Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/53**

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.

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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**
	$g = -\text{gradient} \times \dfrac{B+m}{2ms}$ **or** $g = y\text{-intercept} \times \dfrac{B+m}{2Bs}$	**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	

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**

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. $v = -\frac{2}{\text{gradient}} = -\frac{2}{2\text{(c)(iii)}}$	**1**
	L determined from *y*-intercept **and** *v* and *L* given to 2 or 3 significant figures. Correct substitution of numbers must be seen. $L = \frac{v}{2} \times y\text{-intercept} = \frac{v}{2} \times \text{(c)(iv)} = -\frac{y\text{-intercept}}{\text{gradient}} = -\frac{\text{(c)(iv)}}{\text{(c)(iii)}}$	**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**