Cambridge Assessment International Education

# Cambridge International AS & A Level

**PHYSICS** **9702/35**

Paper 3 Advanced Practical Skills 1 **October/November 2023**

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.

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Cambridge International is publishing the mark schemes for the October/November 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

| Question | Answer | Marks |
|---|---|---|
| 1(a) | Final value of $E$ in the range 2.50–6.00 V. | **1** |
| 1(b) | Six (or more) sets of readings of $R_1$ and $R_2$ (different values of ($R_1$ + $R_2$)) and $I$ with the correct trend (as ($R_1$ + $R_2$) increases, $I$ decreases) and without help from the Supervisor scores 3 marks, five sets scores 2 marks, etc. | **3** |
| | Range: Uses ($R_1$ + $R_2$) = 45 Ω **and** ($R_1$ + $R_2$) = 138 Ω. | **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. ($R_1$ + $R_2$) / Ω, $\frac{1}{I}$ ($A^{-1}$). Do not allow 1 / $I$ (A). | **1** |
| | Consistency: <u>All</u> raw values of $I$ must be given to 0.1 mA or <u>all</u> given to 0.01 mA. | **1** |
| | Significant figures: All values of $\frac{1}{I}$ must be given to the same number of s.f. as (or one more than) the number of s.f. in raw $I$ values. | **1** |
| | Calculation: Values of $\frac{1}{I}$ are correct. | **1** |

| Question | Answer | Marks |
|---|---|---|
| 1(c)(i) | Axes:<br>Axes must be labelled with the correct 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. Scales must not be awkward (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 $\leqslant$ 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 positive.<br>All points in the table must be plotted on the grid (at least 5).<br>It must be possible to draw a straight line that is within $\pm$ 4 $\Omega$ on the ($R_1$ + $R_2$) axis of <u>all</u> plotted points. | **1** |
| 1(c)(ii) | Line of best fit:<br>'Best fit' is judged by the balance of all points on the grid (at least 5 points) 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 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 5 points left after the anomalous point is disregarded. | **1** |

| Question | Answer | Marks |
|---|---|---|
| 1(c)(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>The method of calculation must be correct, not $\Delta x / \Delta y$.<br>The gradient sign on the answer line must be consistent with the graph drawn. | **1** |
| | *y*-intercept:<br>Intercept read directly from the graph, with read-off at ($R_1 + R_2$) = 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(d) | Value of *F* = candidate's gradient **and** value of *G* = candidate's *y*-intercept.<br>The values must not be written as fractions or given to only one significant figure. | **1** |
| | Correct unit for *F* e.g. $mA^{-1}\Omega^{-1}$<br>**and**<br>correct unit for *G* e.g. $mA^{-1}$. | **1** |
| 1(e)(i) | All raw values given to either 0.01 mm or all to 0.001 mm<br>**and**<br>final value of *d* in the range 0.100–0.300 mm with unit. | **1** |
| | Measurements of *d* repeated. | **1** |
| 1(e)(ii) | Correct calculation of $\rho$ using $\rho = \pi d^2 EG / 4L$. | **1** |

| Question | Answer | Marks |
|---|---|---|
| 2(a) | Evidence of mass of 5 or more paper clips measured to the nearest 0.1 g or better<br>**and**<br>mass of one paper clip determined. | **1** |
| 2(b)(i) | Raw *h* recorded to the nearest millimetre **and** final value of *h* in range 10.0–60.0 cm. | **1** |
| 2(b)(ii) | *N* recorded. | **1** |
| 2(b)(iii) | Value of *t* in the range 0.50–10.00 s with unit. | **1** |
| | Evidence of repeats. | **1** |
| 2(b)(iv) | Percentage uncertainty based on an absolute uncertainty in *t* in the range 0.2–0.5 s.<br>Correct method of calculation to find percentage uncertainty e.g. absolute uncertainty × 100 / value from **(b)(iii)**.<br>If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if working is shown clearly. | **1** |
| 2(b)(v) | Value of *a* calculated correctly. | **1** |
| 2(b)(vi) | Justification for significant figures in *a* linked to significant figures in *h* and *t.* | **1** |
| 2(c) | Second values of *N* and *t.* | **1** |
| | Second value of *t* is smaller than the first value of *t*. | **1** |
| 2(d) | Two values of *k* calculated correctly.<br>The final *k* values must not be written as fractions or given to only one significant figure. | **1** |
| 2(e) | Calculation of percentage difference between candidate's two *k* values.<br>Comparison of percentage difference with 25% leading to a consistent conclusion. | **1** |

| Question | Answer | Marks |
|---|---|---|
| 2(f)(i) | A Two readings are not enough to draw a (valid) conclusion (**not** "not enough for accurate results", "few readings").<br><br>B Difficult to measure *h* with a reason e.g. because mass hanger is not horizontal **or** rule not vertical **or** rule disturbs mass hanger/pulley.<br><br>C *t* is small so uncertainty is large **or** large <u>percentage</u> uncertainty in *t*.<br><br>D Difficult to measure *t* with a reason e.g. difficult to start stop-watch and release mass at the same time.<br><br>E Difficulty with pulley and/or string e.g. hanger starts and stops **or** pulley too narrow so masses collide **or** masses too wide so collide.<br><br>F Difficulty with adhesive putty e.g. mass of putty not taken into account **or** adhesive putty adds mass to slotted mass.<br><br>G Difficulty with paper clips e.g. paper clips fall off mass hanger **or** difficult to balance clips on hanger **or** paper clips are discrete (large increments) so mass hanger suddenly releases and falls.<br><br>*1 mark for each point up to a maximum of 4.* | **4** |

| Question | Answer | Marks |
|---|---|---|
| 2(f)(ii) | A Take more readings (for different values of *N*) and plot a graph **or** take more readings and compare *k* values (**not** "repeat readings" on its own).<br><br>B Workable method to measure *h* accurately e.g. clamp metre rule (and use a fiducial marker).<br><br>C Use a longer string **or** larger *h*.<br><br>D Workable method to measure *t* e.g. record/film/video with timer in view/frame by frame **or** electromagnet for start, gate for end with timer **or** motion sensor above or below.<br><br>E Workable improvement e.g. use a pulley with larger diameter **or** masses of smaller diameter.<br><br>F Valid method to account for the mass of the adhesive putty e.g. measure mass and add on **or** tie mass using string **or** use tape.<br><br>G Workable method for improvement e.g. hook/container added to hanger **or** use smaller/lighter paper clips.<br><br>*1 mark for each point up to a maximum of 4.* | **4** |