CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

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.

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 *h* is the dependent variable or measure *h.* [1]

P Keep current in coil constant. [1]

Methods of data collection (5 marks)

M Labelled diagram of apparatus: including working circuit with a.c. supply, coil, stand and ring. [1]

M Signal generator (or variable frequency power generator). [1]

M Measure *h* with a rule/calipers. [1]

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

M Measure *h* from opposite sides of the ring (and determine mean)/wait for ring to stabilise. [1]

Method of analysis (2 marks)

A Plot a graph of lg *h* against lg *f*. (Allow ln – ln graphs.) [1]

A $k = 10^{y\text{-intercept}}$ and n = gradient. [1]

Safety considerations (1 mark)

S Reasoned method to prevent the coil overheating – switch off when not in use. Or reasoned method to prevent injury from hot coil – do not touch hot coil, use gloves. Do not allow "small currents". [1]

Additional detail (4 marks)

D Relevant points might include [4]
1 Use iron/steel retort stand
2 Method to keep current constant
3 Method to determine period from oscilloscope using time-base
4 When using oscilloscope, $f = 1/T$
5 Use coil of many turns/large current to have measurable heights
6 Logarithmic equation e.g. $\lg h = n \lg f + \lg k$
7 Relationship is valid if a straight line is produced

Do not allow vague computer methods.

[Total: 15]

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2 Analysis, conclusions and evaluation (15 marks)

	Mark	Expected Answer	Additional Guidance
(a)	A1	Gradient = $v/4$ y-intercept = $-k$	y-intercept must be negative.
(b)	T1	$1/f$ / 10^{-3} s	Column heading. Allow equivalent unit. e.g. f^{-1}/ 10^{-3} Hz^{-1} or $1/f$ (10^{-3} s)
	T2	3.13 or 3.125 2.94 or 2.941 2.65 or 2.646 2.34 or 2.336 2.08 or 2.083 1.95 or 1.953	A mixture of 3 s.f. and 4 s.f. is allowed.
(c) (i)	G1	Six points plotted correctly	Must be less than half a small square. Ecf allowed from table. Penalise "blobs".
	U1	All error bars in d plotted correctly	Must be within half a small square. Each error bars should be five small squares
(ii)	G2	Line of best fit	If points are plotted correctly then lower end of line should pass between (2.06, 16) and (2.10, 16) **and** upper end of line should pass between (3.12, 24.5) and (3.16, 24.5).
	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.
	U2	Uncertainty in gradient	Method of determining absolute uncertainty Difference in worst gradient and gradient.
(iv)	C2	y-intercept – must be negative	Check substitution in $y = mx + c$. Allow ecf from **(c)(iii)**. FOX does not score. Should be about –1 (–0.35 to –1.33).
	U3	Uncertainty in y-intercept	Check substitution in $y = mx + c$. Difference in worst y-intercept and y-intercept. Allow ecf from **(c)(iv)** but FOX does not score.

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(d)	C3	k = – y-intercept cm or m v = 4 × gradient cm s^{-1} or m s^{-1}	Method required with appropriate unit. Do not penalise POT. Allow ecf from **(c)(iii)** and **(iv)**.
	U4	Determines absolute uncertainties in k and v	Uncertainty k = uncertainty in y-intercept. Uncertainty in v = 4 × uncertainty in gradient.
(e) (i)	C4	Between 250 and 260 given to 2 or 3 s.f.	Must be in range. Check method.
(ii)	U5	Percentage uncertainty in f	Absolute uncertainties in d and k must be added. $\Delta(d + k) = \Delta d + \Delta k$ % uncertainty in v + % uncertainty in (d + k).

[Total: 15]

Uncertainties in Question 2

(c) (iii) Gradient [U2]

Uncertainty = gradient of line of best fit – gradient of worst acceptable line

Uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)

(c) (iv) y-intercept [U3]

Uncertainty = y-intercept of line of best fit – y-intercept of worst acceptable line

Uncertainty = ½ (steepest worst line y-intercept – shallowest worst line y-intercept)

(d) [U4]

Uncertainty in k = uncertainty in y-intercept

Uncertainty in v = 4 × uncertainty in gradient

(e) [U5]

$$\max f = \frac{\max v}{4(\min d + \min k)} = \frac{\max \text{ gradient}}{(\min d + \min k)}$$

$$\min f = \frac{\min v}{4(\max d + \max k)} = \frac{\min \text{ gradient}}{4(\max d + \max k)}$$

Percentage uncertainty = % uncertainty in v + % uncertainty in (d + k)

Percentage uncertainty = % uncertainty in gradient + % uncertainty in (d + k)

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