CAMBRIDGE INTERNATIONAL EXAMINATIONS

**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

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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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 $0.33\,\text{k}\Omega$, <u>and</u> $4.7\,\text{k}\Omega$ 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.

**(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 $150\text{ mm} \leqslant L \leqslant 250\text{ mm}$ and to nearest mm only. [1]

**(b) (ii)** Value of $d = 0.5L \pm 20\text{ mm}$. [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 $6\text{ s} \leqslant t \leqslant 20\text{ s}$. [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]

| **(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]**