CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2012 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 *v* is the independent variable or vary *v*. [1]

P *E* is the dependent variable or measure *E*. [1]

P Keep the number of turns on the coil <u>constant</u>. [1]

Methods of data collection (5 marks)

M1 Labelled diagram showing magnet falling vertically through coil. [1]

M2 Voltmeter or c.r.o. connected to the coil. Allow voltage sensor connected to datalogger. [1]

M3 Method to change speed e.g. change height. [1]

M4 Measurements to determine *v*. Use metre rule to measure distance magnet falls to the <u>bottom</u> of the coil or metre rule/ruler to measure length of coil or ruler to measure length of the magnet. [Allow timing instrument to measure the time of the fall from the start to the bottom of the coil.] [1]

M5 Method of determining *v* corresponding to appropriate distance e.g. $v = \sqrt{2gh}$ or $v=2h/t$ (for height method) or $v = L/t$ for length of magnet or coil <u>and</u> by stopwatch, timer or lightgate(s) connected to datalogger. [Allow $v = gt$ for timing fall to bottom of coil.] [1]

Method of analysis (2 marks)
A Plot a graph of *E* against *v*. [Allow lg *E* against lg *v*] [1]

A Relationship valid if <u>straight</u> line <u>through origin</u>. [1]
[If lg-lg then straight line with gradient = (+)1 (ignore reference to *y*-intercept)]

Safety considerations (1 mark)
S Keep away from falling magnet/use sand tray/cushion to catch magnet. [1]

Additional detail (4 marks)
D1/2/3/4 Relevant points might include [4]
Use coil with large number of turns/drop magnet from large heights/strong magnet
1 Detailed use of datalogger/storage oscilloscope to determine maximum *E*; allow video camera <u>including slow motion play back</u>
2 Use same magnet or magnet of same strength.
3 Use of short magnet so that *v* is (nearly) constant
4 Use short/thin coil so that *v* is (nearly) constant
5 Use a non-metallic <u>vertical</u> guide/tube
6 Method to support <u>vertical</u> coil or guide/tube
7 Repeat experiment for each *v* <u>and</u> average

Do not allow vague computer methods.

[Total: 15]

2 Analysis, conclusions and evaluation (15 marks)

Part	Mark	Expected Answer	Additional Guidance
(a)	A1	Gradient = *hc*/*e* *y*-intercept = – *B*/*e*	Note *y*-intercept must be negative
(b)	T1	$1/\lambda$ / 10^6 m^{-1}	Appropriate column heading
	T2	1.05 or 1.053 1.14 or 1.143 1.53 or 1.527 1.79 or 1.786 1.98 or 1.980 2.33 or 2.326	Must be values in table. A mixture of 3 s.f. and 4 s.f. is allowed.
(c) (i)	G1	Six points plotted correctly	Must be within half a small square. Penalise 'blobs'. Ecf allowed from table.
	U1	All error bars in *V* / V plotted correctly.	Do not allow near misses
(c) (ii)	G2	Line of best fit	If points are plotted correctly then lower end of line should pass between (1.12, 0.7) and (1.16,0.7) **and** upper end of line should pass between (2.32, 2.25) and (2.34, 2.25). 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. Should be about 1.3×10^{-6}.
	U2	Uncertainty in gradient	Method of determining absolute uncertainty Difference in worst gradient and gradient. [± 0.08]
(c) (iv)	C2	*y*-intercept	Must be negative Expect to see point substituted into $y = mx + c$ FOX does not score. Do not penalise POT. Should be between –0.72 and –0.86
	U3	Method of determining uncertainty in *y*-intercept	Difference in worst *y*-intercept and *y*-intercept. [Should be about ± 0.14]. FOX does not score. Allow ecf from **(c)(iv)**.

(d) (i)	C3	h in the range 6.77×10^{-34} to 7.14×10^{-34} <u>and</u> given to 2 or 3 significant figures	Gradient must be used. Penalise 1 s.f. or >3 s.f. h = gradient × e/c = gradient × 5.33×10^{-28} Allow 6.8×10^{-34} to 7.1×10^{-34} to 2 s.f.
(d) (ii)	U4	Percentage uncertainty in h	$\frac{\Delta m}{m} \times 100$ or $\frac{\Delta h}{h} \times 100$ [should be about 6%]
(e)	C4	$B = -e \times y$-intercept <u>and</u> J or C V or V C	Ignore '–' signs. y-intercept must be used but allow ecf from FOX. Should be between 1.16×10^{-19} J and 1.37×10^{-19} J. If FOX 8.3×10^{-20} J
	U5	Absolute uncertainty in B	Uncertainty = best B – worst B = Δy-intercept × e

[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)

(iv) [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) (ii) [U4]

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

Percentage uncertainty = $\frac{\Delta h}{h} \times 100 = \frac{1}{2}\frac{(\max h - \min h)}{h} \times 100$

(e) [U5]

Absolute uncertainty = best B – worst B

Absolute uncertainty = Δy-intercept × e

Absolute uncertainty = $\frac{\Delta c}{c} \times B$