Cambridge International AS & A Level

**Cambridge Assessment International Education**
Cambridge International Advanced Subsidiary and Advanced Level

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

Paper 5 Planning, Analysis and Evaluation **May/June 2019**

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 International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2019 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.





Cambridge Assessment International Education

## Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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| GENERIC MARKING PRINCIPLE 5:<br><br>Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen). |
| GENERIC MARKING PRINCIPLE 6:<br><br>Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind. |

| Question | Answer | Marks |
|---|---|---|
| 1 | **Defining the problem** | |
| | *m* is the independent variable and $\theta$ is the dependent variable **or** vary *m* and measure $\theta$<br>**or**<br>$\theta$ is the independent variable and *m* is the dependent variable **or** vary $\theta$ and measure *m* | **1** |
| | keep position of load constant or *L* constant | **1** |
| | **Methods of data collection** | |
| | labelled diagram of workable experiment including:<br>• load shown touching at P<br>• load labelled and at least one other label | **1** |
| | use a protractor to measure $\theta$ | **1** |
| | if *m* is the independent variable: (slowly) change the angle until the block (just) topples<br>**or**<br>if $\theta$ is the independent variable: (slowly) change mass until block (just) topples | **1** |
| | use a balance to measure *m* | **1** |

| Question | Answer | Marks |
|---|---|---|
| 1 | **Method of analysis** | |
| | plot a graph of cos $\theta$ against 1 / $m$ (**or** reverse axes 1 / $m$ against cos $\theta$)<br>(**not** 1 / cos $\theta$ against $m$ or $m$ against 1 / cos $\theta$) | **1** |
| | relationship valid if a straight line<br>(**not** 'through the origin' unless the choice of axes indicates the intercept is zero) | **1** |
| | $\alpha = \dfrac{2L \times \text{gradient}}{V \times w}$ **or** $\alpha = \dfrac{\text{gradient}}{V \times y\text{-intercept}}$<br><br>for reverse axes:<br><br>$\alpha = \dfrac{2L}{V \times w \times \text{gradient}}$ **or** $\alpha = -\dfrac{1}{V \times y\text{-intercept}}$ | **1** |

| Question | Answer | | Marks |
|---|---|---|---|
| 1 | **Additional detail including safety considerations** | | **Max. 6** |
| | D1 | use cushion/foam/sandbox <u>in case block/load falls</u> | |
| | D2 | measure $L$ with a rule | |
| | D3 | correctly positioned protractor to measure $\theta$, e.g. protractor with its centre over the nail and its straight edge parallel to an edge of the block | |
| | D4 | method to fix $m$ to strip | |
| | D5 | method to determine volume of block, e.g. $V = w \times h \times l$ | |
| | D6 | measure $w$, $h$ and $l$ with calipers/micrometer/rule | |
| | D7 | (if $m$ is the independent variable:) repeat experiment for $\theta$ <u>and</u> determine the average $\theta$<br>**or**<br>(if $\theta$ is the independent variable:) repeat experiment for $m$ <u>and</u> determine the average $m$ | |
| | D8 | equation must be in the form of $y = mx + c$ with cos $\theta$ on one side and $m$ on the other side<br>e.g. for a graph of cos $\theta$ against 1 / $m$<br>$\cos\theta = \frac{\alpha Vw}{2Lm} + \frac{w}{2L}$<br>or for a graph of 1 / $m$ against cos $\theta$<br>$\frac{1}{m} = \frac{2L\cos\theta}{\alpha Vw} - \frac{1}{\alpha V}$ | |
| | D9 | method to determine centre of load or centre of block e.g. measure diameter/width and halve or diagonals across the block | |
| | D10 | method to ensure that block or strip is horizontal, e.g. check with a spirit level that table/block is horizontal or use a rigid strip | |

| Question | Answer | Marks |
|---|---|---|
| 2(a) | gradient = $4\pi^2 M$ | **1** |
| 2(b) | <table><tr><td>$T$ / s</td><td>$T^2$ / $s^2$</td></tr><tr><td>1.12 or 1.120</td><td>1.25 or 1.254</td></tr><tr><td>0.950 or 0.9500</td><td>0.903 or 0.9025</td></tr><tr><td>0.815 or 0.8150</td><td>0.664 or 0.6642</td></tr><tr><td>0.655 or 0.6550</td><td>0.429 or 0.4290</td></tr><tr><td>0.570 or 0.5700</td><td>0.325 or 0.3249</td></tr><tr><td>0.47 or 0.470</td><td>0.22 or 0.221</td></tr></table> | |
| | Values of $T$ as above. | **1** |
| | Values of $T^2$ as above. | **1** |
| | Uncertainties in $T$ increase from ±0.01 to ±0.02. | **1** |
| | Uncertainties in $T^2$ about ±0.02. | **1** |
| 2(c)(i) | Six points plotted correctly.<br>Must be accurate to the nearest half a small square. Diameter of points must be less than half a small square. | **1** |
| | Error bars in $T^2$ plotted correctly.<br>All error bars to be plotted. Length of bar must be accurate to less than half a small square and symmetrical. | **1** |
| 2(c)(ii) | Line of best fit drawn.<br>If points are plotted correctly then lower end of line should pass between (0.048, 0.5) and (0.052, 0.5) **and** upper end of line should pass between (0.098, 1.0) and (0.104, 1.0). | **1** |
| | Worst acceptable line drawn (steepest or shallowest possible line that passes through all the error bars).<br>All error bars must be plotted. | **1** |

| Question | Answer | Marks |
|---|---|---|
| 2(c)(iii) | Gradient determined with clear substitution of points from the line of best fit into $\Delta y / \Delta x$.<br>Distance between points must be 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(d)(i) | *M* determined from gradient **and** given to 2 or 3 significant figures **and** with correct unit.<br><br>$M = \frac{\text{gradient}}{4\pi^2} = \frac{\textbf{(c)(iii)}}{39.478}$ | **1** |
| 2(d)(ii) | % uncertainty in *M* = % uncertainty in gradient | **1** |

| Question | Answer | Marks |
|---|---|---|
| 2(e) | *k* calculated.<br>Correct substitution of numbers required.<br>$k = \left(\frac{4\pi^2 M}{T^2} = \right)\frac{4\pi^2\textbf{(d)(i)}}{2.5^2}$ **or** $6.3165\times\textbf{(d)(i)}$<br>**or**<br>$k = \left(\frac{\text{gradient}}{T^2}\right) = \frac{\textbf{(c)(iii)}}{2.5^2}$ **or** $\frac{\textbf{(c)(iii)}}{6.25}$ | **1** |
| | Absolute uncertainty in *k*.<br>Correct substitution of numbers required.<br>Using *M*:<br>$\text{uncertainty in } k = \left(\frac{\Delta M}{M} + 2\times\frac{\Delta T}{T}\right)\times k$<br>$\text{uncertainty in } k = \left(\frac{\textbf{(d)(ii)}}{100} + 0.008\right)\times k$<br>$\max k = \frac{4\pi^2 \times \max M}{\min T^2}$ **or** $\min k = \frac{4\pi^2 \times \min M}{\max T^2}$<br>Using gradient:<br>$\text{uncertainty in } k = \left(\frac{\Delta\text{gradient}}{\text{gradient}} + 0.008\right)\times k$<br>$\max k = \frac{\max \text{gradient}}{\min T^2}$ **or** $\min k = \frac{\min \text{gradient}}{\max T^2}$ | **1** |