Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/33**

Paper 3 Advanced Practical Skills 1 **October/November 2023**

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 October/November 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

Question	Answer	Marks
1(a)	Value of L in range 52.5–53.5 cm.	**1**
1(b)	Value of T in the range 1.00–2.00 s.	**1**
	At least two measurements of nT where $n \geqslant 5$.	**1**
1(c)	Six (or more) sets of readings of S (different values) and T with the correct trend (as S increases T decreases) and without help from the Supervisor scores 4 marks, five sets scores 3 marks, etc.	**4**
	Range: Includes $S \leqslant 10.0$ cm **and** $S \geqslant 40.0$ 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. $\sqrt{(L - S)}$ / $\text{cm}^{1/2}$.	**1**
	Consistency: All values of S must be given to the nearest 0.1 cm.	**1**
	Calculation: Values of $\sqrt{(L - S)}$ are correct.	**1**
1(d)(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. 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 x and y directions.	**1**
	Quality: Trend of points must be positive. All points in the table must be plotted on the grid (at least 5). It must be possible to draw a straight line that is within $\pm$ 0.2 $\text{cm}^{1/2}$ ($\pm$ 0.02 $\text{m}^{1/2}$) on the $\sqrt{(L - S)}$ axis of all plotted points.	**1**

Question	Answer	Marks
1(d)(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**
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: 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 and substituted correctly into $y = mx + c$ or an equivalent expression. Read-off accurate to half a small square in both x and y directions.	**1**
1(e)(i)	Value of A = candidate's gradient **and** value of B = candidate's y-intercept. The values must not be written as fractions or surds or given to only one significant figure.	**1**
	Unit for A: $\mathrm{s\,m^{-1/2}}$ or $\mathrm{s\,cm^{-1/2}}$ **and** unit for B: s.	**1**
1(e)(ii)	g calculated correctly using $g = \pi^2 / A^2$ and with correct unit.	**1**

Question	Answer	Marks
2(a)(i)	x, y and z measured to the nearest millimetre **and** x in the range 0.495–0.505 m.	**1**
	Correct calculation of volume.	**1**
2(a)(ii)	Justification for significant figures in V linked to significant figures in x, y and z.	**1**
2(b)(i)	d in the range 0.145–0.155 m.	**1**
2(b)(ii)	F measured to the nearest 0.01 N **and** final F in range 0.10–1.00 N.	**1**
	At least two measurements of F.	**1**
2(b)(iii)	Percentage uncertainty in F based on an absolute uncertainty in the range 0.02–0.06 N. Correct method of calculation to obtain percentage uncertainty, e.g. (absolute uncertainty $\times$ 100 / final value from **(b)(ii)**). If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is shown clearly.	**1**
2(b)(iv)	Second value of d **and** second value of F.	**1**
	Second value of F larger than first value of F.	**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**
2(e)	Correct calculation of ρ 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 *y* is small so uncertainty is large **or** large <u>percentage</u> uncertainty in measuring *y*. C Difficult to measure *d* with a reason e.g. difficult to judge the centre of the mass, parallax error, difficult to hold/maintain ruler parallel to strip. D Difficult to get a value of *F* <u>with reason</u> e.g. reading changes suddenly **or** difficult to determine when strip leaves the rod. E Difficult to keep/ensure/maintain the newton meter vertical. F Newton meter not at the end of the strip. G Mass of adhesive putty not taken into account. *1 mark for each point up to a maximum of 4.*	**4**
2(f)(ii)	A Take more readings (for different values of *d*) <u>and</u> plot a graph **or** take more readings <u>and</u> compare *k* values (**not** "repeat readings" on its own). B Improved method to measure *y* e.g. use micrometer or (vernier/digital) calipers. C Improved method to measure *d* e.g. measure to the edge of the mass <u>and</u> add on the radius of the mass **or** clamp ruler. D Improved method to get value *F* e.g. video/record/film <u>with newton meter</u> (and strip) <u>in view</u> **or** force sensor <u>and</u> data logger. E Improved method to ensure vertical e.g. use a clamped metre rule <u>and</u> a set square to ensure vertical **or** use a plumb line as reference. F Add a hook/tape at end **or** tape string to strip **or** glue string to strip. G Subtract weight of putty from *F* **or** add mass of putty onto the mass **or** tape mass (instead of putty). *1 mark for each point up to a maximum of 4.*	**4**