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PHYSICS **9702/31**

Paper 3 Advanced Practical Skills 1 **October/November 2016**

MARK SCHEME

Maximum Mark: 40

Published

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1 (b) Value for T in the range 0.60 s to 0.80 s with unit. [1]

Evidence of repeat timings (at least two recordings of nT where $n \geqslant 5$). [1]

(c) Correct calculation of k. [1]

Value of k must be given to the same number of s.f. as (or one more than) the s.f. in the values of the raw times. [1]

(e) Six sets of readings of $(h - h_1)$ and T (with correct trend and without help from Supervisor) scores 5 marks, five sets scores 4 marks etc. [5]

Range: [1]
$\Delta(h - h_1) \geqslant 30.0$ cm.

Column headings: [1]
Each column heading must contain a quantity and a unit where appropriate.
The presentation of the quantity and unit must conform to accepted scientific convention, e.g. T / s or T (s).

Consistency: [1]
All values of $(h - h_1)$ must be given to the nearest mm.

(f) (i) Axes: [1]
Sensible scales must be used. Awkward scales (e.g. 3:10, fractions or non-linear) are not allowed.
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.

Plotting of points: [1]
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.

Quality: [1]
All points in the table must be plotted on the grid for this mark to be awarded.
All points must be within 0.01 s on the y-axis of a straight line.

(ii) Line of best fit: [1]
Judge by balance of all points on the grid about the candidate's line (at least 5 points). 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.
Line must not be kinked or thicker than half a small square.

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(iii) Gradient: [1]
The hypotenuse of the triangle must be greater than half the length of the drawn line.
The method of calculation must be correct. Do not allow $\Delta x / \Delta y$.
Both read-offs must be accurate to half a small square in both the x and y directions.

y-intercept: [1]
Either:
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:
Check read-off of the intercept directly from the graph (accurate to half a small square.

(g) Value of P = candidate's gradient and value of Q = candidate's intercept. [1]
Do not allow fractions.

Units for P (e.g. s m^{-1} or s cm^{-1} or s mm^{-1}) and Q (s) correct. [1]

2 (a) (i) Value for D with unit in the range 0.14 mm to 0.16 mm. [1]

(ii) Percentage uncertainty in D based on an absolute uncertainty of 0.01 mm.
Correct method of calculation to obtain percentage uncertainty. [1]

(c) (iii) Value of I in range $10\,\text{mA} \leqslant I \leqslant 200\,\text{mA}$ with unit (collected without help from Supervisor). [1]

(iv) Value of V in range $0.4\,\text{V} \leqslant V \leqslant 1.0\,\text{V}$ with unit (collected without help from Supervisor). [1]

(d) (i) Value of $d > D$ and $d < 1\,\text{mm}$. [1]

(ii) Correct calculation of G. [1]

(iii) Justification for s.f. in G linked to s.f. in D and d. [1]

(f) (i) Second value of V. [1]

Quality: second value of V less than first value of V. [1]

(ii) Second value of d. [1]

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(g) (i) Two values of *k* calculated correctly, and to at least 2 significant figures. [1]

(ii) Valid comment consistent with calculated values of *k,* testing against a stated numerical criterion. [1]

(h)	**(i)** Limitations [4]	**(ii)** Improvements [4]	Do not credit
A	Two readings not enough to draw a conclusion	Take many readings (for different diameters) and plot a graph/ take more readings and compare *k* values	Two readings not enough for accurate results Repeat readings Few readings Take more readings and calculate average *k*
B	Difficult to measure diameter(s) with reason e.g. awkward placing micrometer round wire/ only one direction to measure diameter	Provide separate lengths of wire	
C	Meter readings changed in a particular direction over time/ repeat readings of I or V were often different/ contact resistance varies	Use power supply/ allow reading to reach steady value/ method of cleaning crocodile clips or wires	
D	Wire is very thin introducing a large percentage error in the diameter	Use thicker wire/ use digital micrometer	
E	Rheostat movement not precise enough – overshot I reading	Method to ensure exact current easier to produce e.g. use of screw thread adjustment	

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