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**

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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*<br>[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 <u>to avoid ball / spring hitting eye</u> | |
| | 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 <u>and</u> 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 = $\frac{b}{kx^2}$ | |

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>gradient = $Q / E$<br>$y$-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.<br><br>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<br>must be within half a small square</td><td>1</td></tr>
<tr><td>error bars in $1 / P$ plotted correctly<br>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<br>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<br>steepest or shallowest possible line<br>mark scored only if all error bars are plotted</td><td>1</td></tr>
</table>

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| 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<br>*or*<br>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<br>*or*<br>uncertainty = ½ (steepest worst line *y*-intercept – shallowest worst line *y*-intercept). | **1** |
| 2(d)(i) | *E* determined with correct unit using *y*-intercept<br>$E = \frac{1}{y - intercept}$ | **1** |
| | *Q* determined with correct unit using gradient and given to two or three significant figures<br>penalise power of ten errors<br>correct substitution of numbers must be seen<br>$Q = E \times gradient = \frac{gradient}{y - intercept}$ | **1** |
| 2(d)(ii) | percentage uncertainty in *Q*<br>correct substitution of numbers must be seen<br>%uncertainty *E* + %uncertainty in gradient *or* %uncertainty in *y*-intercept + %uncertainty in gradient<br><br>Maximum/minimum methods<br>$Max\,Q = \max gradient \times \max E = \frac{\max gradient}{\min y - intercept}$<br>$Min\,Q = \min gradient \times \min E = \frac{\min gradient}{\max y - intercept}$ | **1** |