Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/51**

Paper 5 Planning, Analysis and Evaluation **October/November 2017**

MARK SCHEME

Maximum Mark: 30

Published

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Question	Answer	Marks
1	**Defining the problem**	
	d is the independent variable and *R* is the dependent variable **or** vary *d* and measure *R*	**1**
	keep intensity/power of light source constant	**1**
	Methods of data collection	
	labelled diagram showing a light source fixed above container of water with the labelled LDR positioned in the beaker	**1**
	correct circuit diagram to measure *R*, e.g. *V* and *I* methods or ohmmeter	**1**
	method to determine *R*, e.g. $R = \frac{\text{p.d. across LDR}}{\text{current}}$ or read off ohmmeter	**1**
	method to determine *d*, e.g. use a ruler or drawn labelled vertical ruler adjacent to container with *d* indicated	**1**
	Method of analysis	
	plots a graph of *R* against d^2	**1**
	relationship valid if a straight line produced passing through the origin	**1**
	$K = \frac{4\pi}{\text{gradient}}$	**1**

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Question	Answer		Marks
1	**Additional detail including safety considerations**		**Max. 6**
	D1	dark glasses to prevent damage to eyes due to light source **or** do not look directly at light source **or** do not touch hot lamp/use gloves to position hot lamp/heat-proof gloves to position lamp	
	D2	dark room or shielding LDR (so as to avoid light from other sources)	
	D3	use high intensity lamp or collimated beam or laser	
	D4	method described to check that current in light source is constant, e.g. use an ammeter and variable resistor / variable power supply	
	D5	keep position of light source constant or distance between light source and LDR constant	
	D6	light source is placed close to water surface to increase intensity/reduce reflections **or** light source is placed further away to make it more directional	
	D7	use tall container to give a wide range of *d* or *R* or to reduce uncertainties **or** use a wide container to reduce reflections	
	D8	method to position ruler vertically to measure *d* described e.g. use a set square/spirit level	
	D9	use of horizontal fiducial mark from ruler to meniscus or middle of LDR, e.g. pin **or** *d* = reading on rule at surface – reading at top of LDR	
	D10	ensure that the electrical connections/wire to the LDR are waterproof	

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>gradient = $-\frac{2mg}{s}$

y-intercept = mg</td><td>1</td></tr>
<tr><td>2(b)</td><td><table><tr><td>$(T_1 - T_2)$ / N</td></tr><tr><td>5.5 ± 0.2</td></tr><tr><td>4.6 ± 0.2</td></tr><tr><td>3.6 ± 0.2</td></tr><tr><td>2.8 ± 0.2</td></tr><tr><td>1.9 ± 0.2</td></tr><tr><td>1.3 ± 0.2</td></tr></table>
First mark for column heading and values of $(T_1 - T_2)$ / N.

Second mark for all uncertainties = ±0.2.</td><td>2</td></tr>
<tr><td rowspan="2">2(c)(i)</td><td>Six points plotted correctly.
Must be within half a small square. Diameter of points must be less than half a small square</td><td>1</td></tr>
<tr><td>Error bars in P plotted correctly.
All error bars to be plotted. Length of bar must be accurate to less than half a small square and symmetrical.</td><td>1</td></tr>
</table>

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Question	Answer	Marks
2(c)(ii)	Line of best fit drawn. Must not be drawn from top point to bottom point. If points are plotted correctly then upper end of line should pass between (0.125, 5.0) and (0.140, 5.0) **and** lower end of line should pass between (0.360, 1.5) and (0.380, 1.5).	**1**
	Worst acceptable line drawn correctly (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. 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 from substitution into $y = mx + c$.	**1**
	y-intercept determined using gradient of worst acceptable line. 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) No ECF from false origin method.	**1**

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Question	Answer	Marks
2(d)(i)	*m* determined using candidate's *y*-intercept **and** correct units for *m* and *s*. $m = \frac{y\text{-intercept}}{g} = \frac{y\text{-intercept}}{9.81}$	**1**
	s determined using candidate's gradient **and** *m* and *s* given to 2 or 3 significant figures. Correct substitution of numbers must be seen. $s = \frac{-2mg}{\text{gradient}} = \frac{-2 \times y\text{-intercept}}{\text{gradient}}$	**1**
2(d)(ii)	percentage uncertainty in *m* = percentage uncertainty in *y*-intercept	**1**
	percentage uncertainty in *s* = percentage uncertainty in gradient + percentage uncertainty in *y*-intercept **or** percentage uncertainty in *s* = percentage uncertainty in gradient + percentage uncertainty *m* Maximum/minimum methods: $\max s = \frac{-2 \times \max y\text{-intercept}}{\text{min gradient}}$ **or** $\frac{-2g \times \max m}{\text{min gradient}}$ $\min s = \frac{-2 \times \min y\text{-intercept}}{\text{max gradient}}$ **or** $\frac{-2g \times \min m}{\text{max gradient}}$ Correct substitution of numbers must be seen.	**1**

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