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PHYSICS **9702/33**

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

MARK SCHEME

Maximum Mark: 40

Published

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1 (a) (v) Value of I in range 20 mA $\leqslant I \leqslant$ 200 mA with unit. [1]

(c) Six sets of readings of R and y (with correct trend and without help from Supervisor) scores 5 marks, five sets scores 4 marks etc. [5]

Range: [1]
Values of R must include 33 Ω.

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. $1/y/\text{m}^{-1}$ or $1/y$ (m^{-1}).

Consistency: [1]
All values of raw y must be given to the nearest mm.

Significant figures: [1]
Every value of $1/R$ must be given to 2 or 3 significant figures.

Calculation: [1]
$1/y$ calculated correctly to the number of s.f. given by the candidate.

(d) (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").
Plotted points must be accurate to 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 0.001 cm^{-1} (0.1 m^{-1}) (to scale) 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.

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

Units for P (e.g. $\Omega\,m^{-1}$) and Q (e.g. m^{-1}) correct. [1]

(f) (ii) Value of X in the range 5.0 Ω to 20.0 Ω from correct calculation. [1]

2 (b) (iii) All raw readings stated to at least 0.1 s. Value for T with unit in the range 0.50 s to 0.90 s. [1]

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

(c) (i) Correct calculation of l. [1]

(ii) Justification of s.f. in l linked to s.f. in time readings (e.g. time, raw time, nT). [1]

(d) (ii) Value of d ($l \pm 0.050$ m). [1]

(iii) Absolute uncertainty in d in range 2 mm–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]

(e) (ii) Value for t in the range 2.0 s–8.0 s. [1]

(f) Second value of T. [1]

Second value of t. [1]

Quality: Second value of t > first value of t. [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 masses) 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 set d with reason e.g. knot takes some string/knot or weight slips	Improved method to set d e.g. trial and error/glue knots to stop slipping	
C	Difficult to measure d with reason e.g. parallax error/cannot get ruler close/hands move holding ruler in place/difficult to judge centre of mass(es)/rule not vertical	Clamped metre rule/ measure to top and bottom of masses and find the average/ detailed method to check rule vertical/ detailed method to reduce parallax error	Eyes level Eyes perpendicular Reference to set square without detail
D	Difficult to measure $(n)T$ with reason e.g. difficult to judge complete oscillation	Use fiducial marker at centre of oscillation/ use a motion sensor placed under masses	Reaction time error Force on release
E	Difficult to see when coil separation is constant **or** Separation of coils constant for a short time	Video with timer/ video and view frame by frame/ screen behind spring	Video timer
F	Movement of spring along rod	Method to fix spring to rod e.g. Blu-Tack or groove in rod	Air conditioning/draughts Unwanted modes of oscillation

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