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**PHYSICS**

**9702/53**

Paper 5 Planning, Analysis and Evaluation

**May/June 2017**

MARK SCHEME

Maximum Mark: 30

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**Published**

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This document consists of **6** printed pages.

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

Question	Answer	Marks
	<b>Additional detail including safety considerations</b>	<b>Max. 6</b>
D1	use cushion/foam/sandbox for <u>falling</u> body ( <u>B</u> )	
D2	(sin) $\theta$ 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> $\theta$ 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>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> </tbody> </table> <p>First mark for all values of <math>t</math> 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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0.73 ± 0.01								
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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) <b>and</b> 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 <b>or</b> 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 <b>or</b> uncertainty = $\frac{1}{2}$ (steepest worst line y-intercept – shallowest worst line y-intercept)	1
2(d)(i)	v determined from gradient <b>and</b> 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 <b>and</b> 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 <b>or</b> % uncertainty in $L$ = % uncertainty in $y$ -intercept + % uncertainty in $v$  Correct substitution of numbers must be seen.  Maximum/minimum methods: $\text{Max } L = \text{max } y\text{-intercept} \times \text{max } v \text{ or } \frac{\text{max } y\text{-intercept}}{\text{min gradient}}$ $\text{Min } L = \text{min } y\text{-intercept} \times \text{min } v \text{ or } \frac{\text{min } y\text{-intercept}}{\text{max gradient}}$	1