Cambridge Assessment International Education

Interactive

Interactive Example Candidate Responses
Paper 3 (May/June 2016), Question 2

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.

2 In this experiment, you will investigate the movement of a loaded wire.

(a) (i) Take the **shorter** of the two wires.

(ii) Measure and record the diameter d of the wire.

$$\frac{0\cdot31 + 0\cdot29 + 0\cdot29}{3}$$
$= 0\cdot297$
$= 0\cdot30\text{mm}$

$(0\cdot30 \pm 0\cdot01)\text{mm}$

$d =$ ~~(0·3 ± 1·0)mm~~ [1]

(iii) Calculate the cross-sectional area A of the wire using

$$A = \frac{\pi d^2}{4}.$$

$$A = \frac{\pi(0\cdot30)^2}{4}$$
$= 0\cdot07067$
$= 0\cdot071\ \text{mm}^2.$

$A =$ 0.071mm² [1]

Select page

HIGH | MIDDLE | LOW

Your Mark

2(a)(ii)

2(a)(iii)

2(b)(iii)

2(b)(iv)

2(c)(i)

2(c)(ii)

2(d)(ii)

2(e)(ii)

2(f)(i)

2(f)(ii)

2(g)(i)

2(g)(ii)

Q2	Mark scheme
(a)(ii)	All raw values of d either to the nearest 0.01 or 0.001 mm with unit and in the range 0.250 mm to 0.450 mm **[1]**
(a)(iii)	Correct calculation of A with consistent unit and power of ten. **[1]**
(b)(iii)	Value of L with appropriate unit in range 10.0 cm ≤ L ≤ 20.0 cm. **[1]**
(b)(iv)	Percentage uncertainty in L based on absolute uncertainty of 2 mm to 8 mm. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. Correct method of calculation to obtain percentage uncertainty. **[1]**
(c)(i)	Correct calculation of C to the s.f. given by the candidate. **[1]**
(c)(ii)	Correct justification for s.f. in C linked to s.f. in d and L. **[1]**
(d)(ii)	Raw values for time to the nearest 0.1 s or better. T with unit and in range 0.5 s ≤ T ≤ 2.0 s. **[1]**
(e)(ii)	Second values of d and L. *Second value of T.* Quality: If $d_1 > d_2$ then second value of T > first value of T. **[1]**
(f)(i)	Two values of k calculated correctly. **[1]**
(f)(ii)	Sensible comment relating to the calculated values of k, testing against a criterion specified by the candidate. **[1]**

EXAMINER COMMENTS

MARK SCHEME

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(b) (i) Secure the hook of the mass hanger to one end of the wire leaving at least 20 cm of excess wire.
The wire may be wrapped around the hook several times.

(ii) Set up the apparatus as shown in Fig. 2.1.

The length L of wire between the clip and the hook of the mass hanger should be approximately 15 cm.

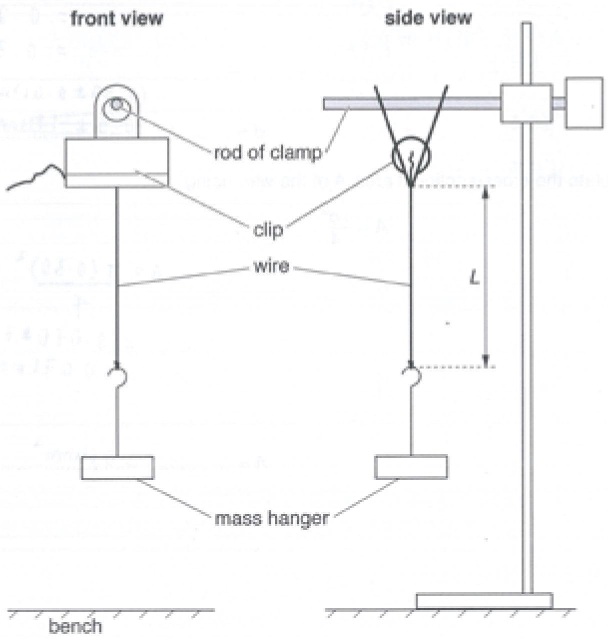

Fig. 2.1

(iii) Measure and record L.

$\frac{15.4 + 15.4}{2} = 15.4\text{cm}$

L = (15.4 ± 0.1) cm [1]

(iv) Estimate the percentage uncertainty in your value of L.

$\frac{0.1}{15.4} \times 100$

$= 0.65\%$

percentage uncertainty = 0.65% [1]

Your Mark	
2(a)(ii)	
2(a)(iii)	
2(b)(iii)	
2(b)(iv)	
2(c)(i)	
2(c)(ii)	
2(d)(ii)	
2(e)(ii)	
2(f)(i)	
2(f)(ii)	
2(g)(i)	
2(g)(ii)	

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EXAMINER COMMENTS

MARK SCHEME

(c) (i) Calculate C where

$1cm = 10mm$
$1cm^2 = 100mm^2$
$x = 0.071$
$x = 7.1 \times 10^{-6} cm^2$

$$C = \frac{\sqrt{L}}{A}.$$

$C = \frac{\sqrt{L}}{A}$
$= \frac{\sqrt{15.4}}{7.1 \times 10^{-6}}$ $= 553,000$
$= 552715.97$

$C =$ ......553,000 cm^{-1}...... [1]

(ii) Justify the number of significant figures that you have given for your value of C.

A has two significant figures, so to increase the accuracy, 3 significant figures were used for C.
..... [1]

(d) (i) Twist the mass hanger through approximately 180°.

Release the mass hanger. The mass hanger will oscillate as shown in Fig. 2.2.

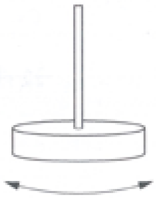

Fig. 2.2

(ii) Take measurements to determine the period T of the oscillations.

Record T.

$\frac{22.0 + 22.7}{42}$
$= 1.1s.$

$T =$ ......$(1.18 \pm 0.1)s$...... [1]

(iii) Remove the wire from the mass hanger.

Your Mark

2(a)(ii)
2(a)(iii)
2(b)(iii)
2(b)(iv)
2(c)(i)
2(c)(ii)
2(d)(ii)
2(e)(ii)
2(f)(i)
2(f)(ii)
2(g)(i)
2(g)(ii)

Q2	Mark scheme
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(a)(iii)	Correct calculation of A with consistent unit and power of ten. **[1]**
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Select page

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(e) (i) Take the **longer** wire. Repeat **(a)(ii)** and **(a)(iii)**.

$\frac{0.11 + 0.10 + 0.10}{3} = 0.103 = 0.10\,mm$

$d =$ $(0.10 \pm 0.01)\,mm$

$A =$ $0.0079\,mm^2$

(ii) Secure the hook of the mass hanger to one end of the wire leaving 40 cm of excess wire.
Repeat **(b)(ii)**, **(b)(iii)**, **(c)(i)** and **(d)** for a value of L of approximately 30 cm.

$\frac{\cancel{30.9}\ 29.9 + \cancel{30.9}\ 29.9}{2} = \cancel{30.4}\ 29.9$

$L =$ $(\cancel{30.9}\ 29.9 \pm 0.1)\,cm$

$C =$ ~~7,040,000~~ 6,920,000 cm^{-1}

$\cancel{52.97}\ \frac{26.2 + 26.2}{16} = 3.35$

$T =$ $(3.3 \pm 0.1)\,s$

[3]

Your Mark

2(a)(ii)

2(a)(iii)

2(b)(iii)

2(b)(iv)

2(c)(i)

2(c)(ii)

2(d)(ii)

2(e)(ii)

2(f)(i)

2(f)(ii)

2(g)(i)

2(g)(ii)

Q2	Mark scheme
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EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH MIDDLE LOW

(f) It is suggested that the relationship between T and C is

$$T = kC$$

where k is a constant.

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

$1.1 = k(553{,}000)$
$k = 1.99 \times 10^{-6}$

$3.3 = k(6{,}920{,}000)$
$k = 4.77 \times 10^{-7}$

first value of k = 1.99×10^{-6} ~~s~~ cms

second value of k = 4.77×10^{-7} cms [1]

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

$\frac{|k_1 - k_2|}{k_1} \times 100\%$
$= 76.03\%$

No, as the percentage ~~uncertai~~ uncertainty 76.03% is more than 20%.

[1]

Your Mark

2(a)(ii)
2(a)(iii)
2(b)(iii)
2(b)(iv)
2(c)(i)
2(c)(ii)
2(d)(ii)
2(e)(ii)
2(f)(i)
2(f)(ii)
2(g)(i)
2(g)(ii)

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EXAMINER COMMENTS

MARK SCHEME

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

1. Only two readings were taken to draw a conclusion which is insufficient.

2. The loop of wire around the mass hanger slips.

3. ~~Parallax error in measuring~~ Hard to measure length L as wire not straight.

4. Hard to ~~[illegible]~~ determine where is one oscillation of the mass hanger.

5. ~~Wire is not straight, hard to measure length~~ Parallax error in measuring L. [4]

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

1. More readings should have been taken and a graph plotted to get a more accurate conclusion.

2. Use adhesive tape to stick the wire to the mass hanger.

3. ~~Mark length L on the wire used and measure before attaching wire to clip.~~ Straighten wires by using a motor and running the wire through the motor.

4. ~~Take a~~ ~~The~~ Video camera with a timer should be used.

5. Mark length L on wire used and measure before attaching wire to clip. [4]

[Total: 20]

Your Mark

2(a)(ii)

2(a)(iii)

2(b)(iii)

2(b)(iv)

2(c)(i)

2(c)(ii)

2(d)(ii)

2(e)(ii)

2(f)(i)

2(f)(ii)

2(g)(i)

2(g)(ii)

Q2 Mark scheme

(g)	(i) Limitations **[4]**	(ii) Improvements **[4]**	Do not credit
A	Two readings not enough to draw a conclusion	Take many readings and plot a graph/ obtain more k values and compare	"Repeat readings" on its own/few readings/only one reading/not enough readings for accurate value
B	Difficult to judge beginning and/or end of a cycle/a complete cycle	Draw a line/mark on the mass/ (fiducial) marker at equilibrium position	
C	Wire not straight/ kinked	Method of straightening wire e.g. use larger mass	
D	Difficult to measure *L* with reason e.g. metre rule awkward to position/parallax error	Improved method of measuring *L* e.g. marking *L* before putting into clip/ detailed method using set squares or ruler/ use a length guide (e.g. 15 cm wood)/ use string with detail/ use tape measure	Vernier calipers on its own/ set square on its own/ 30 cm ruler on its own
E	Wire slips (in clip)	Better method of gripping wire e.g. wrap wire around clamp/use two wooden blocks and wire	Any reference to attaching the mass to the wire
F	Mass swings as well as rotates/ clip moves around rod/there is a force on release	Better method of attaching clip to rod e.g. glue	
G	Shorter/thicker wire has too few cycles/dampens quickly/ (percentage) uncertainty greater for shorter/thicker wire	Video and timer/replay frame by frame	Repeats Longer wire **[TOTAL: 18]**

EXAMINER COMMENTS

MARK SCHEME

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

2 In this experiment, you will investigate the movement of a loaded wire.

(a) (i) Take the shorter of the two wires.

(ii) Measure and record the diameter d of the wire.

0.01 × 38

$d =$ 0.38 mm [1]

(iii) Calculate the cross-sectional area A of the wire using

$$A = \frac{\pi d^2}{4}.$$

$\cancel{A = \frac{\pi (0.38)^2}{4} = 0.113}$ (0.00038)

$\cancel{= 1.13 \times 10^{-7}}$

1 m = 1000 mm
x = 0.38
0.00038 m.

$A = \frac{\pi (0.038)^2}{4}$

$= \cancel{0.0298}$

$= 1.13 \times 10^{-3}$

$A =$ ~~0.113 × 10⁻⁷ mm²~~ [1]

~~0.0298 cm²~~

$A = \boxed{1.13 \times 10^{-3}\ \text{cm}^2}$

Select page

HIGH MIDDLE LOW

Your Mark

2(a)(ii)

2(a)(iii)

2(b)(iii)

2(b)(iv)

2(c)(i)

2(c)(ii)

2(d)(ii)

2(e)(ii)

2(f)(i)

2(f)(ii)

2(g)(i)

2(g)(ii)

Q2	Mark scheme
(a)(ii)	All raw values of d either to the nearest 0.01 or 0.001 mm with unit and in the range 0.250 mm to 0.450 mm **[1]**
(a)(iii)	Correct calculation of A with consistent unit and power of ten. **[1]**
(b)(iii)	Value of L with appropriate unit in range 10.0 cm ≤ L ≤ 20.0 cm. **[1]**
(b)(iv)	Percentage uncertainty in L based on absolute uncertainty of 2 mm to 8 mm. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. Correct method of calculation to obtain percentage uncertainty. **[1]**
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EXAMINER COMMENTS

MARK SCHEME

(b) (i) Secure the hook of the mass hanger to one end of the wire leaving at least 20 cm of excess wire.
The wire may be wrapped around the hook several times.

(ii) Set up the apparatus as shown in Fig. 2.1.

The length L of wire between the clip and the hook of the mass hanger should be approximately 15 cm.

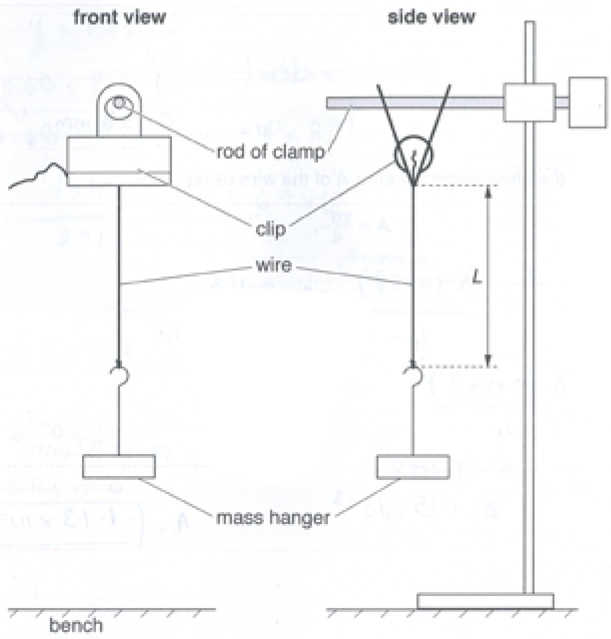

Fig. 2.1

(iii) Measure and record L.

15.40 cm.

L = ~~0.152m~~ ~~24.2 cm~~ ~~15.20cm~~ 15.40 cm [1]

(iv) Estimate the percentage uncertainty in your value of L.

$\frac{0.2}{\cancel{24.2}\ \cancel{15.2}\ 15.40} \times 100 = 1.3$

$= 1\%$

percentage uncertainty = 1 % [1]

Your Mark

2(a)(ii)
2(a)(iii)
2(b)(iii)
2(b)(iv)
2(c)(i)
2(c)(ii)
2(d)(ii)
2(e)(ii)
2(f)(i)
2(f)(ii)
2(g)(i)
2(g)(ii)

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EXAMINER COMMENTS

MARK SCHEME

Select page

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(c) (i) Calculate C where

$$C = \frac{\sqrt{L}}{A}.$$

$D \cdot 113 - mm^2$
$0 \cdot 00113 - cm$:

$C = \frac{\sqrt{15 \cdot 4}}{\cancel{0 \cdot 00113}\ \cancel{0 \cdot 113}}$
$0 \cdot 0298$

$C = \frac{\sqrt{15 \cdot 40}}{\cancel{1 \cdot 13 \ldots}\ 1 \cdot 13 \times 10^{-3}}$
$= 3472 \cdot 8$

$C =$ ~~34500~~ 3470 [1]

(ii) Justify the number of significant figures that you have given for your value of C.

The raw value of L and A are given to 3 significant figues so

[1]

(d) (i) Twist the mass hanger through approximately 180°.

Release the mass hanger. The mass hanger will oscillate as shown in Fig. 2.2.

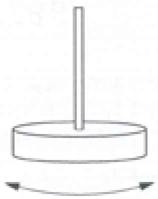

Fig. 2.2

(ii) Take measurements to determine the period T of the oscillations.

Record T.

T_1/s	T_2/s	T_3/s	T_{avg}/s
[illegible] 0·97	1·0	0·96	0·98

$T =$ ~~3·665~~ 0·985 [1]

(iii) Remove the wire from the mass hanger.

Your Mark

2(a)(ii)
2(a)(iii)
2(b)(iii)
2(b)(iv)
2(c)(i)
2(c)(ii)
2(d)(ii)
2(e)(ii)
2(f)(i)
2(f)(ii)
2(g)(i)
2(g)(ii)

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EXAMINER COMMENTS

MARK SCHEME

(e) (i) Take the **longer** wire. Repeat **(a)(ii)** and **(a)(iii)**.

$15 \times 0.01 = 0.15$

$d =$ ~~0.38mm~~ to 0.15 mm

$= \frac{\pi (1.5 \times 10^{-3})^2}{4} = 1.77 \times 10^{-6}$

$A =$ 1.77×10^{-6} cm^2

1.77×10^{-6}

(ii) Secure the hook of the mass hanger to one end of the wire leaving 40 cm of excess wire.
Repeat **(b)(ii)**, **(b)(iii)**, **(c)(i)** and **(d)** for a value of L of approximately 30 cm.

$L =$ 15.90 cm

15.20

$C = \frac{\sqrt{15.20}}{1.13 \times 10^{-3}}$

$C =$ 3450

T/s	T_2/s	T_3/s	T_{avg}/s
3.67	3.65	3.86	3.66

$T =$ 3.66 s.

[3]

Select page

HIGH | MIDDLE | LOW

Your Mark

2(a)(ii)

2(a)(iii)

2(b)(iii)

2(b)(iv)

2(c)(i)

2(c)(ii)

2(d)(ii)

2(e)(ii)

2(f)(i)

2(f)(ii)

2(g)(i)

2(g)(ii)

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(c)(ii)	Correct justification for s.f. in C linked to s.f. in d and L. **[1]**
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(e)(ii)	Second values of d and L. *Second value of T.* Quality: If $d_1 > d_2$ then second value of $T >$ first value of T. **[1]**
(f)(i)	Two values of k calculated correctly. **[1]**
(f)(ii)	Sensible comment relating to the calculated values of k, testing against a criterion specified by the candidate. **[1]**

EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH | MIDDLE | LOW

(f) It is suggested that the relationship between T and C is

$$T = kC$$

where k is a constant.

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

$k_1 = \frac{C}{T}$

$k_1 = \frac{3470}{0.98}$

$= 3540$

$k_2 = \frac{C}{T}$

$= \frac{3450}{3.66}$

$= 943$

first value of k = 3540

second value of k = 943

[1]

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

$\frac{3540 - 943}{3540} \times 100 = 73\%$

73% results of my investigation shows that it does not support the suggested relationship as it is greater than 30%.

[1]

Your Mark

2(a)(ii)

2(a)(iii)

2(b)(iii)

2(b)(iv)

2(c)(i)

2(c)(ii)

2(d)(ii)

2(e)(ii)

2(f)(i)

2(f)(ii)

2(g)(i)

2(g)(ii)

Q2	Mark scheme
(a)(ii)	All raw values of d either to the nearest 0.01 or 0.001 mm with unit and in the range 0.250 mm to 0.450 mm **[1]**
(a)(iii)	Correct calculation of A with consistent unit and power of ten. **[1]**
(b)(iii)	Value of L with appropriate unit in range 10.0 cm $\leq L \leq$ 20.0 cm. **[1]**
(b)(iv)	Percentage uncertainty in L based on absolute uncertainty of 2 mm to 8 mm. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. Correct method of calculation to obtain percentage uncertainty. **[1]**
(c)(i)	Correct calculation of C to the s.f. given by the candidate. **[1]**
(c)(ii)	Correct justification for s.f. in C linked to s.f. in d and L. **[1]**
(d)(ii)	Raw values for time to the nearest 0.1 s or better. T with unit and in range 0.5 s $\leq T \leq$ 2.0 s. **[1]**
(e)(ii)	Second values of d and L. *Second value of T.* Quality: If $d_1 > d_2$ then second value of T > first value of T. **[1]**
(f)(i)	Two values of k calculated correctly. **[1]**
(f)(ii)	Sensible comment relating to the calculated values of k, testing against a criterion specified by the candidate. **[1]**

EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH MIDDLE LOW

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

1. Two sets of readings are not enough to arrive at a valid conclusion.

2. Difficult to measure ~~the~~ T ~~because~~ for shorter wire, because it stops rotation very quickly and speed of rotation was high

3. The fans in the room affected rotation because wire is thin and light weight so it moved by wind as well.

4. The longer wire was very thin. It breaks when the clip ~~was~~ is tight or ~~if~~ if it is clipped several times. [4]

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

1. Take more readings and ~~plot~~ plot a graph or compare k values with more readings.

2. use a ~~vid~~ play back camera or a slow motion camera to find T.

3. Turn off the fans while doing the experiment.

4. ~~use a small ball of clay~~ use a cork and a a small ball of clay to hang the wire instead of the clip. [4]

[Total: 20]

Your Mark

2(a)(ii)

2(a)(iii)

2(b)(iii)

2(b)(iv)

2(c)(i)

2(c)(ii)

2(d)(ii)

2(e)(ii)

2(f)(i)

2(f)(ii)

2(g)(i)

2(g)(ii)

Q2 Mark scheme

(g)	(i) Limitations [4]	(ii) Improvements [4]	Do not credit
A	Two readings not enough to draw a conclusion	Take many readings and plot a graph/ obtain more k values and compare	"Repeat readings" on its own/few readings/only one reading/not enough readings for accurate value
B	Difficult to judge beginning and/or end of a cycle/a complete cycle	Draw a line/mark on the mass/ (fiducial) marker at equilibrium position	
C	Wire not straight/ kinked	Method of straightening wire e.g. use larger mass	
D	Difficult to measure *L* with reason e.g. metre rule awkward to position/parallax error	Improved method of measuring *L* e.g. marking *L* before putting into clip/ detailed method using set squares or ruler/ use a length guide (e.g. 15 cm wood)/ use string with detail/ use tape measure	Vernier calipers on its own/ set square on its own/ 30 cm ruler on its own
E	Wire slips (in clip)	Better method of gripping wire e.g. wrap wire around clamp/use two wooden blocks and wire	Any reference to attaching the mass to the wire
F	Mass swings as well as rotates/ clip moves around rod/there is a force on release	Better method of attaching clip to rod e.g. glue	
G	Shorter/thicker wire has too few cycles/dampens quickly/ (percentage) uncertainty greater for shorter/thicker wire	Video and timer/replay frame by frame	Repeats Longer wire

EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH MIDDLE LOW

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

2 In this experiment, you will investigate the movement of a loaded wire.

(a) (i) Take the **shorter** of the two wires.

(ii) Measure and record the diameter d of the wire.

$$\text{diameter} = \frac{0.2+0.3+0.4}{3}$$

$$= 0.3$$

$d =$ ....0.03 mm.........[1]

(iii) Calculate the cross-sectional area A of the wire using

$$A = \frac{\pi d^2}{4}.$$

$$A = \frac{\pi (0.03)^2}{4}$$

$$= 7.07 \times 10^{-4}$$

$A =$ ....$7.07 \times 10^{-4}\ mm^2$........[1]

Your Mark

2(a)(ii)

2(a)(iii)

2(b)(iii)

2(b)(iv)

2(c)(i)

2(c)(ii)

2(d)(ii)

2(e)(ii)

2(f)(i)

2(f)(ii)

2(g)(i)

2(g)(ii)

Q2	Mark scheme
(a)(ii)	All raw values of d either to the nearest 0.01 or 0.001 mm with unit and in the range 0.250 mm to 0.450 mm **[1]**
(a)(iii)	Correct calculation of A with consistent unit and power of ten. **[1]**
(b)(iii)	Value of L with appropriate unit in range 10.0 cm ≤ L ≤ 20.0 cm. **[1]**
(b)(iv)	Percentage uncertainty in L based on absolute uncertainty of 2 mm to 8 mm. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. Correct method of calculation to obtain percentage uncertainty. **[1]**
(c)(i)	Correct calculation of C to the s.f. given by the candidate. **[1]**
(c)(ii)	Correct justification for s.f. in C linked to s.f. in d and L. **[1]**
(d)(ii)	Raw values for time to the nearest 0.1 s or better. T with unit and in range 0.5 s ≤ T ≤ 2.0 s. **[1]**
(e)(ii)	Second values of d and L. *Second value of T.* Quality: If $d_1 > d_2$ then second value of T > first value of T. **[1]**
(f)(i)	Two values of k calculated correctly. **[1]**
(f)(ii)	Sensible comment relating to the calculated values of k, testing against a criterion specified by the candidate. **[1]**

EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH | MIDDLE | LOW

(b) (i) Secure the hook of the mass hanger to one end of the wire leaving at least 20 cm of excess wire.
The wire may be wrapped around the hook several times.

(ii) Set up the apparatus as shown in Fig. 2.1.

The length L of wire between the clip and the hook of the mass hanger should be approximately 15 cm.

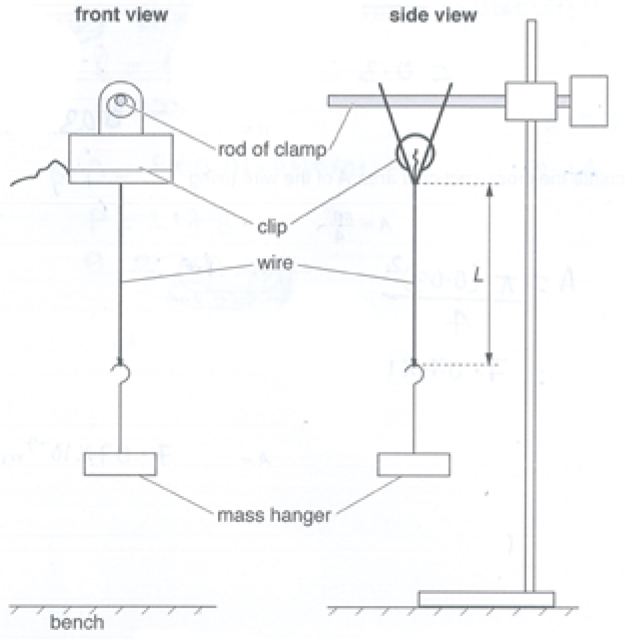

Fig. 2.1

(iii) Measure and record L.

~~[illegible]~~

$L = \frac{14 + 15 + 14.5}{3}$

L = 14.5cm. ~~[illegible]~~ [1]

(iv) Estimate the percentage uncertainty in your value of L.

Percentage Uncertainty $= \frac{\Delta L}{L} \times 100\%$

$= \frac{0.1}{14.5} \times 100\%$

percentage uncertainty = 0.689% [1]

Your Mark

2(a)(ii)

2(a)(iii)

2(b)(iii)

2(b)(iv)

2(c)(i)

2(c)(ii)

2(d)(ii)

2(e)(ii)

2(f)(i)

2(f)(ii)

2(g)(i)

2(g)(ii)

Q2	Mark scheme
(a)(ii)	All raw values of d either to the nearest 0.01 or 0.001 mm with unit and in the range 0.250 mm to 0.450 mm **[1]**
(a)(iii)	Correct calculation of A with consistent unit and power of ten. **[1]**
(b)(iii)	Value of L with appropriate unit in range 10.0 cm $\le L \le$ 20.0 cm. **[1]**
(b)(iv)	Percentage uncertainty in L based on absolute uncertainty of 2 mm to 8 mm. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. Correct method of calculation to obtain percentage uncertainty. **[1]**
(c)(i)	Correct calculation of C to the s.f. given by the candidate. **[1]**
(c)(ii)	Correct justification for s.f. in C linked to s.f. in d and L. **[1]**
(d)(ii)	Raw values for time to the nearest 0.1 s or better. T with unit and in range 0.5 s $\le T \le$ 2.0 s. **[1]**
(e)(ii)	Second values of d and L. *Second value of T.* Quality: If $d_1 > d_2$ then second value of $T >$ first value of T. **[1]**
(f)(i)	Two values of k calculated correctly. **[1]**
(f)(ii)	Sensible comment relating to the calculated values of k, testing against a criterion specified by the candidate. **[1]**

EXAMINER COMMENTS

MARK SCHEME

(c) (i) Calculate C where

$$C = \frac{\sqrt{L}}{A}.$$

$C = \frac{\sqrt{14.5 \times 10^{-1}}}{7.07 \times 10^{-4}}$

$= 1.70 \times 10^{3}$

$C =$ ......1.70×10^{3}...... [1]

(ii) Justify the number of significant figures that you have given for your value of C.

I've used three significant figure. As all my value of L and A are in three significant figure. [1]

(d) (i) Twist the mass hanger through approximately 180°

Release the mass hanger. The mass hanger will oscillate as shown in Fig. 2.2.

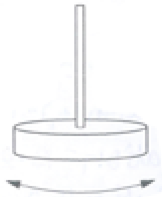

Fig. 2.2

(ii) Take measurements to determine the period T of the oscillations.

Record T.

Time taken for 10 oscillation(t_1) = 10.63.
Time taken for 1 oscillation(t_1) = 1.063.

Time taken for 10 oscillation = 12.78
Time taken for 1 oscillation(t_2) = 1.278

$T = \frac{t_1 + t_2}{2}$

$= 1.171$

$T =$ ......1.171s...... [1]

(iii) Remove the wire from the mass hanger.

Your Mark

2(a)(ii)

2(a)(iii)

2(b)(iii)

2(b)(iv)

2(c)(i)

2(c)(ii)

2(d)(ii)

2(e)(ii)

2(f)(i)

2(f)(ii)

2(g)(i)

2(g)(ii)

Q2	Mark scheme
(a)(ii)	All raw values of d either to the nearest 0.01 or 0.001 mm with unit and in the range 0.250 mm to 0.450 mm **[1]**
(a)(iii)	Correct calculation of A with consistent unit and power of ten. **[1]**
(b)(iii)	Value of L with appropriate unit in range 10.0 cm ≤ L ≤ 20.0 cm. **[1]**
(b)(iv)	Percentage uncertainty in L based on absolute uncertainty of 2 mm to 8 mm. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. Correct method of calculation to obtain percentage uncertainty. **[1]**
(c)(i)	Correct calculation of C to the s.f. given by the candidate. **[1]**
(c)(ii)	Correct justification for s.f. in C linked to s.f. in d and L. **[1]**
(d)(ii)	Raw values for time to the nearest 0.1 s or better. T with unit and in range 0.5 s ≤ T ≤ 2.0 s. **[1]**
(e)(ii)	Second values of d and L. *Second value of T.* Quality: If $d_1 > d_2$ then second value of $T >$ first value of T. **[1]**
(f)(i)	Two values of k calculated correctly. **[1]**
(f)(ii)	Sensible comment relating to the calculated values of k, testing against a criterion specified by the candidate. **[1]**

Select page

HIGH MIDDLE LOW

(e) (i) Take the **longer** wire. Repeat **(a)(ii)** and **(a)(iii)**.

$d = \frac{0.1 + 0.2}{2}$

$d =$ 0.15 mm

$A = \frac{\pi (0.015)^2}{4}$

$A =$ 1.76×10^{-4} mm^2

(ii) Secure the hook of the mass hanger to one end of the wire leaving 40 cm of excess wire.
Repeat **(b)(ii)**, **(b)(iii)**, **(c)(i)** and **(d)** for a value of L of approximately 30 cm.

$L = \frac{29.5 + 30 + 29}{3}$

$L =$ 29.5 cm

$C = \frac{\sqrt{29.5 \times 10^{-1}}}{1.76 \times 10^{-4}}$

$= 9.76 \times 10^3$

$C =$ 9.76×10^3.

Time taken for 10 oscillation = 13.78

Time taken for 1 oscillation (t_1) = 1.378

Time taken for 10 oscillation = 13.22

Time taken for 1 oscillation (t_2) = 1.322

$T = \frac{t_1 + t_2}{2}$

$T =$ 1.35 s

[3]

Your Mark

2(a)(ii)

2(a)(iii)

2(b)(iii)

2(b)(iv)

2(c)(i)

2(c)(ii)

2(d)(ii)

2(e)(ii)

2(f)(i)

2(f)(ii)

2(g)(i)

2(g)(ii)

Q2	Mark scheme
(a)(ii)	All raw values of d either to the nearest 0.01 or 0.001 mm with unit and in the range 0.250 mm to 0.450 mm **[1]**
(a)(iii)	Correct calculation of A with consistent unit and power of ten. **[1]**
(b)(iii)	Value of *L* with appropriate unit in range 10.0 cm ≤ *L* ≤ 20.0 cm. **[1]**
(b)(iv)	Percentage uncertainty in L based on absolute uncertainty of 2 mm to 8 mm. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. Correct method of calculation to obtain percentage uncertainty. **[1]**
(c)(i)	Correct calculation of *C* to the s.f. given by the candidate. **[1]**
(c)(ii)	Correct justification for s.f. in *C* linked to s.f. in d and *L*. **[1]**
(d)(ii)	Raw values for time to the nearest 0.1 s or better. *T* with unit and in range 0.5 s ≤ *T* ≤ 2.0 s. **[1]**
(e)(ii)	Second values of *d* and *L*. *Second value of T.* Quality: If $d_1 > d_2$ then second value of $T >$ first value of T. **[1]**
(f)(i)	Two values of k calculated correctly. **[1]**
(f)(ii)	Sensible comment relating to the calculated values of k, testing against a criterion specified by the candidate. **[1]**

EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH MIDDLE LOW

(f) It is suggested that the relationship between T and C is

$$T = kC$$

where k is a constant.

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

For first value .
$T = KC$
$1{\cdot}17 = K \times 1{\cdot}70 \times 10^3$
$K = 6{\cdot}88 \times 10^{-4}$

For second value.
$T = KC$.
$1{\cdot}35 = K \times 9{\cdot}76 \times 10^3$
$K = 1{\cdot}38 \times 10^{-4}$

first value of k = $6{\cdot}88 \times 10^{-4}$

second value of k = $1{\cdot}38 \times 10^{-4}$

[1]

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

The result ~~does not~~ supports the relationship because as the value of K increases the value of T also increases with it.

[1]

Your Mark

2(a)(ii)
2(a)(iii)
2(b)(iii)
2(b)(iv)
2(c)(i)
2(c)(ii)
2(d)(ii)
2(e)(ii)
2(f)(i)
2(f)(ii)
2(g)(i)
2(g)(ii)

Q2	Mark scheme
(a)(ii)	All raw values of d either to the nearest 0.01 or 0.001 mm with unit and in the range 0.250 mm to 0.450 mm **[1]**
(a)(iii)	Correct calculation of A with consistent unit and power of ten. **[1]**
(b)(iii)	Value of L with appropriate unit in range 10.0 cm ≤ L ≤ 20.0 cm. **[1]**
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(c)(i)	Correct calculation of C to the s.f. given by the candidate. **[1]**
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(f)(i)	Two values of k calculated correctly. **[1]**
(f)(ii)	Sensible comment relating to the calculated values of k, testing against a criterion specified by the candidate. **[1]**

EXAMINER COMMENTS

MARK SCHEME

Select page

HIGH MIDDLE LOW

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

1. Two sets of of data are not enough to draw conclusion.
2. ~~Parall.~~ Error while seeing the oscillation.
3. The angle of rotation might not be approximately 180°.
4. The wire at the clip ~~...~~ brings error while ~~...~~ rotating.

[4]

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

1. Aleast six sets of reading is required and plot its graph.
2. ~~DD~~ Sensor must be used for viewing the wire while it goes back and forth.
3. Protractor must be used to while rotating.
4. The wire must be glued at the top so that it doesnot move while rotating.

[4]

[Total: 20]

Your Mark

2(a)(ii)
2(a)(iii)
2(b)(iii)
2(b)(iv)
2(c)(i)
2(c)(ii)
2(d)(ii)
2(e)(ii)
2(f)(i)
2(f)(ii)
2(g)(i)
2(g)(ii)

Q2 Mark scheme

(g)	(i) Limitations [4]	(ii) Improvements [4]	Do not credit
A	Two readings not enough to draw a conclusion	Take many readings <u>and</u> plot a graph/ obtain more k values and <u>compare</u>	"Repeat readings" on its own/few readings/only one reading/not enough readings for accurate value
B	Difficult to judge beginning and/or end of a cycle/a complete cycle	Draw a line/mark on the mass/ (fiducial) marker at equilibrium position	
C	Wire not straight/ kinked	Method of straightening wire e.g. use larger mass	
D	Difficult to measure *L* with reason e.g. metre rule awkward to position/parallax error	Improved method of measuring *L* e.g. marking *L* before putting into clip/ detailed method using set squares or ruler/ use a length guide (e.g. 15 cm wood)/ use string with detail/ use tape measure	Vernier calipers on its own/ set square on its own/ 30 cm ruler on its own
E	Wire slips (in clip)	Better method of gripping wire e.g. wrap wire around clamp/use two wooden blocks and wire	Any reference to attaching the mass to the wire
F	Mass swings as well as rotates/ clip moves around rod/there is a force on release	Better method of attaching clip to rod e.g. glue	
G	Shorter/thicker wire has too few cycles/dampens quickly/ (percentage) uncertainty greater for shorter/thicker wire	Video and timer/replay frame by frame	Repeats Longer wire

EXAMINER COMMENTS

MARK SCHEME

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