Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/32**

Paper 3 Advanced Practical Skills 2 **May/June 2022**

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)(i)	Value of raw x to the nearest mm **and** final value in the range 4.0–8.0 cm.	**1**
1(a)(ii)	Value for R with unit in the range $18.0\,\Omega \leqslant R \leqslant 30.0\,\Omega$.	**1**
1(b)	Five sets of readings of n and R with correct trend (R decreases as n increases) and without help from the Supervisor scores 4 marks, four sets scores 3 marks etc.	**4**
	Range: $n_{min} \leqslant 3$ **and** $n_{max} \geqslant 9$.	**1**
	Column headings: Each column heading must contain a quantity and a unit where appropriate. The presentation of quantity and unit must conform to accepted scientific convention e.g. R / Ω. The quantities n and $(n – 1 / n)$ must have no unit.	**1**
	Consistency: All values of raw R must be given to the nearest $0.1\,\Omega$.	**1**
	Significant figures: All $(n – 1 / n)$ values must be given to three significant figures.	**1**
	Calculation: $(n – 1 / n)$ calculated correctly.	**1**
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 are no more than 2 cm (one large square) 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 must be plotted (at least 4) for this mark to be awarded. Trend of points must be negative. It must be possible to draw a straight line that is within $\pm 0.5\,\Omega$ in the R direction of <u>all</u> plotted points.	**1**

Question	Answer	Marks
1(c)(ii)	Line of best fit: Judge by the balance of all points on the grid about the candidate's line (at least 4 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 4 points left after the anomalous point is disregarded. Lines must not be kinked or thicker than half a small square.	**1**
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 (not $\Delta x / \Delta y$). Gradient sign on answer line matches graph drawn.	**1**
	y-intercept: Correct read-off from a point on the line substituted into $y = mx + c$ or an equivalent expression, with read-off accurate to half a small square in both *x* and *y* directions. **or** Intercept read directly from the graph, with read-off at $(n - 1 / n) = 0$ accurate to half a small square in *y* direction.	**1**
1(d)	Value of *a* = candidate's gradient **and** value of *b* = candidate's intercept. The values must not be written as fractions.	**1**
	Units for *a* and *b* correct (e.g. Ω for *a* and Ω for *b*).	**1**
1(e)	Correct value of *r* **and** correct unit (e.g. $\Omega\ m^{-1}$) given.	**1**

Question	Answer	Marks
2(a)(i)	Value for L with unit **and** raw values of L to nearest mm.	**1**
2(a)(ii)	Value for t_s with unit and in range 2.0–5.0 s.	**1**
	Evidence of repeat readings for t_s.	**1**
2(a)(iii)	Percentage uncertainty in t_s based on an absolute uncertainty of 0.2–0.5 s. If several readings have been taken, then the absolute uncertainty can be half the range (but not zero) provided working is clearly shown. Correct method of calculation to obtain percentage uncertainty.	**1**
2(b)(i)	Value for T_1 with unit. All raw values given to nearest 0.01 s or all raw values given to nearest 0.1 s.	**1**
2(b)(ii)	Value for T_2 less than T_1.	**1**
2(b)(iii)	Correct calculation of B with unit of s.	**1**
2(c)	Second L < first L.	**1**
	Second value of t_s.	**1**
	Second values of T_1 and T_2.	**1**
2(d)	Two values of k calculated correctly. The final k values must not be written as fractions.	**1**
2(e)	Calculation of percentage difference between candidate's two k values. Comparison of percentage difference with 15% 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"). B Difficult to measure t_s with a reason i.e. difficult to judge when twisting changes to swinging. C Difficult to measure *L* with a reason: difficult to judge when strings are vertical/hand moves when holding the ruler/difficult to hold ruler still/ruler moves the strings/ruler not horizontal. D Loops move on rod/string slides off rod. E Large uncertainty in *B* with a reason e.g. difference between T_1 and T_2 is small. *1 mark for each point up to a maximum of 4.*	**4**
2(f)(ii)	A Take more readings and plot a graph or take more readings and compare *k* values (**not** "repeat readings" on its own). B Record/film/video rod with timer in view. **or** record/film/video rod and view frame by frame. C Support ruler being used to measure *L* in a clamp/use set square between clamp and string/use plumb-line/use a spirit level. D Make grooves around rod/add notches to rod/use tape to hold string on rod/use a rough rod. E Tilt rod at steeper angle/increase difference in length of the strings. *1 mark for each point up to a maximum of 4.*	**4**