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PHYSICS **9702/33**

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

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Question	Answer	Marks
1(a)	Final value of L in the range 44.0–46.0 cm **and** final value of V in range 0–2.0 V.	**1**
1(b)	Six sets of readings of L (different values) and V with the correct trend (as L increases, V increases) **and** without help from supervisor scores 3 marks, five sets scores 2 marks, etc.	**3**
	Range: Uses $L \leqslant 25.0$ cm **and** $L \geqslant 85.0$ cm.	**1**
	Column headings: Each column heading must contain a quantity and a unit. The presentation of quantity and unit must conform to accepted scientific convention, e.g. $\frac{1}{L}$ / cm^{-1}	**1**
	Consistency: <u>All</u> raw values of L must be given to 0.1 cm.	**1**
	Significant figures: All values of $\frac{1}{V}$ must be given to the same number of s.f. as (or one more than) the number of s.f. in raw V values.	**1**
	Calculation: Values of $\frac{1}{V}$ are correct.	**1**

Question	Answer	Marks
1(c)(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 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 ⩽ 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 (at least 5) on the grid for this mark to be awarded. It must be possible to draw a straight line that is within $\pm$ 0.5 V^{-1} ($\pm$ 0.0005 mV^{-1}) on the $\frac{1}{V}$ axis (normally *y*-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 five 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 five points left after the anomalous point is disregarded.	**1**

Question	Answer	Marks
1(c)(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. Method of calculation must be correct (not $\Delta x / \Delta y$). Gradient sign on answer line consistent with graph drawn.	**1**
	y-intercept: Intercept read directly from the graph, with read-off at $\frac{1}{L} = 0$, accurate to half a small square in *y* direction. **or** Correct read-off from a point on the line 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(d)	*J* = candidate's gradient value **and** *W* = candidate's *y*-intercept value. The values must not be written as fractions, roots or given only to one significant figure.	**1**
	Correct unit for *J*: V^{-1} m or V^{-1} cm **and** correct unit for *W*: V^{-1}.	**1**
1(e)(i)	Value of *d* in the range 0.200–0.300 mm with unit **and** <u>all</u> raw values given to either 0.01 mm or <u>all</u> to 0.001 mm.	**1**
	Repeat values of *d*.	**1**
1(e)(ii)	ρ correctly calculated from *J* and *W*: $\rho = \frac{\pi d^2 RW}{4J}$ Final answer with correct power of ten for ρ.	**1**

Question	Answer	Marks
2(a)	Mass *m* of A (and string) measured **and** to the nearest 0.1 g or better.	**1**
2(b)(i)	Value of *b* in the range 2.0–4.0 cm, recorded to the nearest millimetre **and** value of *d* in the range 9.0–11.0 cm, recorded to the nearest millimetre.	**1**
	Value of $\sqrt{(d-b)}$ calculated with correct unit i.e. $cm^{1/2}$.	**1**
2(b)(ii)	Number of significant figures in $\sqrt{(d-b)}$ must link to number of significant figures in $(d-b)$.	**1**
2(b)(iii)	Final value of *H*: $b < H < d$.	**1**
	Evidence of repeats.	**1**
2(b)(iv)	Percentage uncertainty based on absolute uncertainty in *H* in range 0.3–1.0 cm. Correct method of calculation to find percentage uncertainty e.g. (absolute uncertainty / value from **2(b)(iii)**) × 100. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown.	**1**
2(b)(v)	$\sqrt{(H-b)}$ calculated correctly.	**1**
2(c)	Second values of *H* and *M*.	**1**
	Second value of *H* > first value of *H*.	**1**
2(d)	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(e)	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(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 *b* with a reason e.g. difficult to locate the centre of the ball / holding ball A whilst measuring at the same time. C Difficult to measure *H* with reason e.g. difficult to judge <u>when</u> at maximum height / at maximum height for a <u>short</u> period of time / final horizontal position not known. D Difficulty with <u>collision</u> / <u>impact</u> e.g. ball B and ball A are not at the same height / ball A does not hit ball B head-on / glances off at an angle. E Difficulty with <u>mass</u>(es) with reason e.g. mass of adhesive putty not taken into account / mass added is not uniformly distributed / mass not added at the centre of gravity. *1 mark for each point up to a maximum of 4.*	**4**

Question	Answer	Marks
2(f)(ii)	A Take more readings (for different values of *M*) and plot a graph **or** take more readings and compare *k* values (**not** "repeat readings" on its own). B Use a clamped rule (to measure *b*) **or** measure to the bottom and top of ball **or** measure diameter of ball and measure to top or bottom of ball **or** clamp or place stop for ball A (related to measuring *b*). C Video / record / film with rule in view **or** place grid behind **or** trial and error with pointer / stop. D Set up the two strings with two separate clamps (so balls are at the same height at the point of impact). E Specified method to determine / account for the mass of the adhesive putty e.g. measure mass of adhesive putty and add to mass or measure total mass **or** repeat with heavier ball (A) instead of using extra 10 g mass. *1 mark for each point up to a maximum of 4.*	**4**