CAMBRIDGE
International Education

Cambridge International AS & A Level

PHYSICS **9702/33**

Paper 3 Advanced Practical Skills 1 **May/June 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.

Cambridge International is publishing the mark schemes for the May/June 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

Question	Answer	Marks
1(a)	Value of a in range 46.0–49.0 cm with unit.	**1**
1(b)	Value(s) of raw y to the nearest mm with unit.	**1**
1(c)	Six sets of readings of n (different values, not including zero) and y with correct trend (y decreases as n increases) and without help from the Supervisor scores 5 marks, five sets scores 4 marks etc.	**5**
	Range: Includes $n = 1$ **and** $n = 7$.	**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. y / cm and no units for n or $1 / n$.	**1**
	Significant figures: All values of y / n must be given to 3 s.f.	**1**
	Calculation: Correct calculation of y / n.	**1**
1(d)(i)	Axes: Axes must be labelled with the required quantities. Scales must be chosen so that the plotted points occupy at least half the graph grid in both x and y directions. Scale markings are no more than 2 cm (one large square) apart. Sensible scales must be used. Scales must not be awkward (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 the x and y directions.	**1**
	Quality: All points in the table (at least 5) must be plotted on the grid. Trend must be correct. It must be possible to draw a straight line that is within $\pm$ 0.04 on the $1 / n$ axis of all plotted points.	**1**

Question	Answer	Marks
1(d)(ii)	Line of best fit: 'Best fit' is judged by 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. Line must not be kinked or thicker than half a small 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**
1(d)(iii)	Gradient: 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. The method of calculation must be correct, not $\Delta x / \Delta y$. The gradient sign on the answer line must be consistent with the graph drawn.	**1**
	y-intercept: Correct read-off from a point on the line and substituted correctly into $y = mx + c$ or an equivalent expression. Read-off accurate to half a small square in both the x and y directions. **or** Intercept read directly from the graph, with read-off at $1 / n = 0$, accurate to half a small square in y direction.	**1**
1(e)	Value of P = candidate's gradient **and** value of Q = – candidate's intercept. The values must not be written as fractions or given to only one significant figure.	**1**
	Units for P and Q: m, cm or mm consistent with y values given.	**1**
1(f)	Correct calculation of R.	**1**

Question	Answer	Marks
2(a)(i)	Value(s) of raw L_0 to the nearest mm with unit.	**1**
2(a)(ii)	Percentage uncertainty in L_0 based on absolute uncertainty in the range 2–10 mm. Correct method of calculation to obtain percentage uncertainty e.g. (absolute uncertainty / value from **(a)(i)**) $\times$ 100. If several readings have been taken, then the absolute uncertainty can be half the range (but not zero) provided the working is shown clearly.	**1**
2(b)	Values of w_0 and t **and** $w_0 > t$.	**1**
	All raw values of w_0 and t to the same precision, either all to 0.01 mm or all to 0.001 mm with a unit.	**1**
2(c)(i)	Values of L and w **and** $L > L_0$.	**1**
2(c)(ii)	Correct calculation of ΔL and Δw.	**1**
2(c)(iii)	Justification for significant figures in ΔL linked to significant figures of $(L - L_0)$ (when calculated to the correct number of decimal places).	**1**
2(d)	Second values of L and w.	**1**
	Second value of $w <$ first value of w.	**1**
2(e)	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(f)	Calculation of percentage difference between candidate's two k values. Comparison of percentage difference with 25% leading to a consistent conclusion.	**1**
2(g)	Correct calculation of F.	**1**

Question	Answer	Marks
2(h)(i)	A Two readings are not enough to draw a (valid) conclusion (**not** "not enough for accurate results", "few readings"). B Difficult to set up $\underline{L_0}$ with a reason e.g. because not sure/difficult to judge when the rubber band is just straight/just not stretched. C Difficult to measure $\underline{L}$ or $\underline{L_0}$ or length of rubber band with reason e.g. because of parallax error/measuring to curved edge or surface. D No account of thickness change e.g. not measuring thickness change. E Difficult to measure $\underline{w}$, $\underline{w_0}$ or $\underline{t}$ with a reason e.g. micrometer squashes the rubber band because it is not rigid. F Difficult to manipulate micrometer to measure $\underline{t}$ when rubber band is positioned between the clamps. *1 mark for each point up to a maximum of 4.*	**4**

Question	Answer	Marks
2(h)(ii)	A Take more readings (for different values of L) <u>and</u> plot a graph **or** take more readings <u>and</u> compare k values (**not** "repeat readings" on its own). B Hang rubber band from newton meter (to check not under tension). C Use calipers (to measure L or L_0) **or** use clamped rule (with pointers) **or** use thinner rods. D Measure thickness <u>when stretched/loaded/under tension</u>. E Lay rubber band flat on surface to measure w_0 **or** remove rubber band to measure t **or** use travelling microscope. F Measure multiple thicknesses nt (and divide by n). *1 mark for each point up to a maximum of 4.*	**4**