Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/31**

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.

Cambridge International will not enter into discussions about these mark schemes.

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[Turn over

Question	Answer	Marks
1(a)	Value of d with unit and in the range 18.0–20.0 cm.	**1**
1(b)	Value of T on the answer line with unit and in the range 0.4–1.0 s.	**1**
	Evidence of repeat readings: at least two values of at least $5T$.	**1**
1(c)	Five sets of readings of d (different values) and time with correct trend (as d decreases, time decreases) and without help from the Supervisor scores 4 marks, four sets scores 3 marks etc.	**4**
	Range: $d_{min} \leqslant 9.5$ 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. d / cm , T / s , T^2 / s^2.	**1**
	Consistency: All values of raw d must be given to the nearest mm.	**1**
	Calculation: Values of T^2 are correct.	**1**
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 must be 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 4) 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 ± 1.0 cm (± 0.01 m) (to scale) on the d 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 4) 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 4 points left after one 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**
1(d)(iii)	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 $d = 0$, accurate to half a small square.	**1**
1(e)	Value of A = candidate's gradient **and** value of B = candidate's intercept. Values must not be written as fractions.	**1**
	Unit for A correct e.g. $s^2\,cm^{-1}$ or $s^2\,m^{-1}$ or $s^2\,mm^{-1}$ **and** unit for B is s^2.	**1**
1(f)	g correctly calculated with a consistent unit.	**1**

Question	Answer	Marks
2(a)(i)	Value of l to the nearest mm and final $l \leqslant 25.0$ cm with unit.	**1**
2(a)(ii)	Final value of p with unit and in the range 11.0–13.0 cm.	**1**
2(a)(iii)	Correct calculation of $\sqrt{\left(1-\frac{p^2}{l^2}\right)}$.	**1**
2(b)	Justification for significant figures in R linked to significant figures in p and l.	**1**
2(c)(i)	Values of raw θ given to the nearest degree **and** final θ in range 15°–35°.	**1**
	Evidence of repeat values of θ.	**1**
2(c)(ii)	Absolute uncertainty in θ in range 3°–8°. 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(d)	Second values of l and p.	**1**
	Second value of θ.	**1**
	Second value of θ is less than first value of θ.	**1**
2(e)	Two values of k calculated correctly. The final k values must not be written as fractions.	**1**
2(f)	Calculation of percentage difference between candidate's two k values. Comparison of percentage difference with 10% leading to a consistent conclusion.	**1**

Question	Answer	Marks
2(g)(i)	A Two readings are not enough to draw a (valid) conclusion (**not** "not enough for accurate results", "few readings"). B Difficulty measuring l with reason e.g. difficult to locate centre of clay/pendulum moves as rule touches it/clay has irregular shape/rule not vertical/parallax. C Difficulty with *p* with a reason e.g. difficult to locate centre of clay (*credit only once in B or C*)/ parallax error (*credit only once in B or C*)/*p* may change before release as hand moves/need to move eyes to look at protractor before release. D Difficulty measuring (max) θ/angle with a reason e.g. protractor held in hand/hand moves while holding protractor/only achieved for a very short time/ difficult to judge or predict where maximum will be. E Difficulty with collision with reason e.g. inconsistency/twisting/shape/goes off at an angle/miss each other. *1 mark for each point up to a maximum of 4.*	**4**
2(g)(ii)	A Take more readings and plot a graph or take more readings and compare *k* values (**not** "repeat readings" on its own). B Improved method to measure l e.g. add a horizontal pointer or marker from the centre of the clay/clamp rule/detail of method to ensure rule is vertical. C Improved method to measure/ensure *p* has the same value in each experiment e.g. use of a stop or card gate. D Improved method for measuring θ e.g. clamp protractor or video/record/film with protractor in view. E Improved method e.g. use board to ensure flat surfaces of clay. *1 mark for each point up to a maximum of 4.*	**4**