Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **March 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.

Cambridge will not enter into discussions about these mark schemes.

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Question	Answer	Marks
1	**Defining the problem**	
	M is the independent variable and *v* is the dependent variable, or vary *M* and measure *v*	**1**
	keep *x*/compression of spring constant	**1**
	Methods of data collection	
	labelled diagram including horizontal spring in line with vehicle attached to wall / retort stand	**1**
	use a ruler / calliper to determine compression of spring	**1**
	use of stopwatch / use of light gate connected to a timer / motion sensor correctly positioned	**1**
	use of balance to measure mass of vehicle *M*	**1**
	Method of Analysis	
	plots a graph of $1/v^2$ against *M* [Do not allow lg-lg graphs]	**1**
	relationship valid if a straight line produced	**1**
	$k = \frac{1}{gradient \times x^2}$ *or* $k = \frac{b}{y - intercept \times x^2}$	**1**

Question	Answer	Marks
	Additional detail including safety considerations	**Max 6**
	D1 use safety screen; use goggles to avoid ball / spring hitting eye	
	D2 add masses to the vehicle to change *M*	
	D3 repeat experiment for each *M* and average *v*	
	D4 use of ruler to measure an appropriate distance for the time taken in stopwatch / light gate methods	
	D5 method to determine speed of vehicle, e.g. time vehicle over a measured distance and use speed = distance/time	
	D6 method to release ball with guide or support for spring /ball	
	D7 release the ball close to the vehicle	
	D8 detail on determining *x* e.g. difference between compressed length and original length	
	D9 method to ensure constant speed along track, e.g. friction compensate track / use of air track	
	D10 (relationship valid if a straight line produced) with (*y*-)intercept = $\frac{b}{kx^2}$	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>gradient = Q / E
y-intercept = $1 / E$</td><td>1</td></tr>
<tr><td rowspan="2">2(b)</td><td><table>
<tr><td>4.0 or 4.00 or 4.000</td><td>1.5 or 1.52</td></tr>
<tr><td>3.0 or 3.03 or 3.030</td><td>1.2 or 1.16</td></tr>
<tr><td>2.1 or 2.13 or 2.128</td><td>0.870 or 0.8696</td></tr>
<tr><td>1.8 or 1.79 or 1.786</td><td>0.769 or 07692</td></tr>
<tr><td>1.5 or 1.47 or 1.471</td><td>0.671 or 0.6711</td></tr>
<tr><td>1.2 or 1.19 or 1.190</td><td>0.610 or 0.6098</td></tr>
</table>
First mark for all first column correct either 2 and 3 significant figures or 3 and 4 significant figures.

Second mark for all second column correct.</td><td>2</td></tr>
<tr><td>absolute uncertainties from 0.4 to 0.1</td><td>1</td></tr>
<tr><td rowspan="2">2(c)(i)</td><td>six points plotted correctly
must be within half a small square</td><td>1</td></tr>
<tr><td>error bars in $1 / P$ plotted correctly
all error bars to be plotted</td><td>1</td></tr>
<tr><td rowspan="2">2(c)(ii)</td><td>line of best fit drawn
If points are plotted correctly then lower end of line should pass between (1.50, 0.70) and (1.65, 0.70) and upper end of line should pass between (3.60, 1.40) and (3.80, 1.40).</td><td>1</td></tr>
<tr><td>worst acceptable line drawn
steepest or shallowest possible line
mark scored only if all error bars are plotted</td><td>1</td></tr>
</table>

Question	Answer	Marks
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 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**
2(d)(i)	*E* determined with correct unit using *y*-intercept $E = \frac{1}{y - intercept}$	**1**
	Q determined with correct unit using gradient and given to two or three significant figures penalise power of ten errors correct substitution of numbers must be seen $Q = E \times gradient = \frac{gradient}{y - intercept}$	**1**
2(d)(ii)	percentage uncertainty in *Q* correct substitution of numbers must be seen %uncertainty *E* + %uncertainty in gradient *or* %uncertainty in *y*-intercept + %uncertainty in gradient Maximum/minimum methods $Max\,Q = \max gradient \times \max E = \frac{\max gradient}{\min y - intercept}$ $Min\,Q = \min gradient \times \min E = \frac{\min gradient}{\max y - intercept}$	**1**