Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/53**

Paper 5 Planning, Analysis and Evaluation **October/November 2019**

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	**Additional detail including safety considerations**		
	D1	use large box/tray to collect ball (to prevent ball rolling on floor/bouncing) **or** reasoned method to avoid draughts, e.g. switch off fans, close windows, use a screen	**6**
	D2	method to determine P from correct circuit, e.g. $P = I \times V$ or use wattmeter to measure P	
	D3	stand on bench with clamped rule vertically to measure vertical distance	
	D4	method to ensure clamped rule to measure h is vertical, e.g. correctly positioned set square indicated at right angles between the rule and the horizontal surface **or** plumb line shown in appropriate position	
	D5	$r = d / 2$ when diameter measured	
	D6	repeat diameter measurement in different directions and find average	
	D7	repeat experiment for each value of r and determine average h	
	D8	method to determine h, e.g. h = reading top of ball – r – top of blower **or** h = reading bottom of ball + r – top of blower **or** h = (distance from top of ball to top of blower + distance from bottom of ball to top of blower) / 2	
	D9	wait for the ball to become stationary (vertically)	
	D10	video (camera) shown level with elevated ball and description of playback frame-by-frame or slow motion	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>gradient = q

and
y-intercept = $\lg\left(\frac{2\pi}{\sqrt{k}}\right) = \lg 2\pi - \frac{1}{2}\lg k$</td><td>1</td></tr>
<tr><td rowspan="5">2(b)</td><td><table><tr><th>T / s</th><th>lg (T / s)</th></tr><tr><td>1.56</td><td>0.193 or 0.1931</td></tr><tr><td>1.79</td><td>0.253 or 0.2529</td></tr><tr><td>1.97</td><td>0.294 or 0.2945</td></tr><tr><td>2.14</td><td>0.330 or 0.3304</td></tr><tr><td>2.31</td><td>0.364 or 0.3636</td></tr><tr><td>2.45</td><td>0.389 or 0.3892</td></tr></table></td><td></td></tr>
<tr><td>Values of T as above.</td><td>1</td></tr>
<tr><td>Values of lg T as above.</td><td>1</td></tr>
<tr><td>Uncertainties in T all ±0.04.</td><td>1</td></tr>
<tr><td>Uncertainties in lg (T/s) consistent with uncertainties in T e.g. from ±0.011 to ±0.007.</td><td>1</td></tr>
</table>

Question	Answer	Marks
2(c)(i)	Six points plotted correctly. Must be accurate to the nearest half a small square. Diameter of points must be less than half a small square.	**1**
	Error bars in lg *T* plotted correctly. All error bars must be plotted. Length of bar must be accurate to less than half a small square and symmetrical.	**1**
2(c)(ii)	Line of best fit drawn. Lower end of line should pass between (2.22, 0.22) and (2.25, 0.22) **and** upper end of line should pass between (2.49, 0.34) and (2.51, 0.34). Do not accept line from first to last plot.	**1**
	Worst acceptable line drawn (steepest or shallowest possible line that passes through all the error bars). All error bars must be plotted.	**1**
2(c)(iii)	Gradient determined with clear substitution of data points from the line of best fit into $\Delta y / \Delta x$. Distance between data points must be greater than half the length of the drawn line.	**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 determined by substitution of correct point from the line of best fit into $y = mx + c$.	**1**
2(d)	*k* determined from *y*-intercept. $k\left(=\left(\frac{2\pi}{10^{y\text{-intercept}}}\right)^2\right)=\left(\frac{2\pi}{10^{\textbf{(c)(iv)}}}\right)^2$	**1**
	q = answer to **(c)(iii) and** given to 2 or 3 significant figures.	**1**

Question	Answer	Marks
2(e)	*M* determined from **(d) or (c)(iii) and (c)(iv)** with correct substitution shown. $M = \sqrt[q]{\frac{T\sqrt{k}}{2\pi}} = \sqrt[q]{\frac{\sqrt{k}}{2\pi}} = \sqrt[2q]{\frac{k}{4\pi^2}}$ **or** $\lg M = \frac{(\lg 1) - \lg\left(\frac{2\pi}{\sqrt{k}}\right)}{q}$ $\lg M = -\frac{y\text{-intercept}}{\text{gradient}} = -\frac{\textbf{(c)(iv)}}{\textbf{(c)(iii)}}$ $M = 10^{\left(-\frac{\textbf{(c)(iv)}}{\textbf{(c)(iii)}}\right)}$	**1**