UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2010 question paper

for the guidance of teachers

9702 PHYSICS

9702/53 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 x is the independent variable, B is the dependent variable or vary x and measure B [1]

P2 Keep the number of turns on the coil/radius of the coil constant [1]
Do not accept same coil – 'coil' is not a variable

P3 Keep the current (in the coil) constant [1]

Methods of data collection (5 marks)

M1 Diagram showing coil and Hall probe with a means of read out appropriately positioned along axis [1]

M2 Coil connected to a power supply [1]

M3 Measure x with a ruler [1]

M4 Hall probe at right angles to direction of magnetic field or gives maximum output for each reading [1]

M5 Method to determine axis of coil or to find $x = 0$ [1]

Method of analysis (2 marks)

A1 Plot a graph of ln B against x [1]

A2 Relationship valid if a straight line is produced (ignore reference to y-intercept) [1]

Safety considerations (1 mark)

S1 Precaution linked to (large) current in coil/heating, e.g. switch off when not in use to avoid overheating coil; do not touch because it is hot [1]

Additional detail (4 marks)

D 1/2/3/4 Relevant points might include [4]

1. Method to create a large magnetic field, e.g. use large current or large number of turns.
2. Reasoned method to keep current constant.
3. Reasoned method to keep Hall probe in same orientation (e.g. use of set square, fix to rule, optical bench or equivalent).
4. B is proportional to voltage across Hall probe/calibrate Hall probe (in a known magnetic field).
5. Repeat experiment with Hall probe reversed or equivalent.
6. Identifies logarithmic equation i.e. $\ln B = -p\,x + \ln B_0$
7. Avoid external magnetic fields.
8. Method to keep Hall probe along axis.

Do not allow vague computer methods.

[Total: 15]

2 Analysis, conclusions and evaluation (15 marks)

Part	Mark	Expected Answer	Additional Guidance
(a)	A1	$\frac{4\pi^2}{g}$	Allow $\frac{39.5}{g}$
(b)	T1	Column headings: T / s and T^2 / s^2	There must be a dividing mark between the quantity and the unit, i.e. "in"; "/"; (unit) e.g. T (s).
	T2	3.57 or 3.572 3.20 or 3.204 2.79 or 2.789 2.40 or 2.403 1.99 or 1.988 1.59 or 1.588	Must be values in the table.
	U1	From ± 0.04 to ± 0.02 or ± 0.03	Allow more than one significant figure, e.g. ± 0.038.
(c) (i)	G1	Six points plotted correctly	Must be within half a small square. Ecf allowed from table.
	U2	Error bars in T^2 plotted correctly.	Check first and last point. Must be accurate within half a small square. All plots must have error bars.
(ii)	G2	Line of best fit	If points are plotted correctly then lower end of line should pass between (37, 1.5) and (38, 1.5) **and** upper end of line should pass between (92, 3.7) and (94, 3.7). 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	Error in gradient	Method of determining absolute error. Difference in worst gradient and gradient.
(d)	C2	$g = 4\pi^2$/gradient = 39.5/gradient	Gradient must be used correctly. Allow ecf from **(c)(iii)**.
	U4	Determines uncertainty in g	Uses worst calculated g value or fractional method. Do not check calculation.
	C3	Consistent unit: cm s^{-2} or m s^{-2}	Penalise POT. Allow equivalent cm/s^2 and m/s^2 Unit must be consistent with working.

(e) (i)	C4	24.6 to 25.9 given to 3 sf or 25 or 26 given to 2 sf.	Allow m, etc.
(ii)	U5	Determines percentage uncertainty in l	Check method; allow with or without consideration of ΔT.

[Total: 15]

Uncertainties in Question 2

(c) (iii) Gradient [E3]

1. Uncertainty = gradient of line of best fit – gradient of worst acceptable line
2. Uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)

(d) [E4]

1. Uncertainty = *g* from gradient – *g* from worst acceptable line
2. $\dfrac{\Delta g}{g} = \dfrac{\Delta\text{gradient}}{\text{gradient}}$

(e) [E5]

1. Works out worst l then finds difference then uses 2
2. $\dfrac{\Delta g}{g} \times 100 = \dfrac{\Delta\text{gradient}}{\text{gradient}} \times 100 = \dfrac{\Delta l}{l} \times 100$
3. $\dfrac{\Delta g}{g}\left(+\dfrac{2\Delta T}{T}\right) \times 100 = \dfrac{\Delta\text{gradient}}{\text{gradient}}\left(+\dfrac{2\Delta T}{T}\right) \times 100 = \dfrac{\Delta l}{l} \times 100$