CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2014 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.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2014 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

1 **Planning (15 marks)**

Defining the problem (3 marks)

P r is the independent variable, B is the dependent variable or vary r and measure B. [1]

P Keep the number of turns on the coil(s) constant.
Do not accept "same coil". [1]

P Keep the current in the coil constant. [1]

Methods of data collection (5 marks)

M Diagram showing flat coils and labelled Hall probe positioned at X. Minimum two labels needed.
Solenoids will not be credited. [1]

M Workable circuit diagram for coil connected to a (d.c.) power supply and ammeter.
Do not allow a.c. power supply or incorrect circuit diagrams. [1]

M Connect Hall probe to voltmeter / c.r.o.
Allow galvanometer but do not allow ammeter. [1]

M Measure diameter (radius) with a ruler / vernier calipers. Do not allow micrometer. [1]

M Calibrate Hall probe with a known magnetic flux density. [1]

Method of analysis (2 marks)

A Plot a graph of B against $1/r$ [allow lg B against lg r or other valid graph] [1]

A $\mu_0 = \dfrac{\text{gradient}}{0.72NI}$ [1]

Safety considerations (1 mark)

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

Additional detail (4 marks)

D Relevant points might include [4]
1 Use large current / large number of turns to create a large magnetic field
2 Use rheostat (to adjust current in circuit) (with ammeter) to keep the current constant
3 Hall probe at right angles to direction of magnetic field / parallel to coils. Allow adjust to obtain maximum reading
4 Reasoned method to keep Hall probe perpendicular to direction of magnetic field or at X (e.g. use of set square, fix to rule, optical bench or equivalent)
5 Method to check coils are correctly aligned in parallel
6 Repeat experiment with Hall probe reversed and average
7 Repeat measurement for *d* (or r) and average
8 Relationship is valid if the graph is a straight line passing through the origin for appropriate graph
[if lg–lg then straight line with gradient = –1 (ignore reference to *y*-intercept)]

Do not allow vague computer methods.

[Total: 15]

2 Analysis, conclusions and evaluation (15 marks)

	Mark	Expected Answer	Additional Guidance
(a)	A1	gradient = $\dfrac{-4\pi^2}{g}$ *y*-intercept = $\dfrac{4\pi^2}{g}k$	Gradient must be negative. Allow *y*-intercept = –gradient × *k*
(b)	T1	(mean) t / s, T / s and T^2 / s^2	All column headings to be correct.
	T2	31.8 or 31.81 30.8 or 30.80 29.6 or 29.59 28.7 or 28.73 27.8 or 27.77 26.8 or 26.83	Check all values of T^2. Allow a mixture of significant figures.
(c) (i)	G1	Six points plotted correctly	Must be within half a small square. Penalise "blobs" Ecf allowed from table.
	U1	Error bars in *d* plotted correctly	All error bars to be plotted. Must be accurate to less than half a small square.
(c) (ii)	G2	Line of best fit	Lower end of line should pass between (1.60, 27.0) and (1.64,27.0) **and** upper end of line should pass between (0.44,31.8) and (0.48,31.8).

	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. Examiner judgement on worst acceptable line. Lines must cross. Mark scored only if all error bars are plotted.
(c) (iii)	C1	Gradient of best fit line	Must be <u>negative</u>. 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 –4.)
	U2	Uncertainty in gradient	Method of determining absolute uncertainty: difference in worst gradient and gradient.
(c) (iv)	C2	*y*-intercept	FOX does not score. Check substitution into $y = mx + c$ Allow ecf from **(c)(iii)**. (Should be about 33.7.)
	U3	Uncertainty in *y*-intercept	Uses worst gradient and point on WAL. Do not check calculation. FOX does not score.
(d) (i)	C3	*g* between 9.20 and 9.90 given to 2 or 3 s.f. and correct unit ($\mathrm{m\,s^{-2}}$) having used gradient.	$g = -\dfrac{4\pi^2}{m}$; allow $\mathrm{N\,kg^{-1}}$
	C4	*k* determined correctly with correct unit (m)	$k = c\dfrac{g}{4\pi^2} = \dfrac{c}{-m}$ (*k* must be positive.)
(d) (ii)	U4	Percentage uncertainty in *g*	
	U5	Percentage uncertainty in *k*	Percentage uncertainty in *k* must be larger than the percentage uncertainty in *g*.

[Total: 15]

Uncertainties in Question 2

(c) (iii) Gradient [U2]

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

Uncertainty = $\frac{1}{2}$ (steepest worst line gradient – shallowest worst line gradient)

(c) (iv) [U3]

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

Uncertainty = $\frac{1}{2}$ (steepest *y*-intercept – shallowest *y*-intercept)

(d) (ii) [U4]

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

[U5]

Percentage uncertainty in k = $\frac{\Delta k}{k} \times 100 = \frac{\Delta g}{g} \times 100 + \frac{\Delta c}{c} \times 100$

max k = $\frac{\text{max } g \times \text{max } y\text{-intercept}}{4\pi^2}$ = $\frac{\text{max } y - \text{intercept}}{\text{min gradient}}$

min k = $\frac{\text{min } g \times \text{min-intercept}}{4\pi^2}$ = $\frac{\text{min } y - \text{intercept}}{\text{max gradient}}$