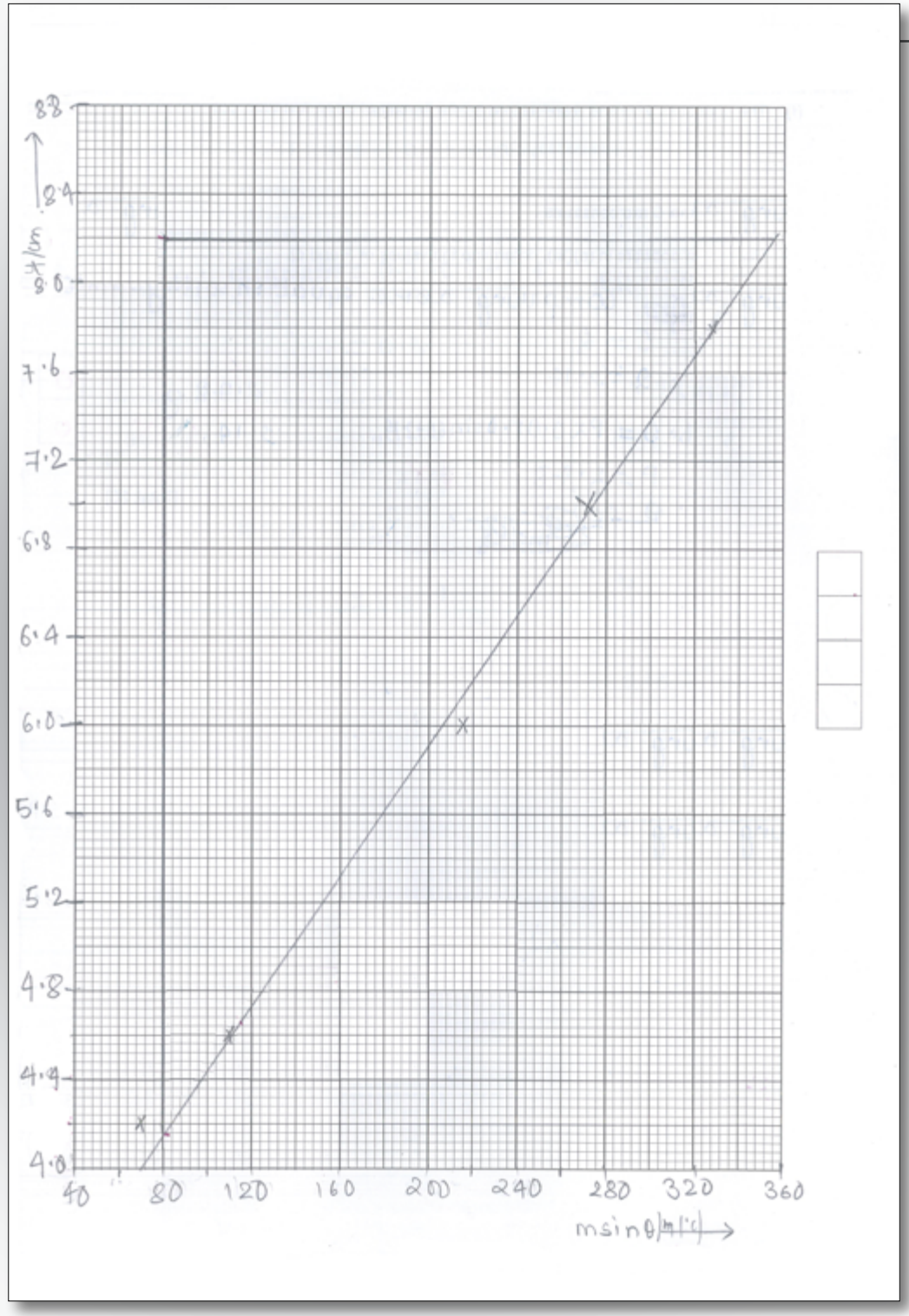

Select page

HIGH | MIDDLE | LOW

	Your Mark
1(b)(ii)	
1(b)(iii)	
1(d)	
1(e)(i)	
1(e)(ii)	
1(e)(iii)	
1(f)	

Q1	Mark scheme
(e)(ii)	**Line of best fit:** **[1]** Judge by balance of all points on the grid about the candidate's line (at least 5 points). There must be an even distribution of points either side of the line along the full length. Allow one anomalous point only if clearly indicated by the candidate. Lines must not be kinked or thicker than half a square
(e)(iii)	**Gradient:** [1] The hypotenuse of the triangle must be greater than half of the length of the drawn line. The method of calculation must be correct. Both read-offs must be accurate to half a small square in both the x and y directions. **y-intercept:** [1] Either: Correct read-off from a point on the line and substituted into $y = mx + c$. Read-offs must be accurate to half a small square in both x and y directions. **Or:** Intercept read off directly from the graph (accurate to half a small square). **[2]**

EXAMINER COMMENTS

MARK SCHEME

(f) The quantities y, m and θ are related by the equation

$$y = Pm\sin\theta + Q$$

where P and Q are constants.

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

comparing above equation with $y = mnt$

$C = Q$

$Q = 2 \cdot 14$

$6 \cdot 0 = P \times 0 \cdot 0170 \sin 60 + 2 \cdot 14$

$P = 2 \cdot 178$

$P =$ 2.178 g

$Q =$ 2.14

[2]

[Total: 20]

	Your Mark
1(b)(ii)	
1(b)(iii)	
1(d)	
1(e)(i)	
1(e)(ii)	
1(e)(iii)	
1(f)	

Q1	Mark scheme
(f)	Value of P = candidate's gradient and value of Q = candidate's intercept. [1] Do not allow fractions. Unit for P correct (m kg^{-1} **or** cm kg^{-1} **or** mm kg^{-1} **or** m g^{-1} **or** cm g^{-1} **or** mm g^{-1}) and consistent with value. Unit for Q correct (m or cm or mm) and consistent with value. [1] **[2]** **[total: 20]**

EXAMINER COMMENTS

MARK SCHEME

Cambridge Assessment International Education
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