Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/35**

Paper 3 Advanced Practical Skills 1 **October/November 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(s) of raw L to the nearest mm.	**1**
	Correct calculation of k.	**1**
1(b)	Six sets of readings of a (different values) and L with the correct trend (L increases as a increases) and without help from the Supervisor scores 4 marks, five sets scores 3 marks etc.	**4**
	Range: $a_{min} \leqslant 20.0\,\text{cm}$ **and** $a_{max} \geqslant 40.0\,\text{cm}$.	**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. $\frac{1}{a}$ / m^{-1}, $\frac{1}{a}$ (cm^{-1}), $\frac{1}{e}$ / 1 / cm.	**1**
	Consistency: All values of a must be given to the nearest 0.1 cm.	**1**
	Significant figures: All values of $\frac{1}{a}$ must be given to the same number of s.f. as (or one more than) the number of s.f. in the raw a values.	**1**
	Calculation: Values of $\frac{1}{e}$ calculated correctly.	**1**

Question	Answer	Marks
1(c)(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 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 positive. It must be possible to draw a straight line that is within $\pm$ 0.005 cm^{-1} ($\pm$ 0.500 m^{-1}) on the $\frac{1}{a}$ axis (normally *x*-axis) of 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) about the candidate's line. There must be an even distribution of points either side of the line along the full length. Candidates do not need to identify an anomalous point. However if there is a point off trend, it may be identified as anomalous by circling or labelling it. There must be at least 5 points left after one anomalous point is disregarded. Lines must not be kinked or thicker than half a small square.	**1**

Question	Answer	Marks
1(c)(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 $\frac{1}{a} = 0$, accurate to half a small square.	**1**
1(d)(i)	Value of B = candidate's gradient value **and** value of C = candidate's y-intercept value. Values must not be written as fractions.	**1**
	B has no unit **and** unit for C (mm^{-1} or cm^{-1} or m^{-1}) correct.	**1**
1(d)(ii)	Correct calculation of R.	**1**

Question	Answer	Marks
2(a)	Final d value to the nearest mm **and** raw d to nearest mm **and** in the range 0.068–0.072 m.	**1**
2(b)(i)	p in the range 0.055–0.065 m.	**1**
	All raw time measurements to the nearest 0.1 s or all to the nearest 0.01 s **and** final T in range 0.50 s $\leqslant T \leqslant$ 1.00 s.	**1**
	Repeats: At least two measurements of at least 2T.	**1**
2(b)(ii)	Absolute uncertainty in nT in the range 0.2–0.4 s or absolute uncertainty in T in the range (0.2 / n) s to (0.4 / n) s where n is the number of oscillations used. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if working is clearly shown. Correct method of calculation to find percentage uncertainty.	**1**
2(b)(iii)	Correct calculation of p^2 and T^2p.	**1**
2(b)(iv)	Justification for significant figures in T^2p correctly linked to significant figures in p and raw times.	**1**
2(b)(v)	Second value of p and second value of T.	**1**
	Second value of T larger than first value of T.	**1**
2(c)	Two values of q calculated correctly. The final q values must not be written as fractions.	**1**
2(d)	Calculation of percentage difference between candidate's two q values. Comparison of percentage difference with 15% leading to a consistent conclusion.	**1**
2(e)	Correct calculation of g with correct unit (e.g. m s^{-2}).	**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 Difficulty linked to the card e.g. card is not flat/card bends (when making hole at P)/difficult to line up pin with P and cork and press without bending card. C Difficult to judge/decide/determine when to start and/or stop the stop-watch or when oscillation begins and/or ends. D Few/small number of oscillations or oscillations die quickly. E Oscillations not in one plane or card hits stand. *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 *q* values (**not** "repeat readings" on its own). B Method to ensure card remains flat when making hole e.g. mat below triangle or use thicker/stiffer/heavier card. C1 Place a grid behind the apparatus or fiducial mark at the centre of the oscillation or plumb-line at centre. C2 Video/film/record with timer/frame-by-frame. D Use longer pin or named material which has less friction than cork **or** use larger hole. E Use thicker/stiffer/heavier card (*award thicker/stiffer/heavier card only once as B or E*) **or** turn off fans/air conditioning **or** use a wind-shield. *1 mark for each point up to a maximum of 4.*	**4**