Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/52**

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

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	**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 $\times 4\pi^2 m$ (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	

<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>

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**

Question	Answer	Marks
2(d)(i)	E determined using gradient **and** units for E and Q with correct power of ten. $E = \frac{1}{\text{gradient}} = \frac{1}{2\text{(c)(iii)}}$	**1**
	Q determined using y-intercept **and** E and Q given to 2 or 3 significant figures. Correct substitution of numbers must be seen. $Q = E \times y\text{-intercept} = E \times 2\text{(c)(iv)} = \frac{y\text{-intercept}}{\text{gradient}} = \frac{2\text{(c)(iv)}}{2\text{(c)(iii)}}$	**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**