CAMBRIDGE
International Education

Cambridge International AS & A Level

PHYSICS **9702/33**

Paper 3 Advanced Practical Skills 1 **February/March 2024**

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.

Cambridge International will not enter into discussions about these mark schemes.

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Question	Answer	Marks
1(a)(i)	Value of x with consistent unit.	**1**
1(a)(ii)	Value of T in range 0.80 s to 2.00 s, with unit.	**1**
1(a)(ii)	Evidence of repeat measurements of T (at least two measurements of 5T).	**1**
1(b)	Six sets of readings of x and T with correct trend and without help scores 4 marks, five sets scores 3 marks etc.	**4**
1(b)	Range: $x_{min} \leqslant 7$ cm **and** $x_{max} = 19$ cm.	**1**
1(b)	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. $\sqrt{x^3}$ / $cm^{1.5}$.	**1**
1(b)	Consistency: All raw values of x must be given to the nearest mm.	**1**
1(b)	Significant figures: All values of $\sqrt{x^3}$ given to same s.f. as x (or one more than s.f of x).	**1**
1(b)	Calculation: Values of $\sqrt{x^3}$ calculated correctly.	**1**
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**
1(c)(i)	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**

Question	Answer	Marks
1(c)(i)	Quality: All points in the table must be plotted (at least 5) for this mark to be awarded. It must be possible to draw a straight line that is within $\pm$ 5 $cm^{1.5}$ in the *x* direction from all 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 4 points left after the anomalous point is disregarded.	**1**
1(c)(iii)	Gradient: Sign of gradient must match graph drawn. The hypotenuse of the triangle used must be greater than half the length of the drawn line. Method of calculation must be correct (not $\Delta x / \Delta y$). Both read-offs must be accurate to half a small square in both the *x* and *y* directions.	**1**
1(c)(iii)	*y*-intercept: **Either** 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 $\sqrt{x^3}$ = zero accurate to half a small square in *y* direction.	**1**
1(d)	*a* equal to candidate's gradient, and *b* equal to candidate's intercept. Values must not be written as fractions or to 1 significant figure.	**1**
1(d)	Units for *a* and *b* correct and consistent with value (e.g. s $cm^{-1.5}$ for *a* and s for *b*).	**1**

Question	Answer	Marks
2(a)(i)	Value for L **and** in range 42.0 to 46.0 cm.	**1**
2(a)(i)	Raw Value for d_A to nearest mm **and** < 50.0 cm.	**1**
2(a)(ii)	Value for θ_A in range 30 to 80° **and** raw values to nearest degree,	**1**
2(a)(ii)	Evidence of repeated measurements of θ_A,	**1**
2(a)(iii)	Uncertainty of 2° to 5° and correct method of calculation to obtain percentage uncertainty in θ_A. If several readings have been taken, then the absolute uncertainty can be half the range if working clearly shown, but not zero if the values are equal.	**1**
2(a)(iv)	Correct calculation of F_A.	**1**
2(a)(v)	Values for d_B , θ_B and F_B.	**1**
2(b)	Second values for d_A and θ_A.	**1**
2(b)	Second values for d_B and θ_B.	**1**
2(b)	Quality: $\theta_B > \theta_A$.	**1**
2(c)	Two values of k calculated correctly. The final k values must not be written as fractions or given to only one significant figure.	**1**
2(d)	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(e)(i)	A Two readings / k values are not enough to draw a (valid) conclusion. B Board may not be vertical. C Difficult to measure d_A (or d_B), with reason (e.g. parallax / finding centre of mass). D Difficult to measure θ without disturbing strip. E Board moves <u>when strip is pushed.</u> F Difficult to identify 'just sticks' position/angle, with reason (e.g. varies when repeating / bench surface is uneven). G Mass of putty not considered. *1 mark for each up to a maximum of 4.*	**4**
2(e)(ii)	A Take more readings <u>and</u> plot a graph / calculate more k values and <u>compare</u>. B Use set square between board and bench / plumbline / fix board to wall. C Measure to edge of mass then add half the diameter / other workable method of avoiding parallax. D Measure distance of base of strip from board then calculate θ / fix strip before using protractor / take photo and measure angle on it. E Clamp stand to bench / use two stands. F Put flatter surface on bench / sand bench. G Add mass of putty to the 100 g / use tape instead of putty. *1 mark for each up to a maximum of 4.*	**4**