CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2013 series

9702 PHYSICS

9702/52 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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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1 Planning (15 marks)

Defining the problem (3 marks)

P *f* is the independent variable or vary *f*. [1]

P I_0 is the dependent variable or measure I_0. [1]

P Keep V_0 constant. [1]

Methods of data collection (5 marks)

M Labelled/ workable circuit diagram of apparatus: including coil connected to power supply/signal generator. [1]

M Variable frequency ac power supply or signal generator (method of varying frequency). [1]

M Measure current using ammeter or p.d. across resistor. [1]

M Measure V across power supply or across coil e.g. voltmeter or c.r.o. explained. [1]

M Measure *f* using oscilloscope/read off signal generator. [1]

Method of analysis (2 marks)

A Plot a graph of $1/I_0^2$ against f^2 or V_0^2/I_0^2 against f^2 or equivalent.
Do not allow log-log graph. [1]

A $L = \sqrt{\frac{V_0^2 \text{gradient}}{4\pi^2}} = \frac{V_0}{2\pi}\sqrt{\text{gradient}}$ or $L = \sqrt{\frac{\text{gradient}}{4\pi^2}}$ [1]

Safety considerations (1 mark)

S Reasoned method to prevent overheating of coil or burns from coil. [1]

Additional detail (4 marks)

D Relevant points might include [4]
1 Use lower frequencies to produce larger currents
2 Keep resistance of circuit/coil constant
3 Additional detail on measuring *T* using timebase
4 *f* = 1 / period
5 Additional detail on measuring V_0 using *y*-gain
6 Relationship is valid if straight line, provided plotted graph is correct
7 Relationship is valid if straight line not passing through origin, provided plotted graph is correct (any quoted expression must be correct)
8 Detail on changing r.m.s. to peak

Do not allow vague computer methods. Ignore reference to iron core / other magnetic fields.

[Total: 15]

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2 Analysis, conclusions and evaluation (15 marks)

	Mark	Expected Answer	Additional Guidance
(a)	A1	Gradient = $\frac{4b}{E}$	
(b)	T1	a^2 / 10^{-4} m^2	Column heading. Allow equivalent unit. Do not award if 10^{-4} omitted.
	T2	44 or 43.6 52 or 51.8 61 or 60.8 71 or 70.6 79 or 79.2 88 or 88.4	A mixture of 2 s.f. and 3 s.f. is allowed.
	U1	1.3 increasing to 1.9	Allow 1 increasing to 2.
(c) (i)	G1	Six points plotted correctly	Must be within half a small square. Ecf allowed from table. Penalise 'blobs'.
	U2	All error bars in a^2 plotted correctly	Must be within half a small square. Ecf allowed from table.
(c) (ii)	G2	Line of best fit	If points are plotted correctly then lower end of line should pass between (1000, 43) and (1000,44.5) **and** upper end of line should pass between (2000, 87) and (2000, 89). 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.
(c) (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.

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(d) (i)	C2	$E = 4b$/gradient	Method required. Do not check calculation. Should be about 36 000. Do not penalise POT error.
	C3	$V\,m^{-1}$ or $N\,C^{-1}$	Penalise POT error.
(d) (ii)	U4	Percentage uncertainty in E	Must be greater than 2.5%.
(e)	C4	V = 540 to 580 V and given to 2 or 3 s.f.	Working must be correct; check for inconsistent units. Must be in stated range.
	U5	Absolute uncertainty in V	

[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]

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

max E = $\frac{\max b}{\min m}$

min E = $\frac{\min b}{\max m}$

Percentage uncertainty = $\left(\frac{\Delta m}{m} + \frac{\Delta b}{b}\right) \times 100 = \left(\frac{\Delta m}{m}\right) \times 100 + 2.5$

(e) [U5]

Absolute uncertainty = max V – V = V – min V = $\frac{\max V - \min V}{2}$

max V = $\frac{\max E \times \max a^2}{4 \min b}$ = $\frac{\max a^2}{\min m}$

min V = $\frac{\min E \times \min a^2}{4 \max b}$ = $\frac{\min a^2}{\max m}$

Absolute uncertainty = $\left(\frac{2\Delta a}{a} + \frac{\Delta m}{m}\right)V = \left(\frac{2\Delta a}{a} + \frac{\Delta E}{E} + \frac{\Delta b}{b}\right)V$

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