

PUBLISHED

Question	Answer	Marks
1(a)	Final value of x with unit in range 29.0–31.0 cm.	1
	Value of θ to nearest degree and in the range 60–80°.	1
1(b)	Six sets of readings of x (different values) and θ with correct trend (as x increases θ increases) and without help from the Supervisor scores 4 marks, five sets scores 3 marks, etc.	4
	Range: $x_{\min} \leq 10.0$ cm and $x_{\max} \geq 55.0$ 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. $\theta/^\circ$, x/cm . $\cos\theta$ must not have a unit.	1
	Consistency: All values of x must be given to the nearest millimetre.	1
	Significant figures: Values of $\cos \theta$ given to 2 or 3 significant figures.	1
	Calculation: Values of $\cos \theta$ calculated correctly.	1

Question	Answer	Marks
1(c)(i)	<p>Axes: Axes must be labelled with the correct 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 apart (one large square). Sensible scales must be used. Scale must not be awkward (e.g. 3:10 or fractions).</p>	1
	<p>Plotting of points: All observations in the table must be plotted on the grid. Diameter of plotted points must be less than half a small square. Points must be plotted to an accuracy of half a small square in both x and y directions.</p>	1
	<p>Quality: Trend of points must be negative. All points in the table must be plotted on the grid. It must be possible to draw a straight line that is within ± 4.0 cm (to scale) on the x-axis of all plotted points.</p>	1
1(c)(ii)	<p>Line of best fit: 'Best fit' is judged by the 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. Lines must not be kinked or thicker than half a 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(c)(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 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: Intercept read directly from the graph, with read-off at $x = 0$, accurate to half a small square in y direction. or Correct read-off from a point on the line and substituted correctly into $y = mx + c$ or an equivalent expression. Read-off is accurate to half a small square in both x and y directions.</p>	1



Question	Answer	Marks
1(d)	Value of a = candidate's gradient and value of b = candidate's intercept. Values must not be written as fractions or given to only one significant figure.	1
	Units for a and b correct and consistent with readings (e.g. cm^{-1} for a and no unit for b).	1
1(e)	Correct calculation of S with unit (e.g. N m^{-1} or N cm^{-1}).	1



Question	Answer	Marks
2(a)(i)	Value for D_1 to nearest mm and in range $4.0 \text{ cm} \leq D_1 \leq 6.0 \text{ cm}$.	1
	Correct calculation of C .	1
2(a)(ii)	Justification for significant figures in C linked to significant figures in M_1 and D_1 .	1
2(a)(iii)	All values of T to nearest 0.01 s or all to the nearest 0.1 s, with unit.	1
	Evidence of repeat readings of T .	1
2(b)(i)	Value for D_2 that is greater than D_1 .	1
2(b)(ii)	Absolute uncertainty in D_2 in the range 0.2–0.5 cm. Correct method of calculation to find percentage uncertainty in D_2 , e.g. (absolute uncertainty / value from 2(b)(i)) \times 100. If repeated readings have been taken, then the absolute uncertainty can be half the range (but not zero) provided the working is clearly shown.	1
2(b)(iii)	Correct calculation of new value of C .	1
2(b)(iv)	Value for T .	1
	New value of T greater than first T .	1
2(c)	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(d)	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(e)(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 T or time with a reason e.g. difficult to judge when mass hanger reaches the floor/difficult to judge start of descent of mass hanger.</p> <p>C Time or T is short so uncertainty in T is large or percentage uncertainty in T is large.</p> <p>D Difficult to measure D_1 or D_2 or diameter with a reason e.g. plastic tube gets in way of ruler/parallax error.</p> <p>E Difficulty with D_2 with a reason e.g. inconsistent thickness of clay layer, thickness of clay layer varies.</p> <p>F Difficult to exactly judge 16 turns of the flywheel/difficult to exactly judge number of turns of the flywheel.</p> <p>G Mass hanger does not fall smoothly/consistently/hanger stops and starts.</p> <p><i>1 mark for each point up to a maximum of 4.</i></p>	4
2(e)(ii)	<p>A Take more readings <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 video/record/film (descent of mass hanger in view) and timer in view/view frame-by-frame.</p> <p>C Method to increase T or time e.g. use longer drop/decrease mass of mass hanger/increase number of turns.</p> <p>D Use (vernier) calipers.</p> <p>E Hold a roller on the modelling clay while flywheel is turned/use a preformed ring of clay/use a mould/flatten clay between boards.</p> <p>F Use height change (preset height) instead of turns or use fiducial mark and line up with slot on mass/mark on mass.</p> <p>G Improved method to allow hanger to fall smoothly e.g. support bamboo rod at both ends/use tube with circular cross-section.</p> <p><i>1 mark for each point up to a maximum of 4.</i></p>	4