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

9702/33 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 –1 (wrong trend is I increases, V^{10} decreases).

Apparatus correctly setup without help from supervisor. [2]

Range of I: $I_{min} \leqslant 10$ mA and $I_{max} \geqslant 35$ mA. Ignore POT errors. [1]

Column headings (e.g. V/V, I/A, V^{10}/V^{10}). [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 values of V must be given to the same number of decimal places (must have dp).
All values of I must be given to the same number of decimal places.

Significant figures.
Sf for V^{10} must be the same as or one more than the sf used in V. Check each row. [1]

Values of V^{10} correct. Underline and check the specified value of V^{10}. [1]
If incorrect, write in the correct value.

(d) Graph

(i) Axes
Sensible scales must be used. Awkward scales (e.g. 3:10) are not allowed. [1]
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.

Plots
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.
All points in table (minimum 5) must be within 2 mA of a straight line. [1]
Do not award if wrong graph or wrong trend.

(iii) Gradient
The hypotenuse of the triangle must be at least half the length of the drawn line. [1]
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]
If inverted axes not corrected for –1
Range of values ($0.1\text{AV}^{-10} \leqslant a \leqslant 0.9\text{AV}^{-10}$, $b = 0 \pm 0.01\text{A}$) and appropriate units [1]

[Total: 20]

2 **(a)** Raw value(s) of x: $25.0\text{ cm} \leqslant x \leqslant 35.0\text{ cm}$ with unit to nearest mm. [1]

(b) **(i)** Evidence of repeated measurements of d in **(b)(i)** or **(e)** [1]
Value of $d = 3.0\text{ mm} \pm 1.0\text{ mm}$ or SV ± 1.0 mm [1]
Raw values of d to at least 0.1 mm

(ii) Value of t in range 1 s to 10 s unless SV indicates otherwise. Allow SV ± 5 s [1]

(c) Absolute uncertainty in t_1 in the range 0.1 to 0.6 s [1]
If repeated readings have been taken, then the uncertainty could be half the range.
Correct calculation to get % uncertainty.

(d) v calculated correctly with consistent units. [1]

(e) Second value for d. [1]
Second value for t. [1]
Quality: t_2 less than t_1. (d increases, t decreases) [1]

(f) **(i)** Calculation of two values of k. [1]

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

(iii) Relate raw values of x, t and d. Any decimal place arguments score zero. [1]

	Limitations (4)	Improvements (4)	Ignore
A	$\mathbf{A_p}$ Two readings not enough (to support conclusion)/too few readings.	$\mathbf{A_s}$ Take more (sets of) readings and plot a graph/compare values of k.	Repeat readings.
B	$\mathbf{B_p}$ Time too short/reaction time large compared to measured time/parallax error in judging start/stop.	$\mathbf{B_s}$ Increase x/lengthen tube/smaller balls/video with timer (playback) in slow motion.	Light gates, motion sensors, data loggers, computers, helpers, solution for parallax error. Set squares, rulers, etc.
C	$\mathbf{C_p}$ Difficult to see glass balls.	$\mathbf{C_s}$ Use coloured balls/shine light through.	Use ball bearings (type of ball and oil stays fixed).
D	$\mathbf{D_p}$ Terminal velocity not reached (by the first marker).	$\mathbf{D_s}$ A valid method to check reached TV, e.g. time constant over three markers/video with timer (playback) in slow motion, multi-flash photography/stroboscope.	References to starting point. Do not accept 'move *x* down' on its own. Change viscosity of oil (oil and glass must remain fixed).
E	$\mathbf{E_p}$ Balls not all the same diameter/size/shape/mass	$\mathbf{E_s}$ Use micrometer screwgauge/top pan balance	
X	$\mathbf{X_p}$ Balls had a hole in/air bubbles on ball or oil.	$\mathbf{X_s}$ Clean balls/immerse in oil	

[Total: 20]