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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2009 question paper for the guidance of teachers

9702 PHYSICS

9702/52 Paper 52 (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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Question 1

Planning (15 marks)

Defining the problem (3 marks)

P1 Vary *d* and measure *y* or *d* is the independent variable and *y* is the dependent variable [1]

P2 Keep current constant [1]

P3 Keep length of wire constant [1]

Methods of data collection (5 marks)

M1 Diagram showing ruler positioned and power supply connected to wire or diagram showing initial and final marks on screen and power supply connected to wire [1]

M2 Use of ammeter to check current – penalise incorrect circuit diagrams [1]

M3 Measurement of *d* using micrometer [1]

M4 Allow time for displacement of wire to stabilise [1]

M5 Detail on measuring *y*; final reading - initial reading [1]

Method of analysis (2 marks)

A1 Plot a graph of log *y* against log *d* [1]

A2 *q* = gradient [1]

Safety considerations (1 mark)

S Safety related to hot wire – use of gloves, wait to cool down/switch off before changing wire, do not touch hot wire [1]

Additional detail (4 marks)

D Relevant points might include [4]

1. Use of vernier scale to measure *y* /well described optical method/use of set square
2. Method for keeping current constant e.g. use of rheostat
3. Check starting position for *y* for same wire
4. lg *y* = *q* lg *d* + lg *p*
5. Repeat measurements of *d* at different points along the wire and determine average
6. Control of additional variables e.g. separation between supports, room temperature
7. Use of protective resistor (either labelled or explained).

15 marks can be scored in total.

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Question 2 Analysis, conclusions and evaluation (15 marks)

Part	Mark	Expected Answer	Additional Guidance
(a)	A1	$\frac{2}{g}$	
(b)	T1	t^2 / s^2	Column heading: allow t^2 (s^2) or t^2in s^2 Do not allow (t / s)^2
	T2	0.12 or 0.123 0.15 or 0.152 0.18 or 0.185 0.20 or 0.203 0.24 or 0.240 0.27 0r 0.270	Must be to two or three significant figures. A mixture of 2sf and 3sf is allowed.
	U1	± 0.007 to ± 0.010 (allow ± 0.011)	Allow more than one significant figure.
(c) (i)	G1	Six points plotted correctly.	Must be within half a small square. Use transparency. 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.
(c) (ii)	G2	Line of best fit.	If points are plotted correctly then lower end of line should pass between (0.60, 0.116) and (0.60, 0.123) **and** upper end of line should pass between (1.30, 0.268) and (1.30, 0.272). Allow ecf from points plotted incorrectly – examiner judgement. Five good trend plots needed.
	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 greater than half the length of the drawn line. Check the read offs. If incorrect circle and write in correct value. Work to half a small square. Do not penalise POT.
	U3	Uncertainty in gradient.	Method of determining absolute error Difference in worst gradient and gradient.
(d)	C2	g = 2/gradient	Gradient must be used. Allow ecf from **(c) (iii)**
	U4	Method of determining uncertainty in *g.*	Uses worst gradient and finds difference. Allow fractional error methods. Do not check calculation.

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	C3	Unit of *g*: **m s^{-2}**	Accept **N kg^{-1}**
(e) (i)	C4	21.9 – 23.5	Answer must be in range given to 2 or 3sf. Allow 22 or 23.
(e) (ii)	U5	Method for percentage uncertainty in *b*.	Calculates percentage uncertainty in t^2 and adds to percentage uncertainty in gradient or *g*. Allow ecf from **(c) (iii)** and/or **(d)**.

[Total: 15]

Uncertainties in Question 2

(c) (iii) Gradient [U3]

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) *g* [U4]

1. Uncertainty = *g* from gradient - *g* from worst acceptable line
2. $\frac{\Delta g}{g} = \frac{\Delta gradient}{gradient}$

(e) *b* [U5]

1. Substitution method to find worst acceptable *g* using
   either largest $g \times 2.22^2$
   or smallest $g \times 2.20^2$
   then determines percentage uncertainty
2. 0.9% + percentage uncertainty in gradient or percentage uncertainty in *g*
3. $\frac{\Delta b}{b} \times 100 = \left(\frac{\Delta g}{g} + 2\frac{\Delta t}{t} \right) \times 100$

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