UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

9702 PHYSICS

9702/33 Paper 3 (Advanced Practical Skills 1), 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 must be read in conjunction with the question papers and the report on the examination.

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1 (a) (i) All raw values of d in the range 0.15 mm ≤ d ≤ 0.40 mm to 0.01 mm with unit, or supervisor's value ± 0.10 mm [1]

(b) (iii) l and V with unit. Value of l in the range 40.0 cm ≤ l ≤ 60.0 cm. [1]

(c) Six sets of readings of l and V scores 5 marks, five sets scores 4 marks etc.
Incorrect trend –1. Major help from supervisor –2. Minor help from supervisor –1. [5]

Range of l: $\Delta l \geq 50$ cm. [1]

Column headings: [1]
Each column heading must contain a quantity and a unit where appropriate.
There must be some distinguishing mark between the quantity and the unit, e.g. $1/V$ / V^{-1}.
Accept $1/V$ (V^{-1}) but do not allow $1/V$ (V)$^{-1}$ or $1/l$ (m).

Consistency of presentation of raw readings: [1]
All values of raw l must be given to 0.001 m.

Significant figures: [1]
Significant figures for $1/V$ must be to the same as, or one more than, the least number of significant figures used in raw V.

Calculation: $1/V$ calculated correctly. [1]

(d) (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.
Scales must be labelled with the quantity which 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.
Check that the points are correctly plotted. Work to an accuracy of half a small square in both the x and y directions.
Do not accept 'blobs' (points with diameter greater than half a small square).

Quality: [1]
All points in the table must be plotted (at least 5) for this mark to be scored. Scatter of points must be less than ± 0.2 m^{-1} (0.002 cm^{-1}) of $1/l$ of a straight line.

(ii) Line of best fit: [1]
Judge by balance of <u>all</u> the points on the grid (at least 5) about the candidate's line.
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.

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(d) (iii) Gradient: [1]
The hypotenuse of the triangle used must be at least half the length of the drawn line. Both read-offs must be accurate to half a small square in both *x* and *y* directions. The method of calculation must be correct.

Intercept: [1]
Either:
Check correct read-off from a point on the line and substitution into $y = mx + c$. Read-off must be accurate to half a small square in both *x* and *y* directions. Allow ecf of gradient value.
Or:
Check the read-off of the intercept directly from the graph.

(e) (i) *M* = value of gradient, *N* = value of *y*-intercept. [1]

(ii) Substitution into equation and answer for ρ in range $2 - 20 \times 10^{-7}\,\Omega\text{m}$ ($0.2 \times 10^{-6} - 2 \times 10^{-6}\,\Omega\text{m}$). [1]

[Total: 20]

2 (a) Measurement of all raw *w* to nearest mm in range $2.0 \leq w \leq 3.5\,\text{cm}$. [1]

(b) (iii) Value of l in range $25\,\text{cm} \leq l \leq 50\,\text{cm}$ with unit. [1]

(c) (ii) Correct calculation of *d*. Write in correct value if incorrect. Unit not needed. [1]

(iii) Absolute uncertainty in *d* in the range 3–15 mm (but if repeated readings have been taken then the absolute uncertainty could be half the range, unless zero). Correct method shown used to find the percentage uncertainty. [1]

(d) Value of *T* in range $0.3\,\text{s} < T < 1.5\,\text{s}$. [1]

Evidence of repeats. [1]

(e) Second value of l. [1]

Second value of *T*. [1]

Second value of *T* < first value of *T*. [1]

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

(ii) Justification of s.f. in *k* linked to time AND *d* or l. [1]

(iii) Sensible comment relating to the calculated values of *k*, testing against a criterion specified by the candidate. [1]

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(g)

	(i) Limitations **4 max.**	**(ii)** Improvements **4 max.**	Do not credit
A	Two readings are not enough (to draw a conclusion)	Take more readings and plot a graph/ calculate more *k* values (and compare)	'Few readings'/'take more readings and calculate average *k*'/'only one reading'
B	Loops not the same size/ ruler(s) not horizontal/	Method to ensure loops same size, e.g. use glue or tape to secure ends together/tie around fixed points/template/mark string	Difficult to tie knots Use of spirit level/use of plumbline Rubber bands or other material Use of Blu-Tack String stretching
C	Difficult to judge end/start/ centre of swing/difficult to judge complete swing	Use of fiducial marker/pointer	Reaction time error Human reaction Difficult to know when to start/ stop timer
D	Irregular/uneven/unusual swings/not in same horizontal plane/centre of bottom rule not fixed	Method of ensuring correct release, e.g. (two) stop(s) at either end	Fans/switch off fans Amplitude changes
E	Loops slide	Method, e.g. glue, tape to fix loop to rule/ drill hole to attach string/ make grooves to hold string	'Glue' or 'tape' on its own
F	*T* or time short/large uncertainty in *T*	Improved method of timing, e.g. <u>video</u> and timer/frame-by-frame/increase *d* or *l*, decrease distance between loops, correct position of motion sensor linked to data logger	Use of computer Light gates Camera High speed camera Too fast Time too fast Time more swings Time large no. of swings.
G	Reason for calculation of <u>*d*</u> inaccurate, e.g. different *w*/ thickness of rule not taken into account	Measure *d* directly/measure *w* for both rules/measure and allow for thickness.	Parallax error Use of set squares Vernier callipers Just 'different *w*'

[Total: 20]

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