Cambridge International AS & A Level

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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) constant	**1**
	Methods of data collection	
	labelled diagram showing inclined plane with labelled support **and** P and 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** $g = y\text{-intercept} \times \frac{B+m}{2Bs}$	**1**

Question	Answer	Marks
	Additional detail including safety considerations	**Max. 6**
	D1 use cushion/foam/sandbox for falling body (*B*)	
	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 for each θ and average *v* or *t*	
	D5 use of balance to measure mass of wooden block *m* and falling body *B* and 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* and *m* constant or keep mass of block and 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	

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Question	Answer	Marks
2(a)	gradient = $-\frac{2}{v}$ y-intercept = $\frac{2L}{v}$	**1**
2(b)	0.80 ± 0.01 0.77 ± 0.01 0.73 ± 0.01 0.70 ± 0.01 0.66 ± 0.01 0.62 ± 0.01 First mark for all values of t correct. Second mark for uncertainties correct.	**2**
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**

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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 = ½ (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 = ½ (steepest worst line *y*-intercept – shallowest worst line *y*-intercept)	**1**
2(d)(i)	*v* determined from gradient **and** units for *v* and *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* and *L* given to 2 or 3 significant figures. Correct substitution of numbers must be seen. $L = \frac{v}{2} \times y\text{-intercept} = \frac{v}{2} \times (c)(iv) = -\frac{y\text{-intercept}}{\text{gradient}} = -\frac{(c)(iv)}{(c)(iii)}$	**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: $\text{Max}\,L = \text{max}\,y\text{-intercept} \times \text{max}\,v$ or $\dfrac{\text{max}\,y\text{-intercept}}{\text{min gradient}}$ $\text{Min}\,L = \text{min}\,y\text{-intercept} \times \text{min}\,v$ or $\dfrac{\text{min}\,y\text{-intercept}}{\text{max gradient}}$	**1**