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

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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.

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(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) θ < 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.

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(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.

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