Cambridge International AS & A Level

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PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2017**

MARK SCHEME

Maximum Mark: 30

Published

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Question	Answer	Marks
1	**Defining the problem**	
	r is the independent variable and *f* (frequency of turntable) is the dependent variable **or** vary *r* and measure *f* (frequency of turntable)	**1**
	keep *m* constant	**1**
	Methods of data collection	
	labelled diagram showing power supply connected to motor (two leads) within turntable; circuits must be workable	**1**
	method to change frequency of rotation of the turntable, e.g. adjust output of (variable) power supply or adjust variable resistor	**1**
	increase frequency until the cube moves (relative to the turntable)	**1**
	method to determine period of rotation of the turntable, e.g. stopwatch, light gate attached to a timer/data-logger or stroboscope	**1**
	Method of analysis	
	plots a graph of *f* against 1 / *r* (allow log *f* against log *r*)	**1**
	relationship valid if a straight line produced passing through the origin (for lg *f* vs. lg *r* straight line of gradient of –1)	**1**
	K = gradient × $4\pi^2 m$ (for lg *f* vs. lg *r*, $K = 10^{y\text{-intercept}} \times 4\pi^2 m$)	**1**

Question	Answer		Marks
	Additional detail including safety considerations		**Max. 6**
	D1	use safety screen	
	D2	time at least 10 rotations of turntable or detailed use of stroboscope	
	D3	$f = 1 / T$ for correct determination of period of rotation of turntable	
	D4	repeat experiment for each r and average f	
	D5	use balance to measure mass of cube	
	D6	wait for turntable to rotate steadily before increasing frequency **or** gradual/incremental/slowly increase in frequency	
	D7	use a spirit level to check that turntable is horizontal **or** clean cube/surface	
	D8	use a rule to measure r	
	D9	method to ensure r is measured to the centre of the cube, e.g. put a mark on the cube or align front or back of cube by a set distance	
	D10	method to determine centre of the turntable e.g. measure two or more diameters/maximum distance ideas	

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>gradient = $\frac{1}{E}$
y-intercept = $\frac{Q}{E}$</td><td>1</td></tr>
<tr><td>2(b)</td><td><table><tr><th>P / Ω</th><th>$\frac{1}{I}$ / A^{-1}</th></tr><tr><td>± 9</td><td>29 or 29.4</td></tr><tr><td>± 11</td><td>36 or 35.7</td></tr><tr><td>± 16.5</td><td>53 or 52.6</td></tr><tr><td>± 23.5</td><td>71 or 71.4</td></tr><tr><td>± 28</td><td>83 or 83.3</td></tr><tr><td>± 34</td><td>100</td></tr></table>First mark for uncertainties correct. Allow 1 s.f. e.g. 10, 10, 20, 20, 30, 30.
Second mark for all second column correct. Allow a mixture of significant figures.</td><td>2</td></tr>
<tr><td rowspan="2">2(c)(i)</td><td>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.</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. If points are plotted correctly then lower end of line should pass between (200, 32) and (200, 34) **and** upper end of line should pass between (600, 88) and (600, 91).	**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.	**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 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**

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Question	Answer	Marks
2(d)(i)	*E* determined using gradient **and** units for *E* and *Q* with correct power of ten. $E = \frac{1}{\text{gradient}} = \frac{1}{2(c)(iii)}$	**1**
	Q determined using *y*-intercept **and** *E* and *Q* given to 2 or 3 significant figures. Correct substitution of numbers must be seen. $Q = E \times y\text{-intercept} = E \times 2(c)(iv) = \frac{y\text{-intercept}}{\text{gradient}} = \frac{2(c)(iv)}{2(c)(iii)}$	**1**
2(d)(ii)	% uncertainty in *E* = % uncertainty in gradient	**1**
	% uncertainty in *Q* = % uncertainty in *E* + % uncertainty in *y*-intercept **or** % uncertainty in *Q* = % uncertainty in gradient + % uncertainty in *y*-intercept. Correct substitution of numbers must be seen. Maximum/minimum methods: $\text{Max}Q = \max y\text{-intercept} \times \max E$ or $\frac{\max y\text{-intercept}}{\min \text{gradient}}$ $\text{Min}Q = \min y\text{-intercept} \times \min E$ or $\frac{\min y\text{-intercept}}{\max \text{gradient}}$	**1**