
PHYSICS

9702/51

Paper 5 Planning, Analysis and Evaluation

May/June 2017

MARK SCHEME

Maximum Mark: 30

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

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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 -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)	gradient = $-\frac{2}{v}$ y-intercept = $\frac{2L}{v}$	1						
2(b)	<table border="1" style="margin-left: auto; margin-right: auto;"> <tbody> <tr><td style="text-align: center;">0.80 ± 0.01</td></tr> <tr><td style="text-align: center;">0.77 ± 0.01</td></tr> <tr><td style="text-align: center;">0.73 ± 0.01</td></tr> <tr><td style="text-align: center;">0.70 ± 0.01</td></tr> <tr><td style="text-align: center;">0.66 ± 0.01</td></tr> <tr><td style="text-align: center;">0.62 ± 0.01</td></tr> </tbody> </table> <p>First mark for all values of t correct. Second mark for uncertainties correct.</p>	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
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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 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: Max $L =$ max y -intercept \times max v or $\frac{\text{max } y\text{-intercept}}{\text{min gradient}}$ Min $L =$ min y -intercept \times min v or $\frac{\text{min } y\text{-intercept}}{\text{max gradient}}$	1