UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2008 question paper

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.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

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1 Manipulation, measurement and observation

Successful collection of data

(b) Apparatus setup without help from supervisor. [1]

(b) Value of $90° \leq \theta \leq 180°$. [1]

(c) Six sets of values for θ and n scores 4 marks, five sets scores 3 marks, etc. [4]
Wrong trend –1 (θ increases, n increases; On graph: negative slope).

(c) Repeat readings. [1]

Range and distribution of values

(c) Need 0/1/2 and 10/11. [1]

Presentation of data and observations

Table: layout

(c) Column headings (n (no unit), θ/ °, θ/2 / °, cos(θ/2) (no unit), cos(θ/2(°))). [1]
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
(i.e. solidus is expected, but accept, for example, θ (°)). Allow θ in degrees/θ in °.

Table: raw data

(c) Consistency of presentation of raw readings of θ. If no θ column –1. [1]
Expect integer values. Allow to the nearest degree (e.g. 23, 23.0, 23.5).
All values of θ must be given to the same number of decimal places.

Table: calculated quantities

(c) Significant figures. If no θ column –1. [1]
Apply to cos(θ/2).
If θ is given to 2 sf, then accept cos(θ/2) to 2 or 3 sf.
If θ is given to 3 sf, then accept cos(θ/2) to 3 or 4 sf.
If θ is given to 4 sf, then accept cos(θ/2) to 4 or 5 sf.

(c) Values of cos(θ/2) correct. Use average if present. [1]
Underline and check a value. If incorrect, write in the correct value.
Ignore small rounding errors.

Graph: layout

(Graph) Axes. Allow inverted axis. Wrong axis –1. [1]
Sensible scales must be used. Awkward scales (e.g. 3:10) are not allowed.
Scales must be chosen so that the plotted points must occupy at least half the graph grid in both x (4) and y (6) directions.
Scales must be labelled with the quantity that is being plotted. Ignore units.

Graph: plotting of points

(Graph) All observations must be plotted.
Work to an accuracy of plot ≤ 0.5 small square.
If any plot diameter ≥ 0.5 small square –1.

Graph: trend line

(Graph) Line of best fit. Allow line from 5 trend plots. [1]
Judge by scatter of points about the candidate's line.
There must be a fair scatter of points either side of the line.
If line thicker than 0.5 small square –1.

Quality of data

(Graph) Judge by scatter of points (± 0.4 object) about the examiner's line. [1]
All plots from table are needed (minimum 6) for this mark to be scored.
If –ve trend or wrong axis on graph, no mark.

Analysis, conclusions and evaluation

Interpretation of graph

(e) 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 $\Delta y/\Delta x$ (i.e. do not allow $\Delta x/\Delta y$).

(e) y-intercept from graph or substitute correct read-offs into $y = mx + c$ (Close to 0). [1]
Check false origin. Correct substitution needed and no algebraic error (e.g. $y/mc = c$). Allow ecf from gradient.

Drawing conclusions

(f) Value for T. Allow 1 SF. Valid values: 2, 2.0, 1.96, 1.962 N. [1]

(g) Value for m. Use of gradient = $mg/2T$. Not substitution method. [1]
Unit consistent with value. In range 0.010 – 0.050 kg (10 – 50 g). 2 or 3 SF.
If no unit is given then this mark cannot be scored.

[Total: 20]

2 Manipulation, measurement and observation

Successful collection of data

(b) Set up apparatus to get V_0. Minor help –1, e.g. incorrect connections of LED. Major help –2, e.g. set up circuit. [2]

(b) Voltmeter reading, V_0. Sensible value with unit. $V_0 \leq 4.00\,\text{V} \pm 0.01\,\text{V}$. 2/3 d.p. [1]

(c) (i) Evidence of repeats. Consistent unit. Reading ± 0.01 mm or 0.001 mm. Range 0.5 mm ≤ 16t ≤ *5* mm. [1]

(d) (i) Measurement of voltage V. If **(d)(i)** and/or **(d)(ii)** negative –1. [1]

(d) (ii) Measurement of voltage V. [1]

Quality of data

(d) (ii) $V_0 < V_{(d)(i)} < V_{(d)(ii)}$ [1]

Presentation of data and observations

Display of calculation and reasoning

(c) (iii) Calculation of one thickness t. *16t / 16*. Check calculation (**(c)(i)**/16). Allow ecf **(c)(i)**. [1]

(c) (iv) Justify the number of significant figures in t, related to no. of SF in 16t / raw data. [1]
(Same number of significant figures in 16t or one more.)
Decimal place arguments scores zero.

(e) Calculation to check proportionality. Evidence for (V-V_0) required.
Calculate correct ratio (V-V_0)/n in both cases. If n = 16, -1. [1]

Analysis, conclusions and evaluation

Drawing conclusions

(e) Conclusion. [1]
Sensible comments relating to calculations and suggested relation.
Incorrect ideas score zero. Accept reference back to **(c)(ii)**.

Estimating uncertainties

(c) (ii) Percentage uncertainty in 16t. Consistent units. $\Delta 16t = \pm$ 0.01 mm or 0.001 mm. [1]
If repeated readings have been done then the uncertainty could be half the range.
Correct ratio idea required (0.01 or 0.001/16t x 100 %). Ecf from **(c)(i)**.

Identifying limitations and suggesting improvements

(f) (i) & **(ii)** Identify limitations and improvements by underlining relevant point a annotating the tick using the following letters in the grid.

	Problem **(P)**	Solution **(S)**
A	Two readings not enough (to draw a conclusion).	Take many readings **AND** plot a graph/find many values of k.
B	Alignment of cylinders/ alignment of LED/LDR.	Guide used; ruler/line on desk./ Adjust LED/LDR to get max voltage/method of fixing LED/LDR in cylinder.
C	Stray light coming in/not light tight/cylinders not sealed so let light enter tube/external light hits LDR.	Dark room/black cloth over head/lights off and blinds down/black box/black tape.
D	Difficult to hold all together/voltage meter fluctuates.	Method of fixing; clamp/plasticine/tape.
E	Separation between LED and LDR changes (as paper added).	Pre-slots in tube.
	Max 4	Max 4

X – Other valid limitation or improvement.

Do not allow ‘varying thickness of paper, zero error on micrometer’.
Do not allow ‘repeated readings, parallax error’.
Do not allow ‘use a computer to improve the experiment’.
Ignore separation of layer affects light getting through and squashing of paper for micrometer reading.

[Total: 20]