UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9702 PHYSICS

9702/51 Paper 5 (Planning, Analysis and Evaluation), maximum raw mark 30

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 Planning (15 marks)

Defining the problem (3 marks)

P1 *n* is the independent variable and *V* is the dependent variable or vary *n* and measure *V* [1]
P2 Keep distance from light to photocell constant [1]
P3 Keep intensity of light constant. Allow constant voltage across lamp/current through lamp/brightness. Do not allow 'same lamp/output'. [1]

Methods of data collection (5 marks)

M1 Labelled diagram of apparatus: lamp, glass sheet and photocell in line. [1]
M2 Voltmeter connected to photocell. Penalise unworkable photocell circuit. [1]
M3 Use micrometer (screw gauge) to measure thickness of glass sheet. [1]
M4 Take many readings of thickness and average. [1]
M5 Perform experiment in a dark room or shield apparatus. [1]

Method of analysis (2 marks)

A1 Plot a graph of $\ln V$ against n. Allow $\ln V$ against nt [1]
A2 α = (–)gradient/t. ($\ln V$ against nt then α = (–)gradient) [1]

Safety considerations (1 mark)

S Reasoned method to prevent burns from hot source, e.g. use gloves
Reasoned method to prevent eye damage from bright/intense source, e.g. shield lamp/dark glasses/do not look at source directly
Reasoned method to prevent cuts from glass e.g. use gloves. [1]

Additional detail (4 marks)

D Relevant points might include [4]
1 Use small distance/high intensity to gain large reading.
2 Method to check output of lamp is constant e.g. measure current through/p.d. across lamp/regularly check V_0 with no glass.
3 Reasoned method to ensure output of lamp is constant e.g. workable circuit diagram with variable resistor or variable power supply.
4 Clean sheets of glass before use.
5 Direction of light is perpendicular to glass sheets/constant orientation.
6 $\ln V = -\alpha nt + \ln V_0$.
7 Further safety consideration.

Do not allow vague computer methods.

[Total: 15]

2 Analysis, conclusions and evaluation (15 marks)

Part	Mark	Expected Answer	Additional Guidance
(a)	A1	NkT/A	$290Nk/A$
(b)	T1	$\frac{1}{h}$ / m^{-1}	Column heading. Allow equivalent unit. e.g. h^{-1} / m^{-1}
	T2	2.5 or 2.50 2.8 or 2.78 3.1 or 3.13 3.6 or 3.57 4.2 or 4.17 4.8 or 4.76	A mixture of 2sf and 3sf is allowed.
	U1	From ± 0.03 to ± 0.1, ± 0.11 or ± 0.12	Allow more than one significant figure.
(c) (i)	G1	Six points plotted correctly	Check second and fifth plots <u>and</u> other anomalous plots. Must be less than half a small square. Ecf allowed from table.
	U2	All error bars in $\frac{1}{h}$ plotted correctly	Half square or greater loses the mark. Ecf allowed from table.
(ii)	G2	Line of best fit	If points are plotted correctly then lower end of line should pass between (2.20, 1.0) **and** (2.30, 1.0) and upper end of line should pass between (4.75, 2.1) and (4.85, 2.1). Allow ecf from points plotted incorrectly – examiner judgement.
	G3	Worst acceptable straight line. Steepest or shallowest possible line that passes through <u>all</u> the error bars.	Line should be clearly labelled or dashed. Should pass from top of top error bar to bottom of bottom error bar **or** bottom of top error bar to top of bottom error bar. Mark scored only if error bars are plotted.
(iii)	C1	Gradient of best fit line	The triangle used should be at least half the length of the drawn line. Check the read offs. Work to half a small square. Do not penalise POT.
	U3	Uncertainty in gradient	Method of determining absolute uncertainty Difference in worst gradient and gradient.
(d)	C2	Value of $N = \frac{\text{gradient} \times A}{kT}$	Gradient must be used. Allow ecf from **(c)(iii)** but penalise POT.
	U4	Determines uncertainty in N	Method required. Do not check calculation.
(e) (i)	C3	Method to determine h	$h = \frac{NkT}{pA} = 1.111 \times 10^{-20} \times N$; T = 278 K Must use answer from **(d)**.
	C4	Between 0.361 and 0.391 given to 2 or 3 sf	Must be in range. Allow 0.36, 0.37, 0.38 or 0.39. Assume metres unless otherwise specified.
(ii)	U5	Percentage uncertainty	% uncertainty in N + % uncertainty in T) [Allow ΔT to be 0.5 or 1]

[Total: 15]

Uncertainties in Question 2

(c) (iii) Gradient [U3]
Uncertainty = gradient of line of best fit – gradient of worst acceptable line
Uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)

(d) [U4]
Uncertainty = worst N – N

$$\Delta N = \frac{\Delta m}{m} \times N$$

$$\Delta N = \Delta m \times \frac{A}{kT}$$

(e) [U5]

Percentage uncertainty = $\frac{\Delta h}{h} \times 100$

Percentage uncertainty = percentage uncertainty in N + percentage uncertainty in T