PHYSICS **9702/52**

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/cage 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 expression to determine k from relevant experiment, e.g. $k = mg / x$ or gradient of F–x graph	
	D3 stand on bench with <u>clamped</u> rule <u>vertically</u> to measure vertical distance	
	D4 method to ensure <u>clamped rule to measure h</u> is vertical, e.g. correctly positioned set square indicated at right angles between the rule <u>and</u> the horizontal surface **or** plumb line shown in appropriate position	
	D5 $r = d / 2$ when diameter measured	
	D6 repeat diameter measurement in <u>different </u>directions <u>and</u> find average	
	D7 repeat experiment for each value of x <u>and</u> determine average h	
	D8 method to securely fix spring to the bench e.g. tape/G-clamp	
	D9 experiment to determine $k,$ e.g. place mass m on the spring and measure compression x	
	D10 video (camera) shown level (by eye) with elevated ball and description of play back frame by frame or slow motion	

Question	Answer	Marks
2(a)	gradient = q **and** y-intercept = lg p	**1**
2(b)	<table><tr><td>R / 10^3 Ω</td><td>lg (R / 10^3 Ω)</td></tr><tr><td>9.4 or 9.40</td><td>0.97 or 0.973</td></tr><tr><td>5.9 or 5.88</td><td>0.77 or 0.771 or 0.769</td></tr><tr><td>3.9 or 3.92</td><td>0.59 or 0.591 or 0.593</td></tr><tr><td>2.5 or 2.54</td><td>0.40 or 0.398 or 0.405</td></tr><tr><td>1.7 or 1.71</td><td>0.23 or 0.230 or 0.233</td></tr><tr><td>1.1 or 1.08</td><td>0.04 or 0.041 or 0.033</td></tr></table>	
	Values of R as above.	**1**
	Values of lg R as above.	**1**
	Uncertainties in R from (±0.9 to ±1.2) to (±0.02 to ±0.03) **and** row 2 between ±0.40 and ±0.50 **and** row 4 between ±0.09 and ±0.10.	**1**
	Uncertainties in lg R consistent with uncertainties in R e.g. from ±0.05 to ±0.01.	**1**
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 R plotted correctly. All error bars must 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. Upper end of line should pass between (2.500, 0.70) and (2.502, 0.70) **and** lower end of line should pass between (2.528, 0.30) and (2.532, 0.30). Do not accept line from first to last point.	**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. 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 determined by substitution of correct point from the line of best fit into $y = mx + c$.	**1**
2(d)	p determined from y-intercept. $p \ (= 10^{y\text{-intercept}}) = 10^{\textbf{(c)(iv)}}$	**1**
	q = answer to **(c)(iii) and** given to 2 or 3 significant figures.	**1**

Question	Answer	Marks
2(e)	T determined from **(d) or (c)(iii) and (c)(iv)** with correct substitution shown. $$T = \sqrt[q]{\frac{R}{p}} = \sqrt[q]{\frac{15}{p}}$$ **or** $$\lg T = \frac{\lg 15 - \lg p}{q} = \frac{1.176 - \lg p}{q}$$ $$\lg T = \frac{\lg 15 - y\text{-intercept}}{\text{gradient}} = \frac{1.176 - \textbf{(c)(iv)}}{\textbf{(c)(iii)}}$$ $$T = 10^{\left(\frac{1.176 - \textbf{(c)(iv)}}{\textbf{(c)(iii)}}\right)}$$	**1**