Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/33**

Paper 3 Advanced Practical Skills 1 **May/June 2022**

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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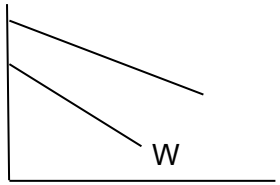
[Turn over

Question	Answer	Marks
1(a)	Value of L to the nearest mm with unit **and** in the range 74.0–76.0 cm.	**1**
1(b)	Values of raw V_1 and V_2 to the nearest mV with unit.	**1**
	$V_2 > V_1$.	**1**
1(c)	Six sets of readings of d, V_1 and V_2 with correct trend (d increases as average V_1 increases and average V_2 decreases) and without help from the Supervisor scores 4 marks, five sets scores 3 marks, etc.	**4**
	Range: $d_{min} \leqslant 22.0$ cm **and** $d_{max} \geqslant 65.0$ 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. $(\frac{V_2}{V_1})d$ / m, d^2 / m^2.	**1**
	Significant figures: All values of $(\frac{V_2}{V_1})d$ must be given to the same number of s.f. as (or one more than) the least number of s.f. in d, V_1 and V_2.	**1**
	Calculation: Correct calculation of $(\frac{V_2}{V_1})d$.	**1**

Question	Answer	Marks
1(d)(i)	Axes: Sensible scales must be used, no awkward scales (e.g. 3:10 or fractions). Scales must be chosen so that the plotted points occupy at least half the graph grid in both the *x* and *y* directions. Axes must be labelled with the quantity that is being plotted. Scale markings are no more than 2 cm (one large square) apart.	**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: All points in the table must be plotted (at least 5) on the grid for this mark to be awarded. Trend of points must be negative. It must be possible to draw a straight line that is within $\pm$ 2.5 cm (to scale) on the $(\frac{V_2}{V_1})d$ axis of all plotted points.	**1**
1(d)(ii)	Line of best fit: Judge by the balance of all points on the grid about the candidate's line (at least 5 points). There must be an even distribution of points either side of the line along the full length. Allow one anomalous point only if clearly indicated (i.e. circled or labelled) by the candidate. There must be at least 5 points left after the anomalous point is disregarded. Lines must not be kinked or thicker than half a small square.	**1**
1(d)(iii)	Gradient: The hypotenuse of the triangle used must 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 matches graph drawn.	**1**
	y-intercept: Correct read-off from a point on the line and substituted into $y = mx + c$ or an equivalent expression. 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 $d^2 = 0$, accurate to half a small square.	**1**

Question	Answer	Marks
1(e)	Value of P = candidate's gradient **and** value of Q = candidate's intercept. The values must not be fractions.	**1**
	Unit for P: m^{-1}, cm^{-1} or mm^{-1} **and** unit for Q: m, cm or mm.	**1**
1(f)	Line labelled W with steeper gradient and smaller intercept. 	**1**

Question	Answer	Marks
2(a)(i)	Raw value(s) of A to the nearest mm with unit **and** $A \geqslant 5.0$ cm.	**1**
	Evidence of repeat readings.	**1**
2(a)(ii)	Percentage uncertainty in A based on absolute uncertainty $\geqslant 3$ mm. If several readings have been taken, then the absolute uncertainty can be half the range (but not zero) provided the working is clearly shown. Correct method of calculation to obtain percentage uncertainty.	**1**
2(b)(i)	Value of θ to the nearest degree in the range 60°–70°.	**1**
	Value of H with unit.	**1**
2(b)(ii)	Correct calculation of $\cos^2 \theta$.	**1**
2(c)	Second value of θ.	**1**
	Second value of H.	**1**
	Second value of H > first value of H.	**1**
2(d)(i)	Two values of k calculated correctly. The final k values must not be written as fractions.	**1**
2(d)(ii)	Justification for significant figures in k linked to significant figures in H, A and either θ or $\cos \theta$.	**1**
2(e)	Calculation of percentage difference between candidate's two k values. Comparison of percentage difference with 20% 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 θ or angle with reason e.g. hand moves during measurement/holding protractor in hand/parallax error/string too thick. C Difficult to judge the horizontal or vertical. D Masses or strings collide/hit stand/string wraps around boss/string slips off rod of clamp/trajectory of motion out of alignment/masses not in the right plane. E Difficult to measure *H* or *A* with reason e.g. uncertain where the top measurement is/measured distance not the same as the height the mass falls/mass moves when touched or measured. *1 mark for each point up to a maximum of 4.*	**4**
2(f)(ii)	A Take more readings and plot a graph or take more readings and compare *k* values (**not** "repeat readings" on its own). B Method to improve measurement of θ e.g. clamp the 10 g mass or clamp protractor/thinner string/put a board behind with marked angle(s)/take a photo and measure angle/project angle onto a screen/use a stop at the correct angle. C Method to determine the vertical or horizontal e.g. use a plumb-line/spirit level/set square with detail. D Method to improve alignment e.g. use longer rod/notched rod/larger diameter on end of rod/place plasticine on the end of the rod/use guide. E Improved method to measure *H* or *A* e.g. use a clamped pointer/take a photo with a scale/use large dividers or calipers. *1 mark for each point up to a maximum of 4.*	**4**