CAMBRIDGE
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PHYSICS **9702/33**

Paper 3 Advanced Practical Skills 1 **February/March 2025**

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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Question	Answer	Marks
1(a)	Value of x in range 0.440 to 0.460 m.	**1**
	Value of I in range 0.0300 to 0.0600 A	**1**
1(b)	Six sets of readings of x and I (different x) with correct trend and without help scores 4 marks, five sets scores 3 marks etc. Correct trend is I increases as x increases.	**4**
	Range: $x_{min} \leqslant 0.200$ m and $x_{max} \geqslant 0.800$ m	**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. $1 / I / A^{-1}$.	**1**
	Consistency: All values of x must be given to the nearest mm.	**1**
	Significant figures: All values of $1 / I$ given to the same s.f. as (or one more than) the s.f. in raw I	**1**
	Calculation: Correct calculation of $1 / I$	**1**

Question	Answer	Marks
1(c)(i)	Axes: Axes must be labelled **with the correct quantities.** Scales must be chosen so that the plotted points occupy at least half the graph grid in both the *x* and *y* directions. Scale markings are no more than 2 cm (one large square) apart. Sensible scales must be used, no awkward scales (e.g. 3:10 or fractions).	**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: Trend of points must be negative. All points in the table (at least 5) must be plotted on the grid for this mark to be awarded. It must be possible to draw a straight line that is within ±**2.0 cm** (to scale) on the *x* axis (normally x-axis) of <u>all</u> plotted points.	**1**
1(c)(ii)	Line of best fit: 'Best fit' is judged by the balance of all points on the grid (at least 5 points) about the candidate's line. There must be an even distribution of points either side of the line along the full length. Lines must not be kinked or thicker than half a square. 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: gradient sign on answer line consistent with graph drawn. The hypotenuse of the triangle used should 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 $\Delta x / \Delta y$.	**1**
	y-intercept: **Either** Intercept read directly from the graph, with read-off at $x = 0$, accurate to half a small square in y direction. **Or** Correct read-off from a point on the line is substituted into $y = mx + c$ or an equivalent expression. Read-off accurate to half a small square in both x and y directions.	**1**
1(d)	a equal to candidate's gradient value **and** b equal to candidate's intercept value. Values must not be written as fractions or to only one significant figure.	**1**
	Units for a **and** b correct and consistent with readings (e.g. $m^{-1}A^{-1}$ for a and A^{-1} for b)	**1**
1(e)	Correct calculation of P	**1**

Question	Answer	Marks
2(a)	Raw L to nearest mm **and** final value for L in range 11.0 to 13.0 cm, with unit.	**1**
	Value for raw T_0 to the nearest degree	**1**
2(b)(i)	Values for raw s and raw d to the nearest mm, with units.	**1**
2(b)(ii)	Value of raw H_2 to the nearest mm and less than H_1, with units	**1**
2(b)(ii)	Value of T greater than T_0	**1**
2(b)(iii)	Absolute uncertainty in H_1–H_2 in range 2 to 4 mm Correct method of calculation to find percentage uncertainty e.g. absolute uncertainty/value from **(b)(iii))** × 100. If repeated readings have been taken, then the uncertainty can be half the range if the working is clearly shown, but **not** zero if values are equal.	**1**
2(b)(iv)	Correct calculation of ΔL, with unit	**1**
2(c)(i)	Second value of L	**1**
2(c)(ii)	Second values of H_1, H_2 and T	**1**
	Quality: Second L greater than first L, And both H_1–H_2 values positive and second H_1-H_2 greater than first H_1–H_2	**1**
2(d)	Two values of k calculated correctly. Values not written as fractions or given to only one significant figure.	**1**
2(e)	Calculation of percentage difference between candidate's two k values. Comparison of percentage difference with 30% leading to a consistent conclusion.	**1**

Question	Answer	Marks
2(f)(i)	A Two readings are <u>not enough to draw a (valid) conclusion</u> , e.g. reference to a relationship B Difficult to measure <u>*s*</u> and / or <u>*d*</u> **with** reason, e.g. parallax error / difficult to judge centre of nail / bolt C Difficult to see mark inside measuring cylinder when adding water, **with reason**. D Problem with measurement of temperature explained: E.g. Water temperature may vary with position / room temperature changes affect $T–T_0$ in 2nd set of values / temperature varies with time, so measurement of H_2 at known temperature is difficult E Pipe above mark heats up: E.g. Conduction or steam may heat parts of pipe above mark F $(H_1 – H_2)$ has large percentage uncertainty G Difficult to measure *L* with reason: E.g. because end of pipe is uneven / not square / pipe is curved H Difficult to measure *H* with reason: e.g. <u>rule</u> / knocks/moves/displaces wooden strip *1 mark for each point up to a maximum of 4.*	**4**

Question	Answer	Marks
2(f)(ii)	A Take more readings <u>and</u> plot a graph / calculate more *k* values and <u>compare.</u> B Measure *s* and / or *d* before setting up apparatus C Use mark on outside of measuring cylinder D Use a stirrer / (thermostatically controlled) water bath E Record / film / video with thermometer, metre rule and wooden strip in view. F Use shorter measuring cylinder G Use longer *L* value / shorter *s* and/or longer *d* / travelling microscope for (H_1–H_2) directly H Sand end of pipe I Use pipe-cutter (to ensure square cut) J Clamp rule *1 mark for each point up to a maximum of 4.*	**4**