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# MARK SCHEME for the October/November 2014 series

## 9702 PHYSICS

**9702/31** Paper 3 (Advanced Practical Skills 1), maximum raw mark 40

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**1 (b)** Value of $T$ in the range 1.1 s – 1.5 s with unit. [1]
Evidence of repeated timings. [1]

**(d)** Six sets of readings of $B$ and $C$ and time scores 5 marks, five sets scores 4 marks etc. [5]
Incorrect trend –1. Help from Supervisor –1.

Range: [1]
$B$ = 1 – 7 (or 8) and $B + C = 8$.

Column headings: [1]
Each column heading must contain a quantity and a unit where appropriate.
The unit must conform to accepted scientific convention e.g. $T^2/B$ / $s^2$, and $C/B$ must not have a unit.

Consistency: [1]
All values of $t$ must be given to either the nearest 0.1 s or 0.01 s.

Significant figures: [1]
All values of $T^2/B$ must be given to the same s.f. as (or one more than) the s.f. in raw $t$.

Calculation: [1]
Values of $T^2/B$ are calculated correctly.

**(e) (i)** Axes: [1]
Sensible scales must be used. Awkward scales (e.g. 3:10) 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 must be no more than three large squares apart.

Plotting: [1]
All observations in the table must be plotted on the graph grid, except $B = 0$.
Diameter of plots must be ≤ half a small square (no "blobs").
Plotted points must be accurate to within half a small square.

Quality: [1]
All points in the table must be plotted (at least 5) for this mark to be awarded.
Judge by scatter of all points about a straight line.
All points must be less than ± 0.05 $s^2$ in the $T^2/B$ direction from a straight line.

**(ii)** Line of best fit: [1]
Judge by balance of all points on the grid (at least 5) about the candidate's line.
There must be an even distribution of points either side of the line along the full length.
Allow one anomalous plot only if clearly indicated by the candidate (i.e. circled or labelled).
Lines must not be kinked or thicker than half a small square.

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**(iii)** Gradient: [1]
Sign of gradient must match graph (expect a positive gradient).
The hypotenuse of the triangle must 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.

$y$-intercept: [1]
Either:
Correct read-offs from a point on the line and substituted into $y = mx + c$.
Read-offs must be accurate to half a small square in both $x$ and $y$ directions.
Or:
Correct read-off of the intercept directly from the graph.

**(f)** Value of $F$ = candidate's gradient. Value of $G$ = candidate's intercept. [1]
Do not allow a value presented as a fraction.

Unit for $F$ ($s^2$) and $G$ ($s^2$) correct. [1]

**[Total: 20]**

**2 (a) (i)** Value of $D$ with unit in range $6.0 \leq D \leq 10.0$ mm. [1]

**(ii)** Value of $d$ with unit to the nearest 0.01 or 0.001 mm in the range 0.14 to 0.16 mm. [1]

**(iii)** Correct calculation of $(D + d/2)$. [1]

**(b) (ii)** Value of $(n + t)$:
Whole number [1]
Representation of part of a turn as a decimal or as a fraction [1]

**(iii)** Absolute uncertainty of twenty-fifth of turn ≤ uncertainty in $(n + t)$ ≤ quarter of a turn.
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 get percentage uncertainty. [1]

**(c)** Second value of $d$. Evidence of repeated readings here or in **(a)(ii)** [1]
Second value of $(n + t)$. [1]
Second value of $(n + t) <$ first value of $(n + t)$. [1]

**(d) (i)** Correct calculation of two values of $k$. [1]

**(ii)** Justification of s.f. in $k$ linked to raw data in $D$, $d$ and $(n + t)$. [1]

**(iii)** Valid conclusion based on the calculated values of $k$, testing against a stated criterion. [1]

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| (e) | (i) Limitations (4 max.) | (ii) Improvements (4 max.) | Do not credit |
|---|---|---|---|
| A | Two readings not enough to draw a conclusion. | Take many readings (for different diameters) and plot a graph / compare *k* values. | repeat readings / few readings |
| B | Difficult to judge fractions of a turn | Improved method to measure the fraction of a turn<br>e.g. have appropriate markings on rod.<br>e.g. measure spare length and work out as a fraction of the circumference of the rod.<br>e.g. 50 / circumference. | |
| C | Wire slips from start position / springs away from rod. | Method to prevent wire moving<br>e.g. tape / Blu-tack / attach weight / clamp wire on rod. | Wire unstable |
| D | Length not exactly 50 cm with reason e.g. kinks | Method to straighten wire<br>e.g. apply load or improved method to cut<br>e.g. use tape and knife or use thinner wire for second wire | |
| E | Thicker wire occupies a longer part of the rod so there are fewer turns / angle of turn of wire affects ($n + t$) / difficult to make turns touch along the rod | Improved method of placing turns close together<br>e.g. use motor to turn rod. | |
| F | The values of ($n + t$) are close together. | Use a thinner rod. | |

**[Total: 20]**

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