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**PHYSICS****9702/52**

Paper 5 Planning, Analysis and Evaluation

**May/June 2017**

MARK SCHEME

Maximum Mark: 30

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**Published**

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This document consists of **6** printed pages.

Question	Answer	Marks
1	<b>Defining the problem</b>	
	$r$ is the independent variable and $f$ (frequency of turntable) is the dependent variable <b>or</b> vary $r$ and measure $f$ (frequency of turntable)	1
	keep $m$ <u>constant</u>	1
	<b>Methods of data collection</b>	
	labelled diagram showing power supply connected to <u>motor</u> (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
	<b>Method of analysis</b>	
	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
	$K = \text{gradient} \times 4\pi^2 m$ (for $\lg f$ vs. $\lg r$ , $K = 10^{\text{y-intercept}} \times 4\pi^2 m$ )	1

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Question	Answer	Marks
	<b>Additional detail including safety considerations</b>	<b>Max. 6</b>
	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 <b>or</b> gradual/incremental/slowly increase in frequency	
	D7 use a spirit level to check that turntable is horizontal <b>or</b> 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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Question	Answer	Marks														
2(a)	gradient = $\frac{1}{E}$ y-intercept = $\frac{Q}{E}$	1														
2(b)	<table border="1" data-bbox="685 403 1552 815"> <thead> <tr> <th data-bbox="685 403 949 499"><math>P/\Omega</math></th> <th data-bbox="949 403 1552 499"><math>\frac{1}{I} / \text{A}^{-1}</math></th> </tr> </thead> <tbody> <tr> <td data-bbox="685 499 949 552">± 9</td> <td data-bbox="949 499 1552 552">29 or 29.4</td> </tr> <tr> <td data-bbox="685 552 949 604">± 11</td> <td data-bbox="949 552 1552 604">36 or 35.7</td> </tr> <tr> <td data-bbox="685 604 949 657">± 16.5</td> <td data-bbox="949 604 1552 657">53 or 52.6</td> </tr> <tr> <td data-bbox="685 657 949 710">± 23.5</td> <td data-bbox="949 657 1552 710">71 or 71.4</td> </tr> <tr> <td data-bbox="685 710 949 762">± 28</td> <td data-bbox="949 710 1552 762">83 or 83.3</td> </tr> <tr> <td data-bbox="685 762 949 815">± 34</td> <td data-bbox="949 762 1552 815">100</td> </tr> </tbody> </table> <p data-bbox="300 852 1346 916">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.</p>	$P/\Omega$	$\frac{1}{I} / \text{A}^{-1}$	± 9	29 or 29.4	± 11	36 or 35.7	± 16.5	53 or 52.6	± 23.5	71 or 71.4	± 28	83 or 83.3	± 34	100	2
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± 28	83 or 83.3															
± 34	100															
2(c)(i)	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.	1														
	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.	1														

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) <b>and</b> 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 <b>or</b> uncertainty = $\frac{1}{2}$ (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 <b>or</b> uncertainty = $\frac{1}{2}$ (steepest worst line $y$ -intercept – shallowest worst line $y$ -intercept)	1

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