UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2009 question paper

for the guidance of teachers

9702 PHYSICS

9702/31 Paper 31 (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 (b) Measurements [6]
One mark for each set of readings for different $R_{\text{total } 47\Omega}$.
Incorrect trend –1 (wrong trend is $R \uparrow I \uparrow$ / negative gradient).
1 or more incorrect values of R –1.

Apparatus setup correctly without help from supervisor. [1]

Range of R: to include (12 / 16 Ω) and (71 / 94 Ω) and (141 / 188 Ω). [1]

Column headings (R/Ω, I/A, 1/I/A^{-1}). Must have R and 1/I columns. [1]
Each column heading must contain a quantity and a unit where appropriate.
Ignore units in the body of the table. Do not accept 1/I/ A or 1/I (A).
There must be some distinguishing mark between the quantity and the unit
(i.e. solidus is expected I/A, but accept, for example, I (A)).

Consistency of presentation of raw readings. [1]
All values of raw I must be given to the same number of decimal places.
Ignore converted current columns. If trailing zeros consistency = 0.
If current same consistency = 0.

Significant figures [1]
Apply to 1/I.
If raw I is given to 2 sf, then accept 1/I to 2 or 3 sf.
If raw I is given to 3 sf, then accept 1/I to 3 or 4 sf.
If raw I is given to 4 sf, then accept 1/I to 4 or 5 sf.

Values of 1/I correct. Underline and check a value for 1/I at R = lowest value. [1]
If incorrect, write in the correct value.

(c) (i) (Graph)
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 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.

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

Line of best fit. Judge by scatter of points about the candidate's line. [1]
There must be a fair scatter of points either side of the line.
5 trend points. No kinked lines.

Quality. Judge by scatter of all points. All table values need to be plotted.
Min 6 needed
If wrong trend Q = 0. If any plot out by 10 Ω from examiners line Q = 0. [1]

(ii) Gradient [1]
The hypotenuse of the Δ must be equal to or greater than half the length of the drawn line. Read-offs must be accurate to half a small square.
Check for Δy/Δx (i.e. do not allow Δx/Δy).

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

(d) Correct method for finding P and Q. m = 1/P. c = Q/P [1]

Correct method needed. Value for P and Q. Ignore negative sign. [1]
P = 1.0 – 5.0 V (or AΩ). Q = 50 – 150 Ω (or V/A) (Resistor X). Unit required. Penalise AE.

[Total: 20]

Special case: If I same, Measurements = 5 max, Consistency = 0, Axes = 0, Q = 0, Gradient = 0. If no I, consistency = 0, 1/I calculation = 0, SF = 0. Allow CH mark on columns present.

2 (a) (ii) Allow reference to measuring cylinder and consistent number of significant figures. Reference to precision of **measuring cylinder**. Consistent with SF in their vol. [1]

(b) (i) All raw heights to nearest mm. (heights < 30.0 cm) [1]

(ii) $\theta < 90°$ [1]

(iii) Percentage uncertainty in θ. $\Delta\theta = 2 – 5°$. [1]
If repeated readings have been done then the uncertainty can be half the range.
Correct ratio idea required. $\Delta\theta/\theta$ ($\times 100\%$) ($\times 100\%$ can be implied)

(c) Measurement of 2nd height less than first height. [1]

Measurement of 2nd raw θ (any value) to nearest degree or half a degree [1]

Measurement of 2nd volume [1]

(c)/(b)(ii) Evidence of repeats in angle measurement [1]

$\theta_{(b)(ii)} > \theta_{(c)}$ [1]

(c), (b)(iv) Volume in **(c)** half of volume in **(b)(iv)**. $0.4 \leqslant V_c / V_b \leqslant 0.6$. [1]

(d) Correct calculation to check inverse proportionality. $\sqrt{h} \times \cos\theta$ = k [1]
One numerical check: check 2nd value if available.

Conclusion. Sensible comments relating to calculations to within 20% or their own value and suggested relation. Allow ecf in conclusion if arithmetical error in calculation. If incorrect ideas or no ratio then conclusion = 0. [1]

Special case: If 2nd Volume ¾ and not ¼ full, then 2nd Vol = 0 and allow for 2nd height and 2nd angle greater than the first height and first angle respectively.

(e)(i) and **(ii)**

Sources of error or limitation. [4]	**Improvements. Use of other apparatus or different procedures. [4]**
A_p Two readings are not enough (to draw a valid conclusion).	**A_s** Take many (sets of) readings and plot a graph of the results. Be clear NOT just repeat readings.
B_p Parallax error in measuring h/θ.	**B_s** Get eye level/'eye level' perpendicular (to protractor lines, ruler scale or meniscus). Put scale onto bottle.
C_p Difficult to measure height owing to refraction/shape of bottle/thickness of bottom not taken into account/ruler does not start at zero/cannot see meniscus clearly.	**C_s** Add dye/use ruler with a zero at the start.
D_p Difficulty in deciding the toppling point.	**D_s** Move by increments/hold with newtonmeter and tilt until F = 0/bottle on tilting ramp idea.
E_p Difficulty in measuring θ owing to container not perfectly right angled (curved) at the bottom/difficult to line up protractor/ horizontal line of protractor not on table/ difficult to manipulate bottle and measure angle/flexible container/shape of bottle.	**E_s** Make bottom square with plasticine/use protractor with horizontal line flush to table top/freestanding or clamped protractor.

[Total: 20]

No reference to light gates, motion sensors, video, reaction time, volume measurements, pointers, changing bottle, repeat readings, calipers or movement of container.