UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2008 question paper

9702 PHYSICS

9702/05 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.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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Question 1

Planning (15 marks)

Defining the problem (3 marks)

P1 *d* is the independent variable or vary *d* (allow in table if numbers given) [1]

P2 *R* is the dependent variable or measure *R* as *d* varied (allow in table) [1]

P3 Keep output of light source constant (allow constant current / e.m.f. / voltage / power) [1]

Methods of data collection (5 marks)

M1 Diagram showing an LDR in a circuit and an independent lamp. [1]

M2 Diagram showing ruler measuring appropriate distance or *d* labelled correctly. [1]

M3 Correct circuit diagram for LDR using conventional symbols; allow labelled diagram [1]
Ammeter and voltmeter with power supply, or potential divider methods
ohmmeter without power supply, or
bridge methods.

M4 Method of determining *R*. [1]
Ohmmeter.
$R = V/I$ justified.
Potential divider equation
Description of balancing bridge with correct equation.

M5 Perform experiment in a dark room/tube [1]

Method of analysis (2 marks)

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

A2 Relationship is correct if log *R* against log *d* graph is a straight line [1]

Safety considerations (1 mark)

S1 Do not look directly at bright light source / do not touch hot light source. [1]
Allow safety glasses with reference to light source.

Additional detail (4 marks)

D1/2/3/4 Relevant points might include [4]
Detail on measuring the distance
Keep orientation of LDR with respect to the light source constant
Reasoned method for keeping light and LDR in correct orientation. (E.g. use of set square, fix to rule, optical bench or equivalent)
Determination of a typical current
Range of ammeter / ohmmeter
Control (or monitoring) of an additional variable e.g. temperature
Reason for performing experiment in a dark room related to the LDR
Method for checking the output of the light source is constant.
Identifies gradient = *n* and/or *y*-intercept = log *k* for log *R* against log *d* graph

Do not allow parallax when reading ruler, or reflectors.

[Total: 15]

Question 2 Analysis, conclusions and evaluation (15 marks)

Part	Mark	Expected Answer	Additional Guidance
(a)	A1	$\frac{8m}{eB^2}$	Allow $gradient = \frac{8}{\frac{e}{m}B^2}$
(b)	T1	4.4 or 4.41 7.8 or 7.84 12 or 11.6 (or 11.56) 15 or 15.2 (or 15.21) 18 or 18.5 (or 18.49) 22 or 22.1 (or 22.09)	Ignore significant figures
	T2	All values given to two or three significant figures.	Must be to two or three significant figures. A mixture of 2s.f. and 3s.f. is allowed.
	E1	± 0.4 (allow ± 0.5), ± 0.6, ± 0.7, ± 0.8, ± 0.9, ± 0.9 or ± 1.0	Allow more than one significant figure.
(c) (i)	G1	Six points plotted correctly.	Must be within half a small square. Use transparency. E.c.f. allowed from table.
	E2	Error bars in d^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 (150, 2) and (200, 2) **and** upper end of line should pass between (3200, 24) and (3250, 23.7). Allow e.c.f. 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 greater than half the length of the drawn line. Check the read offs. Work to half a small square. Do not penalise POT. If points and BFL correct then gradient should be in numerical range (7.00 – 7.35) ($\times 10^{-7}$).
	E3	Error in gradient	Method of determining absolute error. Difference in worst gradient and gradient.
(d)	C2	e/m = 8/(gradient × B^2) = 1.28×10^5/gradient = 1.8×10^{11}	Gradient must be used. Allow e.c.f. from **(c) (iii)** but penalise POT. If gradient within range given, then e/m in range (1.74 – 1.83) × 10^{11}.
	E4	Method of determining error in e/m.	Uses worst gradient and finds difference. Allow fractional error methods. Do not check calculation.
	C3	Unit of e/m: C kg^{-1}.	Accept V m^{-2} T^{-2}.

(e)	C4	$3.80 – 4.00 \times 10^{-3}$ [If POT in **(d)** allow 0.38 – 0.40]	Check method. $B = \sqrt{\frac{8 \times 500}{\frac{e}{m} \times (3.8 \times 10^{-2})^2}}$ Answer must be in range given.
	E5	Method for determining largest error in correct value of *B*.	This mark can only be scored if *B* is in range. Expect to see similar calculation to above with largest e/m x $(3.9 \times 10^{-2})^2$ or smallest e/m x $(3.7 \times 10^{-2})^2$. Allow fractional error methods.

[Total: 15]

Uncertainties in Question 2

(c) (iii) Gradient [E3]

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) *e*/*m* [E4]

1. Uncertainty = *e/m* from gradient – *e/m* from worst acceptable line

2. $\dfrac{\Delta \frac{e}{m}}{\frac{e}{m}} = \dfrac{\Delta gradient}{gradient}$

(e) *B* [E5]

1. Substitution method to find worst acceptable *B* using either largest $e/m \times (3.9 \times 10^{-2})^2$ or smallest $e/m \times (3.7 \times 10^{-2})^2$.

2. $\dfrac{\Delta B}{B} = \dfrac{1}{2}\left(\dfrac{\Delta \frac{e}{m}}{\frac{e}{m}} + \dfrac{2\Delta d}{d}\right) = \left(\dfrac{\Delta \frac{e}{m}}{2\frac{e}{m}} + \dfrac{\Delta d}{d}\right)$

Summary of shorthand notation which may be used in annotating scripts:

XEX Wrong experiment

SFP Significant figure penalty

ECF Error carried forward

AE Arithmetical error

POT Power of ten error

NV Not valid

NR Not relevant

NBL Not best line

NWL Not worst line

FO False origin

NE Not enough

NGE Not good enough

BOD Benefit of the doubt

NA Not allowed

SV Supervisor's value

SR Supervisor's report

OOR Candidate's value is out of range

CON Contradictory physics not to be credited

✓Δ Used to show that the size of a triangle is appropriate

✓M3 Used to show the type of mark awarded for a particular piece of work

✓C Used to show that the raw readings are consistent

✓SF Used to show calculated quantities have been given to an appropriate number of significant figures

^ Piece of work missing (one mark penalty)

^^ Several pieces of work missing (more than one mark penalty)

↔ Scale can be doubled in the x-direction

↕ Scale can be doubled in the y-direction