UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2007 question paper

9702 PHYSICS

9702/31 Paper 31 (Advanced Practical Skills 1), maximum raw mark 40

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UNIVERSITY of CAMBRIDGE
International Examinations

Question 1

Manipulation, measurement and observation

Successful collection of data

(a) (i) Diameter of wire. 2 d.p. (mm) in raw data. Allow 0.195 or 0.190 mm. (0.19 mm ± 0.02 mm or SV ± 0.02 mm). Consistent unit. Unit needed. [1]

(i) Repeat measurement [1]

(c) 6 measurements in table
Five marks for six sets of readings for V and l
Four marks for five sets
Three marks for four sets, etc.
Major or unspecified help –2 (e.g. setting up circuit)
Minor help: –1 (e.g. minor changes with circuit) AND –1 (help with reading micrometer)
Unreasonable values of V –1
(e.g. Voltage values are the same ($V_{max} - V_{min} < 0.5V$), wrong trend ($l\uparrow$, $V\downarrow$) or if any one value of V < 0.5 V.) [5]

Range and distribution of values

(c) ($l_{max} - l_{min}$) must be greater than or equal to 70 cm. Ignore POT error. [1]

Presentation of data and observations

Table: layout

(c) Column headings: *V/V*; *l/cm*; *l/A/m*$^{-1}$. [1]
Each column heading must contain a quantity and a unit where appropriate.
Ignore units in the body of the table. Ignore POT errors.
There must be some distinguishing mark between the quantity and the unit (i.e. solidus is expected, but accept, for example, l (cm)).

Table: raw data

(c) Consistency of presentation of raw readings
All values of l must be given to the same number of decimal places.
l read to 1 mm or 1 cm [1]

Table: calculated quantities

(c) Significant figures. Apply to l/A.
l/A should be given to the same number or one more than the lowest number of significant figures from l or **raw** values of d. [1]

(c) Values of l/A correct using candidate's figures. Allow small rounding errors.
Check a value. If incorrect, write in the correct value. Ignore POT error. [1]

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Graph: layout

(Graph) Axes. If wrong graph plotted (e.g. l against l/A) do not award mark.
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. Allow inverted axes.
Scales must be labelled with the quantity which is being plotted. Ignore units. [1]

Graph: plotting of points

(Graph) All observations must be plotted. No blobs (points $\geqslant$ half a small square ϕ).
Ring and check a suspect plot. Tick if correct. Re-plot if incorrect.
Work to an accuracy of half a small square. [1]

Graph: trend line

(Graph) Line of best fit. Allow 1 point off. At least 5 trend plots needed.
Do not award mark if large scatter.
Judge by scatter of points about the candidate's line.
There must be a fair scatter of points either side of the line.
Indicate best line if candidate's line is not the best line. [1]

Quality of data

(Graph) Judge by scatter of points about the best fit line. Allow up to ± 0.05V.
All plotted points are assessed for this mark.
At least 5 plots needed. If V constant do not award mark. [1]

Analysis, conclusions and evaluation

Interpretation of graph

(d) (iii) Gradient
The hypotenuse of the Δ must be at least half the length of the drawn line.
Read-offs must be accurate to half a small square. Do not allow table values unless on the line of best fit. Write in correct read off.
Check for $\Delta y/\Delta x$ (i.e. do not allow $\Delta x/\Delta y$). [1]

(d) (iii) *y*-intercept
The value must be read to the nearest half square.
The value can be calculated using ratios or $y = mx + c$. Incorrect algebra –1.
If a false origin has been used then label FO. [1]

Drawing conclusions

(e) Value for k, 0.5 V $\leqslant$ k $\leqslant$ 2.5 V
Should be *y*-intercept. Unit required. 2 or 3 SF. [1]

(e) Value for I, 0.05 A $\leqslant I \leqslant$ 0.20 A
Must come from gradient. Working must be checked. Unit required A ($V\Omega^{-1}$).
2 or 3SF.
Sensible answer checked using candidate's figures into correct substitution. $m=\rho I$ [1]

[Total: 20]

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Question 2

Manipulation, measurement and observation

Successful collection of data

(a) (iii) Position of end of rule at equilibrium. Nearest cm or mm. < 1m
Consistent unit. [1]

(b) First value of *d* between 1 and 5 cm. If lowest position given write in correct value of *d*. [1]

(b) First value of highest position within 5 cm of the equilibrium position. [1]

(d) Second value of *d*. Different value to the first. Allow out of range. [1]

(d) Second value of highest position. [1]

(d) Repeated measurements for highest position (evidence from **(b)** or **(d)**) [1]

Quality of data

(d) Bigger *d* gives bigger *x*. Check with corrected values of *d* and *x*.
If $d < x$ in either case or if $d = x$ in both cases, this loses the mark. [1]

Presentation of data and observations

Display of calculation and reasoning

(b) First value of *x* calculated correctly
Calculation must be checked. Write down the correct value if answer wrong. [1]

(d) Second value of *x* calculated correctly
Calculation must be checked. Write down the correct value if answer wrong. [1]

(e) Correct calculation to check proportionality ecf if candidates value of *d* is the lowest position.
Possibilities include: two calculations of *x/d*
ratio of *x* values and ratio of *d* values both calculated [1]

Analysis, conclusions and evaluation

Drawing conclusions

(e) Conclusion based on calculation. Consistent argument.
Incorrect ideas score zero. [1]

Estimating uncertainties

(c) Percentage uncertainty in *x*
Allow uncertainty in *x*; 2 mm $\leqslant \Delta x \leqslant$ 10 mm.
If repeated readings have been done then the uncertainty could be half the range.
Correct ratio idea required x 100 stated/implied. [1]

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Identifying limitations

(f) (i) Relevant points must be underlined and ticked.
Some of these might be:

A Only two readings (are not enough to draw a valid conclusion).

B Hard to judge/see (when/where) highest position with reference to movement.
Do not accept reaction time ideas.

C Parallax (error) or good diagram demonstrating this.

D Difficulty in release/keeping rule still prior to release (reference to force).

E Equilibrium position changes with evidence shown in measurements.

X Other additional source of error. [4]

Suggesting improvements

(f) (ii) Relevant points must be underlined and ticked.4
Some of these might be:

A Take more readings and plot a graph/calculate *k* values.

B High speed (camera to take) photographs/film the motion and play back frame by frame/ slow motion/ use pause OR
motion/position sensor above/ below mass OR
trial and error with light gate/ horizontal marker.

C Measure at eye level/repeat to get eye in right place/ place rule as close as possible to vertical rule/use helper to release or measure/use mounted pin at end of rule (to help locate position on scale).

D Use a named method to release the rule e.g. cotton and candle or scissors/electromagnet/end stop or clamp.

X cm rule – use a mm rule. Need to see evidence in their previous measurements that their readings are taken to the nearest cm or 0.5 cm.

Y Other additional solution, well explained.

Do not allow 'repeated readings, vacuum, draft free room'
Do not allow 'use a computer to improve the experiment'
Do not allow 'increase range/change load on ruler/change length of ruler/changing quality of ruler' [4]

[Total: 20]

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