
PHYSICS

9702/51

Paper 5 Planning, Analysis and Evaluation

May/June 2017

MARK SCHEME

Maximum Mark: 30

Published

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Question	Answer	Marks
1	Defining the problem	
	(sin) θ is the independent variable and v is the dependent variable or vary (sin) θ and measure v	1
	keep s (PQ) <u>constant</u>	1
	Methods of data collection	
	labelled diagram showing inclined plane with labelled support and P <u>and</u> Q marked	1
	method to measure angle e.g. use a protractor to measure θ or use a ruler to measure marked distances from which sin θ or θ may be determined	1
	method of timing for an appropriate distance to determine v (at Q) e.g. use a stopwatch/timer or correctly positioned light gate(s) connected to a timer/data-logger or correctly positioned motion sensor connected to data-logger	1
	measurement of an appropriate distance to determine v (at Q) e.g. rule to measure an appropriate length or length of a card to interrupt light beam or distance from motion sensor to Q	1
	Method of analysis	
	plot a graph of v^2 against sin θ	1
	relationship valid if a straight line produced (not passing through the origin)	1
	$g = -\text{gradient} \times \frac{B + m}{2ms}$ or $g = \text{y-intercept} \times \frac{B + m}{2Bs}$	1

Question	Answer	Marks
	Additional detail including safety considerations	Max. 6
D1	use cushion/foam/sandbox for <u>falling</u> body (<u>B</u>)	
D2	(sin) θ determined using trigonometry relationship using marked lengths	
D3	appropriate equation to determine v (at Q) e.g. $v = \frac{2s}{t}$	
D4	repeat experiment <u>for each</u> θ and average v or t	
D5	use of balance to measure mass of wooden block m <u>and</u> falling body B <u>and</u> rule to measure s	
D6	$y\text{-intercept} = \frac{2Bsg}{B + m}$.	
D7	clean surfaces of blocks/inclined plane/ensure surface of the plane is smooth	
D8	keep B <u>and</u> m constant or keep mass of block <u>and</u> mass of falling body constant	
D9	method to ensure that wooden block starts at the same position P, e.g. put a mark on the block or align front or back of block	
D10	method to prevent plane slipping so that angle being measured remains the same, e.g. a mass as a stop	

Question	Answer	Marks						
2(a)	$\text{gradient} = -\frac{2}{v}$ $y\text{-intercept} = \frac{2L}{v}$	1						
2(b)	<table><tr><td>0.80 ± 0.01</td></tr><tr><td>0.77 ± 0.01</td></tr><tr><td>0.73 ± 0.01</td></tr><tr><td>0.70 ± 0.01</td></tr><tr><td>0.66 ± 0.01</td></tr><tr><td>0.62 ± 0.01</td></tr></table> First mark for all values of t correct. Second mark for uncertainties correct.	0.80 ± 0.01	0.77 ± 0.01	0.73 ± 0.01	0.70 ± 0.01	0.66 ± 0.01	0.62 ± 0.01	2
0.80 ± 0.01								
0.77 ± 0.01								
0.73 ± 0.01								
0.70 ± 0.01								
0.66 ± 0.01								
0.62 ± 0.01								
2(c)(i)	Six points plotted correctly. Must be accurate to less than half a small square. No “blobs”. Diameter of points must be less than half a small square.	1						
	Error bars in t plotted correctly. All error bars to be plotted. Length of bar must be accurate to less than half a small square and symmetrical.	1						

Question	Answer	Marks
2(c)(ii)	Line of best fit drawn. If points are plotted correctly then upper end of line should pass between (4.8, 0.76) and (5.6, 0.76) and lower end of line should pass between (17.6, 0.64) and (18.8, 0.64). Line should not be from first to last plot.	1
	Worst acceptable line drawn (steepest or shallowest possible line). All error bars must be plotted.	1
2(c)(iii)	Gradient determined with a triangle that is at least half the length of the drawn line. Gradient must be negative.	1
	uncertainty = gradient of line of best fit – gradient of worst acceptable line or uncertainty = $\frac{1}{2}$ (steepest worst line gradient – shallowest worst line gradient)	1
2(c)(iv)	y-intercept read-off y-axis to less than half small square or determined by substitution into $y = mx + c$.	1
	uncertainty = y-intercept of line of best fit – y-intercept of worst acceptable line or uncertainty = $\frac{1}{2}$ (steepest worst line y-intercept – shallowest worst line y-intercept)	1
2(d)(i)	v determined from gradient and units for v <u>and</u> L correct with correct power of ten. $v = -\frac{2}{\text{gradient}} = -\frac{2}{2(c)(iii)}$	1
	L determined from y-intercept and v <u>and</u> L given to 2 or 3 significant figures. Correct substitution of numbers must be seen. $L = \frac{v}{2} \times \text{y-intercept} = \frac{v}{2} \times (c)(iv) = -\frac{\text{y-intercept}}{\text{gradient}} = -\frac{(c)(iv)}{(c)(iii)}$	1

Question	Answer	Marks
2(d)(ii)	% uncertainty in v = % uncertainty in gradient	1
	% uncertainty in L = % uncertainty in y-intercept + % uncertainty in gradient or % uncertainty in L = % uncertainty in y-intercept + % uncertainty in v Correct substitution of numbers must be seen. Maximum/minimum methods: $\text{Max } L = \text{max y-intercept} \times \text{max } v \text{ or } \frac{\text{max y-intercept}}{\text{min gradient}}$ $\text{Min } L = \text{min y-intercept} \times \text{min } v \text{ or } \frac{\text{min y-intercept}}{\text{max gradient}}$	1

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Question	Answer	Marks
1	Defining the problem	
	r is the independent variable and f (frequency of turntable) is the dependent variable or vary r and measure f (frequency of turntable)	1
	keep m <u>constant</u>	1
	Methods of data collection	
	labelled diagram showing power supply connected to <u>motor</u> (two leads) within turntable; circuits must be workable	1
	method to change frequency of rotation of the turntable, e.g. adjust output of (variable) power supply or adjust variable resistor	1
	increase frequency until the cube moves (relative to the turntable)	1
	method to determine period of rotation of the turntable, e.g. stopwatch, light gate attached to a timer/data-logger or stroboscope	1
	Method of analysis	
	plots a graph of f against $1/r$ (allow $\log f$ against $\log r$)	1
	relationship valid if a straight line produced passing through the origin (for $\lg f$ vs. $\lg r$ straight line of gradient of -1)	1
	$K = \text{gradient} \times 4\pi^2 m$ (for $\lg f$ vs. $\lg r$, $K = 10^{\text{y-intercept}} \times 4\pi^2 m$)	1

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Question	Answer	Marks
	Additional detail including safety considerations	Max. 6
	D1 use safety screen	
	D2 time at least 10 rotations of turntable or detailed use of stroboscope	
	D3 $f = 1 / T$ for correct determination of period of rotation of turntable	
	D4 repeat experiment for each r and average f	
	D5 use balance to measure mass of cube	
	D6 wait for turntable to rotate steadily before increasing frequency or gradual/incremental/slowly increase in frequency	
	D7 use a spirit level to check that turntable is horizontal or clean cube/surface	
	D8 use a rule to measure r	
	D9 method to ensure r is measured to the centre of the cube, e.g. put a mark on the cube or align front or back of cube by a set distance	
	D10 method to determine centre of the turntable e.g. measure two or more diameters/maximum distance ideas	

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Question	Answer	Marks														
2(a)	$\text{gradient} = \frac{1}{E}$ $y\text{-intercept} = \frac{Q}{E}$	1														
2(b)	<table><tr><th>P/Ω</th><th>$\frac{1}{I} / \text{A}^{-1}$</th></tr><tr><td>$\pm 9$</td><td>29 or 29.4</td></tr><tr><td>± 11</td><td>36 or 35.7</td></tr><tr><td>± 16.5</td><td>53 or 52.6</td></tr><tr><td>± 23.5</td><td>71 or 71.4</td></tr><tr><td>± 28</td><td>83 or 83.3</td></tr><tr><td>± 34</td><td>100</td></tr></table> First mark for uncertainties correct. Allow 1 s.f. e.g. 10, 10, 20, 20, 30, 30. Second mark for all second column correct. Allow a mixture of significant figures.	P/Ω	$\frac{1}{I} / \text{A}^{-1}$	± 9	29 or 29.4	± 11	36 or 35.7	± 16.5	53 or 52.6	± 23.5	71 or 71.4	± 28	83 or 83.3	± 34	100	2
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2(c)(i)	Six points plotted correctly. Must be accurate to less than half a small square. No “blobs”. Diameter of points must be less than half a small square.	1														
	Error bars in P plotted correctly. All error bars to be plotted. Length of bar must be accurate to less than half a small square and symmetrical.	1														

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Question	Answer	Marks
2(c)(ii)	Line of best fit drawn. If points are plotted correctly then lower end of line should pass between (200, 32) and (200, 34) and upper end of line should pass between (600, 88) and (600, 91).	1
	Worst acceptable line drawn (steepest or shallowest possible line). All error bars must be plotted.	1
2(c)(iii)	Gradient determined with a triangle that is at least half the length of the drawn line.	1
	uncertainty = gradient of line of best fit – gradient of worst acceptable line or uncertainty = $\frac{1}{2}$ (steepest worst line gradient – shallowest worst line gradient)	1
2(c)(iv)	y-intercept determined by substitution of correct point into $y = mx + c$.	1
	uncertainty = y-intercept of line of best fit – y-intercept of worst acceptable line or uncertainty = $\frac{1}{2}$ (steepest worst line y-intercept – shallowest worst line y-intercept)	1

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Question	Answer	Marks
2(d)(i)	E determined using gradient and units for E and Q with correct power of ten. $E = \frac{1}{\text{gradient}} = \frac{1}{2(c)(iii)}$	1
	Q determined using y -intercept and E and Q given to 2 or 3 significant figures. Correct substitution of numbers must be seen. $Q = E \times y\text{-intercept} = E \times 2(c)(iv) = \frac{y\text{-intercept}}{\text{gradient}} = \frac{2(c)(iv)}{2(c)(iii)}$	1
2(d)(ii)	% uncertainty in E = % uncertainty in gradient	1
	% uncertainty in Q = % uncertainty in E + % uncertainty in y -intercept or % uncertainty in Q = % uncertainty in gradient + % uncertainty in y -intercept. Correct substitution of numbers must be seen. Maximum/minimum methods: Max Q = max y -intercept $\times$ max E or $\frac{\text{max } y\text{-intercept}}{\text{min gradient}}$ Min Q = min y -intercept $\times$ min E or $\frac{\text{min } y\text{-intercept}}{\text{max gradient}}$	1

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	method to measure angle e.g. use a protractor to measure θ or use a ruler to measure marked distances from which sin θ or θ may be determined	1
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D5	use of balance to measure mass of wooden block m <u>and</u> falling body B <u>and</u> rule to measure s	
D6	$y\text{-intercept} = \frac{2Bsg}{B + m}$.	
D7	clean surfaces of blocks/inclined plane/ensure surface of the plane is smooth	
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	Worst acceptable line drawn (steepest or shallowest possible line). All error bars must be plotted.	1
2(c)(iii)	Gradient determined with a triangle that is at least half the length of the drawn line. Gradient must be negative.	1
	uncertainty = gradient of line of best fit – gradient of worst acceptable line or uncertainty = $\frac{1}{2}$ (steepest worst line gradient – shallowest worst line gradient)	1
2(c)(iv)	y-intercept read-off y-axis to less than half small square or determined by substitution into $y = mx + c$.	1
	uncertainty = y-intercept of line of best fit – y-intercept of worst acceptable line or uncertainty = $\frac{1}{2}$ (steepest worst line y-intercept – shallowest worst line y-intercept)	1
2(d)(i)	v determined from gradient and units for v <u>and</u> L correct with correct power of ten. $v = -\frac{2}{\text{gradient}} = -\frac{2}{2(c)(iii)}$	1
	L determined from y-intercept and v <u>and</u> L given to 2 or 3 significant figures. Correct substitution of numbers must be seen. $L = \frac{v}{2} \times \text{y-intercept} = \frac{v}{2} \times (c)(iv) = -\frac{\text{y-intercept}}{\text{gradient}} = -\frac{(c)(iv)}{(c)(iii)}$	1

Question	Answer	Marks
2(d)(ii)	% uncertainty in v = % uncertainty in gradient	1
	% uncertainty in L = % uncertainty in y-intercept + % uncertainty in gradient or % uncertainty in L = % uncertainty in y-intercept + % uncertainty in v Correct substitution of numbers must be seen. Maximum/minimum methods: $\text{Max } L = \text{max y-intercept} \times \text{max } v \text{ or } \frac{\text{max y-intercept}}{\text{min gradient}}$ $\text{Min } L = \text{min y-intercept} \times \text{min } v \text{ or } \frac{\text{min y-intercept}}{\text{max gradient}}$	1