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Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2014 series

9702 PHYSICS

9702/36 Paper 3 (Advanced Practical Skills 2), maximum raw mark 40

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1 (a) (ii) Value of voltmeter reading with unit in range $0.30\,\text{V} \leqslant V \leqslant 0.70\,\text{V}$. [1]

(b) (ii) Value of l with unit in range $20\,\text{cm} \leqslant l \leqslant 80\,\text{cm}$. [1]

(c) Six sets of readings of R and l scores 5 marks, five sets (or use of $R = 0$) scores 4 marks etc. [5]
Incorrect trend –1. Major help from Supervisor –2. Minor help from Supervisor –1.

Range: [1]
Values of R must include $0.22\,\text{k}\Omega$ or $0.33\,\text{k}\Omega$, and $4.7\,\text{k}\Omega$ or $3.3\,\text{k}\Omega$.

Column headings: [1]
Each column heading must contain a quantity and a unit. The presentation of quantity and unit must conform to accepted scientific convention e.g. $1/R/\text{k}\Omega^{-1}$ or $1/R(\text{k}\Omega)^{-1}$, $1/l(\text{m}^{-1})$ or $1/l(1/\text{m})$ but **not** $1/R/\text{k}^{-1}\Omega^{-1}$, $1/R(\text{k}\Omega)$ or $1/l\,(\text{m})$.

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

Significant figures: [1]
Every value of $1/l$ must given to the same s.f. as (or one greater than) the s.f. in raw l.

Calculation: [1]
Values of $1/R$ calculated correctly to the number of significant figures given by the candidate.

(d) (i) Axes: [1]
Sensible scales must be used, no awkward scales (e.g. 3:10).
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: [1]
All observations in the table must be plotted.
Diameter of points 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.
Scatter of points must be less than $\pm\,0.001\,\text{cm}^{-1}$ of $1/l$ from 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.
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.
Both read-offs must be accurate to half a small square in both the *x* and *y* directions.

y-intercept: [1]
Either:
Correct read-off from a point on the line substituted into $y = mx + c$.
Read-off 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.

(e) *a* = the value of the gradient and *b* = the value of the *y*-intercept. [1]

Unit for *a* and unit for *b* consistent with values given. [1]
e.g. $k\Omega\,m^{-1}$ for *a* and m^{-1} for *b*.

[Total: 20]

2 (a) (ii) Value of *L* in range 150 mm $\leqslant L \leqslant$ 250 mm and to nearest mm only. [1]

(b) (ii) Value of $d = 0.5L \pm 20$ mm. [1]

(iv) Correct justification of significant figures in *c* linked to significant figures in *L* and *d.* [1]

(c) Correct calculation of *q*. [1]

(d) (ii) Value of raw *t* to 0.1 s or better, with unit, in range 6 s $\leqslant t \leqslant$ 20 s. [1]
Evidence of repeat measurements of *t*. [1]

(iii) Absolute uncertainty in *t* in range 0.2 s to 0.5 s.
If repeated readings have been taken, uncertainty can be half the range (but not zero) if the working is shown.
Method of calculation to obtain percentage uncertainty must be correct. [1]

(e) (ii) Second value of *d*. [1]
Second value of *t*. [1]
Quality: Correct trend for *t* with respect to *d* (*t* decreases as *d* increases). [1]

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

(ii) Valid comment consistent with calculated values of *k,* testing against a stated criterion e.g. "The calculated percentage difference between *k* values is less than the percentage uncertainty found in **(d)(iii)**, so the relationship is valid". [1]

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(g)	(i) Limitations (4 max.)	(ii) Improvements (4 max.)	Do not credit
A	Two readings not enough to draw a conclusion	Take more readings (for different *d*) and plot a graph / take more readings and compare *k* values	Not enough readings / repeat readings / few readings / too few readings / 'two readings' (on its own)
B	Difficult to measure *L* or *d* with reason e.g. parallax / transparent liquid / hanging above bench / bottle not vertical / bottle not uniform	Improved method to measure *L* or *d* e.g. detailed use of set square on bench / colour water / add scale to bottle / place bottle on bench and use rule	Marks on bottle / finding centre of nail / meniscus problem
C	Difficult to judge the end of oscillation	Improved method of timing e.g. video with timer / video and view frame by frame / put marker at the centre of oscillation / motion sensor with correct position i.e. placed so the bottle moves towards and away from it.	Release height / amplitude varies / human reaction time / video and play back / high speed camera / slow motion camera / use of motion sensor / use of light gates /
D	*d* varies as bottle swings	Use sand (or named material that can be poured)	
E	Difference in *t* values is small	Use larger change in depths	Use longer bottle / *t* is small
F	Stand (or nail) moves while bottle oscillates	Method to stabilise clamp (or nail) e.g. G-clamp / add weight to stand / clamp nail between wooden blocks	Glue stand to bench

Do not credit:
damping / release force / friction / hitting stand / fans / problems with counting / use computer / just "use data logger" on its own.

[Total: 20]

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