# Cambridge International AS & A Level

**PHYSICS** **9702/31**

Paper 3 Advanced Practical Skills 1 **October/November 2024**

MARK SCHEME

Maximum Mark: 40

**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 October/November 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

This document consists of **9** printed pages.

**[Turn over**

| Question | Answer | Marks |
|---|---|---|
| 1(a) | Value(s) of raw $\theta_0$ to the nearest degree **and** final $\theta_0$ value in the range $75° \leqslant \theta_0 \leqslant 85°$. | **1** |
| 1(b) | Value of $m$ in range $3.0 \text{ g} \leqslant m \leqslant 6.0 \text{ g}$ with unit **and** to at least 0.1 g. | **1** |
| 1(c) | Correct calculation of $e$ with correct unit. | **1** |
| 1(d) | Six (or more) sets of readings of $M$ (different values) and $\theta$ with correct trend (as $M$ increases, $\theta$ decreases) and without help from supervisor scores 4 marks, five sets scores 3 marks etc. | **4** |
| | Range: $M_{max} - M_{min} \geqslant 30 \text{ g}$. | **1** |
| | Column headings:<br>Each column heading must contain a quantity and a unit where appropriate.<br>The presentation of quantity and unit must conform to accepted scientific convention e.g. $L/\text{cm}$, $M/\text{g}$, $e/\text{cm}$, $\theta/°$, $\sin \theta$. | **1** |
| | Consistency:<br>All values of raw $L$ must be given to the nearest mm. | **1** |
| | Significant figures:<br>Values of $\sin \theta$ must be given to the same number of s.f. (or one more than) the number of s.f. in the corresponding raw $\theta$ values. | **1** |
| | Calculation: Values of $\sin \theta$ are correct. | **1** |

| Question | Answer | Marks |
|---|---|---|
| 1(e)(i) | Axes:<br>Axes must be labelled with the required quantities.<br>Scales must be chosen so that the plotted points occupy at least half the graph grid in both the *x* and *y* directions.<br>Scale markings are no more than 2 cm (one large square) apart.<br>Sensible scales must be used, no awkward scales (e.g. 3:10 or fractions). | 1 |
| | Plotting of points:<br>All observations in the table must be plotted on the grid.<br>Diameter of plotted points must be ⩽ half a small square.<br>Points must be plotted to an accuracy of half a small square in both *x* and *y* directions. | 1 |
| | Quality:<br>Trend of points must be negative.<br>All points in the table must be plotted (at least 5) on the grid for this mark to be awarded.<br>It must be possible to draw a straight line that is within ± 0.25 cm (to scale) on the *e* axis (normally *y*-axis) of <u>all</u> plotted points. | 1 |
| 1(e)(ii) | Line of best fit:<br>'Best fit' is judged by the balance of all points on the grid (at least 5 points on the grid) about the candidate's line.<br>There must be an even distribution of points either side of the line along the full length.<br>Lines must not be kinked or thicker than half a small square.<br><br>Some candidates may choose to identify an anomalous point. If they identify **one** point as anomalous (e.g. by circling or labelling) then this point is to be disregarded when judging the line of best fit. There must be at least five points left after the anomalous point is disregarded. | 1 |

| Question | Answer | Marks |
|---|---|---|
| 1(e)(iii) | Gradient:<br>The hypotenuse of the triangle used should be greater than half the length of the drawn line.<br>Both read-offs must be accurate to half a small square in both the *x* and *y* directions.<br>Method of calculation must be correct (not $\Delta x / \Delta y$).<br>Gradient sign on answer line consistent with graph drawn. | 1 |
| | *y*-intercept:<br>Intercept read directly from the graph, with read-off at sin $\theta$ = 0, accurate to half a small square in *y* direction.<br>**or**<br>Correct read-off from a point on the line is substituted correctly into *y* = *mx* + *c* or an equivalent expression.<br>Read-off accurate to half a small square in both *x* and *y* directions. | 1 |
| 1(f) | *P* = candidate's gradient value **and** *Q* = candidate's intercept value.<br>Values must not be written as fractions, roots or given to only one significant figure. | 1 |
| | Correct and consistent units for *P* (e.g. cm or m or mm) **and** *Q* (e.g. cm or m or mm). | 1 |

| Question | Answer | Marks |
|---|---|---|
| 2(a) | Value of *w* on answer line in the range 6.0–8.0 cm with unit **and** value of *x* on answer line in the range 1–4 mm with unit. | **1** |
| 2(b)(i) | Value(s) of raw *d* to the nearest mm. | **1** |
| | Final value of *d* in the range 92.0–99.0 cm. | **1** |
| 2(b)(ii) | Percentage uncertainty based on an absolute uncertainty in *d* in range 2–10 mm. Correct method of calculation to find percentage uncertainty e.g. (absolute uncertainty/value from **2(b)(i)**) × 100. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. | **1** |
| 2(c) | Value of *T* in the range 1.0–2.0 s. | **1** |
| | Repeats: At least two measurements of time. | **1** |
| 2(d) | Second value of *d*. | **1** |
| | Second value of *T*. | **1** |
| | Second value of *T* < first value of *T*. | **1** |
| 2(e)(i) | Two values of *k* calculated correctly. The final *k* values must not be written as fractions or given to only one significant figure. | **1** |
| 2(e)(ii) | Justification for significant figures in *k* linked to significant figures in *T* or time <u>and</u> *d*. | **1** |
| 2(f) | Calculation of percentage difference between candidate's two *k* values. Comparison of percentage difference with 10%, leading to a consistent conclusion. | **1** |

| Question | Answer | Marks |
|---|---|---|
| 2(g)(i) | A Two readings are not enough to draw a (valid) conclusion (**not** "not enough for accurate results", "few readings"). <br><br> B Difficulty with measuring *x* with a reason e.g. *x* is a small value and minimum rule marking 1 mm / rule is not precise enough / rule unwieldly / large percentage uncertainty. <br><br> C Difficult to measure *d* with a reason e.g. rule hand held / rule may not be horizontal / parallax. <br><br> D Difficult to determine *T* with a reason e.g. number of oscillations is small / identifying start or end point of oscillation. <br><br> E Difficulty with spring e.g. rolls at an angle / falls off strip / loops restrict movement / spring slides as well as rolling. <br><br> F Difficulty with board e.g. board twists / does not touch stand because of boss / roughness restricts rolling / stands move during the experiment / board hard to bend. <br><br> *1 mark for each point up to a maximum of 4.* | 4 |
| 2(g)(ii) | A Take more readings (for different values of *d*) <u>and</u> plot a graph / take more readings <u>and</u> compare *k* values (**not** "repeat readings" on its own). <br><br> B Improved method to measure *x* e.g. (vernier/digital) calipers or micrometer screw gauge. <br><br> C Improved method to measure *d* e.g. clamp rule (with pointers). <br><br> D Improved method to measure *T* e.g. fiducial marker at centre of oscillation **or** video / film / record with timer in view. <br><br> E Improved method of release e.g. use of a stop / card gate. <br><br> F Use G-clamps to fix the stands / add weights to stands. <br><br> *1 mark for each point up to a maximum of 4.* | 4 |