Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/33**

Paper 3 Advanced Practical Skills 1 **October/November 2021**

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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[Turn over

Question	Answer	Marks
1(a)	Value of I with unit and in the range 20–120 mA.	**1**
1(b)	Six (or more) I values with different resistance pairings of R_1, R_2 without help from the Supervisor scores 5 marks, five sets scores 4 marks, etc.	**5**
	Range: 33 Ω and 47 Ω resistors used as a pair **and** 68 Ω and 82 Ω resistors used as a pair.	**1**
	Column headings: Each column heading must contain a quantity and a unit. The presentation of quantity and unit must conform to accepted scientific convention, e.g. $1/I$ /A^{-1}, $\left(\frac{R_1R_2}{R_1+R_2}\right)$ / Ω.	**1**
	Consistency: <u>All</u> values of I must be given to the nearest 0.1 mA or <u>all</u> to the nearest 0.01 mA.	**1**
	Significant figures: All values of $\left(\frac{R_1R_2}{R_1+R_2}\right)$ must be given to 2 s.f. or 3 s.f.	**1**
	Calculation: Values of $1/I$ and $\left(\frac{R_1R_2}{R_1+R_2}\right)$ are correct.	**1**

Question	Answer	Marks
1(c)(i)	Axes: Sensible scales must be used, no awkward scales (e.g. 3:10 or fractions). Scales must be chosen so that the plotted points occupy at least half the graph grid in both the *x* and *y* directions. Axes must be labelled with the quantity that is being plotted. Scale markings should be no more than three large squares apart.	**1**
	Plotting of points: All observations in the table must be plotted on the grid. Diameter of plotted points must be $\leqslant$ half a small square. Points must be plotted to an accuracy of half a small square in both *x* and *y* directions.	**1**
	Quality: All points in the table (at least 5) must be plotted on the grid. Trend of points on graph must be correct. It must be possible to draw a straight line that is within $\pm 1\,\Omega$ on the $\left(\frac{R_1R_2}{R_1+R_2}\right)$ axis of all plotted points.	**1**
1(c)(ii)	Line of best fit: Judge by the balance of all points on the grid about the candidate's line (at least 5 points). There must be an even distribution of points either side of the line along the full length. Allow one anomalous point only if clearly indicated (i.e. circled or labelled) by the candidate. There must be at least five points left after the anomalous point is disregarded. Line must not be kinked or thicker than half a small square.	**1**

Question	Answer	Marks
1(c)(iii)	Gradient: The hypotenuse of the triangle used must be greater than half the length of the drawn line. Both read-offs must be accurate to half a small square in both the *x* and *y* directions. Method of calculation must be correct, e.g. $\Delta y / \Delta x$. Gradient sign on answer line matches graph drawn.	**1**
	y-intercept: Correct read-off from a point on the line and substituted into $y = mx + c$ or an equivalent expression. Read-off must be accurate to half a small square in both *x* and *y* directions. **or** Intercept read directly from the graph at $\left(\frac{R_1R_2}{R_1+R_2}\right) = 0$, accurate to half a small square.	**1**
1(d)(i)	Value of *P* = candidate's gradient **and** value of *Q* = candidate's *y*-intercept. Values must not be written as fractions.	**1**
	Unit for *P* is correct e.g. $\Omega^{-1}A^{-1}$ or $\Omega^{-1}mA^{-1}$ or V^{-1} **and** unit for *Q* is correct e.g. A^{-1} or mA^{-1}.	**1**
1(d)(ii)	*E* and *Z* correctly calculated from *P* and *Q* using: $E = 1 / P$ and $Z = EQ$ or $Z = Q / P$ **and** units for *E* (V) and *Z* (Ω) correct.	**1**

Question	Answer	Marks
2(a)(i)	$d = 11.0 \pm 0.5$ cm.	**1**
	Raw value(s) of d recorded to the nearest millimetre.	**1**
2(a)(ii)	A calculated correctly.	**1**
2(a)(iii)	Number of significant figures in A is linked to the number of significant figures in d.	**1**
2(b)(i)	Value of t in the range $0.5 \leqslant t \leqslant 1.0$ s and given to 0.1 s or better.	**1**
	Repeated measurement of t.	**1**
2(b)(ii)	Percentage uncertainty based on an absolute uncertainty in the range 0.2–0.5 s. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if working is clearly shown. Correct method of calculation to find percentage uncertainty.	**1**
2(b)(iii)	Mass in the range 2.0–10.0 g and measured to the nearest 0.1 g or better **and** with unit.	**1**
2(c)(i)	Second value of d.	**1**
2(c)(ii)	Second value of t is larger than the first value of t.	**1**
2(d)(i)	Two values of k calculated correctly. The final values must not be written as fractions.	**1**
2(d)(ii)	Valid comment consistent with the calculated values of k, testing against a criterion stated by the candidate.	**1**

Question	Answer	Marks
2(e)(i)	A Two readings are not enough to draw a (valid) conclusion (**not** "not enough for accurate results", "few readings"). B Difficulty with filter paper at the start, e.g. paper not horizontal/paper too high to view against ruler/parallax in viewing start position/paper held by hand which moves/metre rule not vertical. C Difficult to start stop-watch and release filter paper at the same time. D Problem with fall of filter paper with a reason, e.g. paper does not fall vertically/erratic path/hits boss or stand/misses bench/papers separate while falling. E Difficulty with judging when to stop the stop-watch <u>with a reason</u>, e.g. difficult to align head at bench level/papers arrive separately. F Times are small so large error/uncertainty (in *t*) **or** high <u>percentage</u> uncertainty in *t*. *1 mark for each point up to a maximum of 4.*	**4**

Question	Answer	Marks
2(e)(ii)	A Take more readings and plot a graph or take more readings and compare *k* values (**not** "repeat readings" on its own). B Improved method to hold/release filter paper, e.g. horizontal bar level with top of rule **or** use a set square with detail, e.g. use set square between bench and ruler **or** use plumb-line. C Video/record/film with timer/frame-by-frame. D Use more filter papers/heavier or thicker paper/glue together **or** switch off air-conditioning/close windows/use a wind shield. E Use a pressure sensor below/position sensor above or below. F Use a greater distance to fall through **or** use larger diameters/use fewer papers/use lighter papers/use thinner papers (*Credit once only if heavier papers suggested for D and lighter papers suggested for F.*) *1 mark for each point up to a maximum of 4.*	**4**