Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/33**

Paper 3 Advanced Practical Skills 1 **October/November 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)	Value of E in the range 2.00–3.50 V.	**1**
1(b)	Six sets of readings of x and V with the correct trend (V increases as x increases) and without help from the Supervisor scores 3 marks, five sets scores 2 marks etc.	**3**
	Range: $\Delta x \geqslant 70.0$ cm.	**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. $1 / V$ / V^{-1}.	**1**
	Consistency: All values of x must be given to the nearest millimetre.	**1**
	Significant figures: All values of $1 / V$ must be given to the same number of s.f. as (or one more than) the number of s.f. in the raw V values.	**1**
	Calculation: Values of $1 / V$ are correct.	**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 must be 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 5) on the grid for this mark to be awarded. Trend of points must be negative. It must be possible to draw a straight line that is within $\pm$ 5 cm (to scale) on the x axis of all plotted points.	**1**

Question	Answer	Marks
1(c)(ii)	Line of best fit: 'Best fit' is judged by the balance of all points on the grid (at least 5) about the candidate's line. There must be an even distribution of points either side of the line along the full length. Candidates do not need to identify an anomalous point. However if there is a point off trend, it may be identified as anomalous by circling or labelling it. There must be at least 5 points left after one 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 and substituted into $y = mx + c$ or an equivalent expression. 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 $x = 0$, accurate to half a small square.	**1**
1(d)	Value of *A* = candidate's gradient value **and** value of *B* = candidate's intercept value. Values must not be written as fractions.	**1**
1(e)(i)	Value of *d* in the range 0.290 mm–0.340 mm **and** <u>all</u> raw values given to either 0.01 mm or <u>all</u> to 0.001 mm with unit.	**1**
	Measurement of *d* repeated.	**1**
1(e)(ii)	ρ correctly calculated.	**1**
	Correct unit (e.g. Ωm).	**1**

Question	Answer	Marks
2(a)(i)	Final value L_1 in the range 10.0 cm to 20.0 cm **and** raw values to the nearest millimetre with unit.	**1**
2(a)(ii)	Absolute uncertainty in L_1 in the range 2–6 mm. 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(a)(iii)	k calculated correctly.	**1**
2(a)(iv)	Justification for number of significant figures in k linked to significant figures in W and $(L_2 - L_1)$.	**1**
2(b)(i)	Value of M in range $10\,g \leqslant M \leqslant 100\,g$ with unit.	**1**
	Correct calculation of V.	**1**
2(b)(ii)	Value of L_{oil} with $L_{oil} < L_{air}$.	**1**
2(b)(iii)	Second values of M, L_{air} and L_{oil}.	**1**
	Second value of L_{air} is larger than first value of L_{air}.	**1**
2(c)	Two values of Z calculated correctly. The final Z values must not be written as fractions.	**1**
2(d)	Calculation of percentage difference between candidate's two Z values. Comparison of percentage difference with 5% leading to a consistent conclusion.	**1**
2(e)	ρ_{oil} calculated with correct unit (e.g. $kg\,m^{-3}$).	**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 any L with a reason e.g. parallax error/hard to judge the end of the spring/hard to hold rule (still)/rule disturbs springs/rule not vertical. C ($L_{air} - L_{oil}$) is small so large uncertainty/large <u>percentage</u> uncertainty in ($L_{air} - L_{oil}$). D Volume or mass of paper clip not taken into account. E k determined on one result. F Small difference between ($L_{air} - L_{oil}$) values for the small and large nuts. *1 mark for each point up to a maximum of 4.*	**4**
2(f)(ii)	A Take more readings <u>and</u> plot a graph or take more readings <u>and</u> compare Z values (**not** "repeat readings" on its own). B Method to improve the measurement of L e.g. use white paper or lined or grid sheet behind spring/clamp rule/use clamped pointers/add marker(s) at the end<u>s</u> of the spring. C Use (vernier) calipers/travelling microscope **or** use larger (bigger) nuts / more nuts. D Use a thinn<u>er</u> or light<u>er</u> paperclip/use nylon or cotton thread **or** measure the mass of the paperclip (with or without nuts). E Method to improve determination of spring constant e.g. plot a force–extension graph (and find the gradient). F Extend the range between the size of the nuts **or** use a spring with a smaller k value/less stiff spring. *1 mark for each point up to a maximum of 4.*	**4**