**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Subsidiary Level and GCE Advanced Level**

# MARK SCHEME for the May/June 2010 question paper

# for the guidance of teachers

## 9702 PHYSICS

**9702/35** Paper 31 (Advanced Practical Skills), 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.

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**1 (c)** Six sets of readings of $I$ and $V$ scores 5 marks, five sets scores 4 marks, etc. [5]
Indicate the number of sets of readings.
Incorrect trend then –1 (wrong trend $P$ increases, $R^4$ decreases).

Apparatus correctly set up without help from supervisor. [2]
Major help –2, minor help –1

Range of $V$: $V_{min} \leqslant 2$ V and $V_{max} \geqslant 10$ V. [1]

Column headings ($V$/V, $I$/A, $P$/W, $R$/Ω, $R^4$/Ω$^4$) [1]
Must have $V$ and $I$ columns.
Each column heading must contain a quantity and a unit where appropriate.
Ignore units in the body of the table.
There must be some distinguishing mark between the quantity and the unit (solidus is expected but accept, for example, $V$(V)).

Consistency of presentation of raw readings. [1]
All raw values of $V$ must be given to the same number of decimal places and this must be 0.1 V.
All raw values of $I$ must be given to the same number of decimal places

Significant figures. [1]
S.F. for $P$ must be the same as, or one more than, the least number of S.F. used in $V$ or $I$. Check each row.

Values of $R^4$ correct. Underline and check the specified value of $R^4$. [1]
If incorrect, write in the correct value.

**(d) (i)** Graph
Axes: Sensible scales must be used, no awkward scales (e.g. 3:10). [1]
Scales must be chosen so that the plotted points must occupy at least half the graph grid in both $x$ and $y$ directions. Indicate false origin with FO.
Scales must be labelled with the quantity which is being plotted. Ignore units.
Allow inverted axes but do not allow wrong graph.
Scale markings should be no more than three large squares apart.

Plots
All observations must be plotted.
Write a ringed total of plotted points. [1]
Do not accept blobs (points > 0.5 small square).
Ring and check a suspect plot. Tick if correct. Re-plot if incorrect.
Work to an accuracy of half a small square.

**(ii)** Line of best fit [1]
Judge by balance of at least 5 trend points about the candidate's line.
There must be an even distribution of points either side of the line along the whole length. Indicate best line if candidate's line is not the best line.
Lines must not be kinked.

Quality [1]
Judge by scatter of all points about a straight line.
All points in the table (minimum 5) must be within 50 mW of a straight line.
Do not award if wrong graph or wrong trend.

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**(iii)** Gradient [1]
The hypotenuse of the triangle must be at least half the length of the drawn line.
Both read-offs must be accurate to half a small square.
If incorrect, write in correct value.
Check for $\Delta y / \Delta x$ (i.e. do not allow $\Delta x / \Delta y$).

*y*-intercept from graph or substitute correct read-offs into $y = mx + c$ [1]
Label FO.

**(e)** *a* = gradient value and *b* = *y*–intercept value. [1]
Units for *a* and *b* are correct (expect $W\Omega^{-4}$ for *a* and W for *b*). [1]
Range: $a = 3 \times 10^{-9} \pm 1 \times 10^{-9}$ or SV ± 33%

**[Total: 20]**

**2** **(a)** **(ii)** Value of *d*, with consistent unit. Range of *d*: 5 ± 1 cm [1]
*d* to nearest mm. [1]

**(c)** **(ii)** Evidence of repeated measurements of *t* either in **(c)(ii)** or **(e)(ii)**. [1]
Value of *t* in range 5 to 30 s. [1]

**(d)** Absolute uncertainty in *t* in the range 0.5 to 1.0 s. [1]
If repeated readings have been taken, then the uncertainty can be half the range.
Correct calculation to get % uncertainty. [1]

**(e)** **(ii)** Second value for *d*. [1]
Second value for *t*. [1]
Quality: $t_2$ less than $t_1$. [1]

**(f)** **(i)** Correct calculation of two values of *k* or equivalent. [1]

**(ii)** Valid conclusion based on the calculated values of *k*. [1]
Candidate must test against a specified criterion.

**(iii)** Justification with reference to the significant figures in *t* **and** *d*. [1]

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**(g)**

| | Limitations (4) | Improvements (4) | Ignore |
|---|---|---|---|
| **A** | **$A_p$** Two readings not enough (to support conclusion) / too few readings. | **$A_s$** Take more (sets of) readings <u>and</u> plot a graph / compare values of *k*. | Repeat readings |
| **B** | **$B_p$** Marker never exactly on 2 cm or 0.5 cm: either above or below / increments in changes in amplitude too large / difficult to judge 2 cm and 0.5 cm. | **$B_s$** Video with timer (playback) in slow motion / position sensor above with data logger / measure the amplitudes over time. | Use computer to improve the experiment. Multi-flash photography? Light gates. |
| **C** | **$C_p$** Straw not vertical (straight) / straw bumping into sides/ non-vertical oscillation. | **$C_s$** Wider container / glue straw / method of alignment. | No ref to changing oil |
| **D** | **$D_p$** Difficult to measure '*d*' because of lining up meniscus / refraction of curved container. | **$D_s$** Mark straw/ mark container / use travelling microscope / vernier calliper? | |
| **E** | **$E_p$** Difficult to measure time because moves past the marker quickly / small distances involved. | **$E_s$** Video with timer (playback) in slow motion / position sensor above with data logger. Credit once only. | |

**[Total: 20]**

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