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PHYSICS **9702/31**

Paper 3 Advanced Practical Skills 1 **October/November 2017**

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1(b)	Value of θ in range 80–100° with unit.	**1**
1(c)	Value of T in range 0.80–2.00 s with unit.	**1**
1(d)	Six sets of readings of θ (different values) and time showing the correct trend (T increases as θ decreases) and without help from the Supervisor scores 5 marks, five sets scores 4 marks etc.	**5**
	Range: $\theta \geqslant 120°$ **and** $\theta \leqslant 60°$.	**1**
	Column headings: Each column heading must contain a quantity and a unit where appropriate. The presentation of the quantity and the unit must conform to accepted scientific convention e.g. T^2 / s^2 and θ / °. No unit for cos (θ/ 2).	**1**
	Consistency: All raw values of time must be given to the nearest 0.1 s or all to the nearest 0.01 s.	**1**
	Significant figures: All values of T^2 must be given to the same number of s.f. as (or one more than) the number of s.f. in raw values of time. If raw times recorded to nearest 0.01 s, allow number of s.f. of T^2 to be one less than the number of s.f. of the raw times.	**1**
	Values of cos (θ/ 2) calculated correctly.	**1**

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Question	Answer	Marks
1(e)(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 *x* and *y* directions. Scales must be labelled with the quantity that is being plotted. Scale markings should be no more than three large squares apart.	**1**
	Plotting of points: All observations must be plotted on the grid. Diameter of plotted points must be $\leqslant$ half a small square (no "blobs"). Points must be plotted to an accuracy of half a small square.	**1**
	Quality: All points in the table (at least 5) must be plotted on the grid for this mark to be awarded. It must be possible to draw a straight line that is within 0.05 on the cos (θ/ 2) axis (*x*-axis) of all plotted points.	**1**
1(e)(ii)	Line of best fit: Judge by balance of all points on the grid about the candidate's line (at least 5). 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 five points left after the anomalous point is disregarded. Lines must not be kinked or thicker than half a small square.	**1**
1(e)(iii)	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.	**1**
	y-intercept: Check correct read-off from a point on the line and substituted into $y = mx + c$. Read-off must be accurate to half a small square in both *x* and *y* directions. **or** Intercept read directly from the graph, with read-off at $x = 0$, accurate to half a small square in the *y* direction.	**1**

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Question	Answer	Marks
1(f)	Value of P = candidate's gradient **and** value of Q = candidate's intercept. The values must not be fractions.	**1**
	Units for P **and** Q correct (s^2).	**1**

Question	Answer	Marks
2(a)	Value of t in the range 2–9 mm, t to the nearest 0.01 cm or 0.001 cm.	**1**
2(b)(i)	Value of d to the nearest 0.1 cm or better.	**1**
2(c)(ii)	Value of h with unit.	**1**
2(c)(iii)	Correct calculation of V with consistent unit.	**1**
2(c)(iv)	Justification for s.f. in V linked to s.f. in (d – 2t) and h. Allow d, t and h or allow d and h.	**1**
2(e)(v)	Value of y with evidence of repeats.	**1**
2(f)	Percentage uncertainty in y based on absolute uncertainty of 2–8 mm. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown. Correct method of calculation to obtain percentage uncertainty.	**1**
2(g)	Second value of h.	**1**
	Second value of y.	**1**
	Quality: second value of y less than first value of y.	**1**

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Question	Answer	Marks
2(h)(i)	Two values of *k* calculated correctly.	**1**
2(h)(ii)	Valid comment consistent with calculated values of *k*, testing against a criterion stated by the candidate.	**1**
2(i)(i)	A Two readings/too few readings/only two readings not enough to draw a (valid) conclusion. B Difficult to measure *t* with reason e.g. screw thread in way, curved surface, thickness not the same throughout the glass. C Inaccurate *V* with reason e.g. non-cylindrical shape of jar/equation gives an approximate value. D Difficult to judge correct position of nails. E Difficult to measure *y* with reason e.g. holding the nail and ruler in position. *1 mark for each point up to a maximum of 4.*	**4**
2(i)(ii)	A Take more readings (for different volumes) and plot a graph/take more values of *k* and compare. B Improved method of measuring *t* directly e.g. travelling microscope. C Improved method of measuring volume e.g. fill with water and use a measuring cylinder/measure circumference with string to calculate diameter to put into equation for volume. D Use optical pins/thinner nails. E Have scale on side of jar/place both nails on lab jacks/use marker pen instead of nails/clamp ruler/use a marker to mark position of nail. *1 mark for each point up to a maximum of 4.*	**4**

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