

Cambridge International AS & A Level

PHYSICS**9702/31**

Paper 3 Advanced Practical Skills 1

May/June 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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This document consists of **9** printed pages.

Question	Answer	Marks
1(a)	Value of y to the nearest mm in the range 45.0–55.0 cm with unit.	1
	Value of I to the nearest 0.1 mA with unit.	1
1(b)	Value of y in (b) greater than value of y in (a) .	1
1(c)	Six sets of readings of n (different values) and y with correct trend (average y decreases as n increases) and without help from the Supervisor scores 4 marks, five sets scores 3 marks etc.	4
	Range: Values of n must include 0.5 and 4.	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. y/m . There must be no unit for n and no unit for $n/(n+1)$.	1
	Significant figures: All values of $n/(n+1)$ must be given to 2 significant figures.	1
	Calculation: Correct calculation of $n/(n+1)$.	1
1(d)(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 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 \leq half a small square. Points must be plotted to an accuracy of half a small square in both the x and y directions.	1
	Quality: All points in the table (at least 5) must be plotted on the grid. Trend of points on graph must be negative. It must be possible to draw a straight line that is within ± 0.02 on the $n/(n+1)$ axis of <u>all</u> plotted points.	1

Question	Answer	Marks
1(d)(ii)	<p>Line of best fit: 'Best fit' is judged by 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. Line must not be kinked or thicker than half a small square.</p> <p>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.</p>	1
1(d)(iii)	<p>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.</p>	1
	<p>y-intercept: 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 the x and y directions. or Intercept read directly from the graph, with read-off at $n / (n + 1) = 0$, accurate to half a small square in y direction.</p>	1
1(e)	<p>Value of $P = -$ candidate's gradient and value of $Q =$ candidate's intercept. The values must not be written as fractions or given to only one significant figure.</p>	1
	<p>Units for P and Q: mm or cm or m consistent with y values given.</p>	1
1(f)	Correct calculation of C .	1

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Question	Answer	Marks
2(a)(i)	Value(s) of raw L to the nearest mm with unit.	1
2(a)(ii)	Value(s) of M to the nearest 0.1 g or better with unit.	1
2(a)(iii)	Correct calculation of S .	1
2(a)(iv)	Justification for significant figures in S linked to significant figures in L and M .	1
2(b)(i)	Value(s) of raw a to the nearest mm and final value in the range 1.20–1.80 cm with unit.	1
2(b)(ii)	Percentage uncertainty in a based on absolute uncertainty in the range 2–10 mm. Correct method of calculation to obtain percentage uncertainty e.g. (absolute uncertainty / value from (b)(i)) \times 100. If several readings have been taken, then the absolute uncertainty can be half the range (but not zero) provided the working is shown clearly.	1
2(c)	Value of T in the range 2.0–10.0 s with unit.	1
	Repeats: At least two measurements of at least $3T$.	1
2(d)	Second values of m and a .	1
	Second value of $T >$ first value of T .	1
2(e)	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(f)	Calculation of percentage difference between candidate's two k values. Comparison of percentage difference with 10% leading to consistent conclusion.	1

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Question	Answer	Marks
2(g)(i)	<p>A Two readings are not enough to draw a (valid) conclusion (not “not enough for accurate results”, “few readings”).</p> <p>B Difficult to measure \underline{a} with reason e.g. masses not parallel / masses too wide / difficult to judge or determine the centre of mass / parallax error / stem of wire not straight / masses are angled on rod.</p> <p>C Oscillations in other planes.</p> <p>D Difficulty with measuring \underline{T} with reason e.g. difficult to judge when an oscillation starts/ends/is complete / T varies with amplitude or angle.</p> <p>E Difficulty with set-up e.g. wire or masses move on rod during oscillation / rod is unbalanced or not horizontal / difficult to make rod horizontal / difficult to position wire in the centre of rod.</p> <p>F Difficulty with adhesive putty with detail e.g. mass of adhesive putty is not taken into account / mass of adhesive putty is different on each side.</p> <p>G Difficulty with the angle or point of release e.g. making or judging or setting 90° angle / ensuring the angle is the same each time.</p> <p><i>1 mark for each point up to a maximum of 4.</i></p>	4

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Question	Answer	Marks
2(g)(ii)	<p>A Take more readings (for different values of L) <u>and</u> plot a graph or take more readings <u>and</u> compare k values (not “repeat readings” on its own).</p> <p>B Use thinner masses / use calipers (in order to measure a).</p> <p>D Workable method to measure T e.g. marker at centre of oscillation / video/film/record plus timer/view frame by frame.</p> <p>E Make a notch or groove in the rod / glue wire to the rod / tape wire to the rod / glue masses to the rod.</p> <p>F (Use balance to) <u>measure mass</u> of adhesive putty <u>and</u> add onto m / measure mass of adhesive putty <u>and</u> use the same mass of putty on each side / <u>measure mass</u> of putty and mass at the same time.</p> <p>G Use clamped protractor/clamped set square or use marker/pointer to note initial amplitude/angle.</p> <p><i>1 mark for each point up to a maximum of 4.</i></p>	4