**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

**9702/31** 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 (a)** Ring e.m.f. value

**(c)** Six sets of values for $V$ and $I$ scores 5 marks, five sets scores 4 marks, etc. [5]
Indicate the number of sets of readings.
Incorrect trend –1 (wrong trend $N$ increases, $I$ increases).

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

Range of $N$ in table to include 1 or 2 and 11 or 12. [1]

Column headings ($N$ (no unit), $V$/V, $I$/A, $R$/Ω, ($1/R$)/$\Omega^{-1}$) [1]
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 of $I$ and $V$. [1]
All values of $I$ must be given to the same number of decimal places.
All values of $V$ must be given to the same number of decimal places.

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

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

**(d) Graph**

**(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. Indicate false origin with FO.
Scales must be labelled with the quantity that is being plotted. Ignore units.
Allow inverted axes but do not allow the wrong graph.
Scale markings should be no more than three large squares apart.

All observations must be plotted. [1]
Write a ringed total of plotted points.
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
Judge by scatter of all points about a straight line. [1]
All plots from table (minimum 5) must be within 1 mA of a straight line.
Do not award if wrong graph or wrong trend.

**(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]
(Expect close to 0). Label FO.

**(e)** *M* = gradient value. *L* = *y*–intercept value. No substitution method. [1]
If inverted axes not corrected for –1

Value of *M* = value from part **(a)** ± 0.5V. [1]
Value of *L* = 0 ± 1 mA.
Appropriate units

**[Total: 20]**

**2** **(b)** Total time over which swings are measured > 10 s. [1]
Correct calculation of $T = T_n/n$. [1]

**(c)** **(i)** Value of $l$ = 5 cm ± 1 cm [1]
Evidence of repeats in length value (here or in **d(iii)**). [1]

**(ii)** Measure in two different places/check zero error. [1]

**(iii)** Percentage uncertainty in length. Consistent units. $\Delta l$ = 0.1 mm [1]
If repeated readings have been taken, then the uncertainty can be half the range.
Correct ratio idea required (0.1/length × 100%).

**(d)** **(ii)** Measurement of time for longer tube. [1]

$t_{\text{longer tube}} < t_{\text{shorter tube}}$ [1]

**(iii)** Measurement of length for longer tube to the nearest 1 mm. [1]
Consistent unit

**(iv)** Add two lengths together correctly. Allow rounding. [1]

**(e)** Correct calculation of two values of $k = T^2/l$. [1]
Valid conclusion based on the calculated values of *k*. [1]
Candidate must test against a specified criterion.

| | Limitations (4) | Improvements (4) | Ignore |
|---|---|---|---|
| **A** | **$A_p$** Two readings not enough (to support conclusion)/too few readings. | **$A_s$** Take many readings and plot a graph/compare values of *k*. Do not allow average *k*. | Repeat readings |
| **B** | **$B_p$** ($l$ inaccurate because) gap between long and short tube/ ends of tubes uneven. Tubes not straight/kinked/disjointed. | **$B_s$** Get one long tube without a break/stick two tubes together/use longer tube on its own. Method of smoothing ends. | Parallax error |
| **C** | **$C_p$** Tube(s) not vertical when stationary/ not aligned with string. | **$C_s$** Smaller diameter tube/thicker walled tube/suitable method of alignment. | Thicker string |
| **D** | **$D_p$** Not swinging in one plane only/idea of non-uniform oscillation. | **$D_s$** Method of reducing draught e.g. close windows, turn off fans, screen experiment. | |
| **E** | **$E_p$** Time difficult to measure because difficult to know when oscillation returns to original position/maximum height. | **$E_s$** A marker to time as passes centre/reaches maximum displacement. Light gate at centre with timer/motion sensor at end with data logger/video with timer (playback) in slow motion. | Difficult to release from same point each time/ human error/reaction time/unqualified use of light gates/sensors |

**$X_p$/$X_s$** Other valid suggestions (e.g. knot slipping) with valid method.

**[Total: 20]**