Cambridge International AS & A Level

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**PHYSICS** **9702/36**

Paper 3 Advanced Practical Skills 2 **October/November 2016**

MARK SCHEME

Maximum Mark: 40

**Published**

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**1 (b) (i)** Value for $x$ in range 45.0 cm to 55.0 cm. [1]

**(iii)** Value for $I$ in range 500 μA to 1500 μA (or 0.50 mA to 1.50 mA), with unit. [1]

**(c)** Six sets of values for $x$ and $I$ (with correct trend and without help from Supervisor) scores 5 marks, five sets scores 4 marks etc. [5]

Range: [1]
$x$ values must include 20 cm or less and 80 cm or more.

Column headings: [1]
Each column heading must contain a quantity and an appropriate unit.
The presentation of the quantity and unit must conform to accepted scientific convention e.g. $I$ / μA.

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

**(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 must be no more than three large squares apart.

Plotting of points: [1]
All observations in the table must be plotted on the grid.
Diameter of plotted points must be ⩽ half a small square (no "blobs").
Plotting of points must be accurate to half a small square.

Quality: [1]
All points in the table (at least 5) must be plotted on the grid.
All points must be within ±20 μA (±0.02 mA) of a straight line in the $y$ ($I$) direction.

**(ii)** Line of best fit: [1]
Judge by balance of all points on the grid about the candidate's line (at least five points). There must be an even distribution of points either side of the line along the full length.
One anomalous plot is allowed if clearly indicated (i.e. circled or labelled). There must be at least five points left after disregarding the anomalous point.
Lines 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 $S$ = candidate's gradient and value of $T$ = candidate's intercept.
Do not allow fractions. [1]

Consistent units for $S$ (e.g. $\mu A\,cm^{-1}$) and $T$ (e.g. $\mu A$). [1]

**(f)** Calculation: $r$ calculated correctly to the s.f. given by the candidate. [1]

Significant figures: $r$ given to 2 or 3 s.f. [1]

**2 (b) (ii)** $x_1$ in range 10.0 cm to 40.0 cm. [1]

**(c)** Value of $x_2 < x_1$. [1]

**(d) (i)** Second value of $x_1$. [1]

**(ii)** Value of $x_2$ given to nearest mm and all other raw values of $x$ in **(b)**, **(c)** and **(d)** are to the nearest mm. [1]

**(e) (i)** Two values of $k$ calculated correctly. [1]

**(ii)** Justification of the s.f. in $k$ based on the s.f. in $x_1$ and the s.f in $x_2$. [1]

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

**(f) (i)** Raw values of $D$ to nearest 0.001 cm and in range 1.400 cm to 2.200 cm. [1]

Evidence of repeated readings for $D$. [1]

**(ii)** Absolute uncertainty in $D$ of 0.001 cm or 0.002 cm.
If repeated readings have been taken, then absolute uncertainty could be half the range (but not zero) if working is clearly shown.
Correct method of calculation to obtain percentage uncertainty. [1]

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**(iii)** *V* calculated correctly. [1]

**(iv)** Quality: *M* in range 3 g to 13 g. [1]

| **(g)** | **(i)** Limitations [4] | **(ii)** Improvements [4] | Do not credit |
|---|---|---|---|
| A | Two readings are not enough to draw a valid conclusion | Take more readings and plot graph/<br>take more readings and compare *k* values | Two readings not enough for accurate results<br><br>Repeat readings<br>Few readings<br><br>Take more readings and calculate average *k* |
| B | Empty beaker moves on bench | Fix beaker with Blu-Tack/tape/ glue | |
| C | Difficult to balance rule:<br>rule slips on pivot/<br>wind disturbs balance | Make groove in rule (under 50cm mark)/<br>other practical method e.g. hinge/nail through rule | Blu-tack<br>Tape<br>Switch off fans<br>String slips on rule |
| D | Spheres/string/tape still wet after immersion so <u>mass changes</u><br>**or**<br>string/tape adds to mass of sphere | Use waterproof string/<br>use wire | Dry the spheres<br><br>Waterproof tape |
| E | Difficult to measure *x* with reason, e.g. string too thick (so it covers graduations on rule) | Use thin(ner) string | Parallax problems |
| F | Marble not round | Improved method of finding *V* (e.g. liquid displacement) | Repeat readings and average |

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