UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2010 question paper for the guidance of teachers

9702 PHYSICS

9702/53 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 must be read in conjunction with the question papers and the report on the examination.

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1 Planning (15 marks)

Defining the problem (3 marks)

P1 c, d or A is the independent variable and R is the dependent variable or vary c, d or A and measure R. [1]

P2 If c varied then (t and) d or A kept constant, if d varied then (t and) c or A kept constant, if A varied then c or d kept constant. [1]

P3 Keep temperature constant. [1]

Methods of data collection (5 marks)

M1 Circuit diagram to measure resistance. [1]

M2 Use micrometer screw gauge to measure d or t. (Allow digital or vernier callipers) [1]

M3 Measure c with a ruler/metre rule. [1]

M4 Method of making contact with the strip e.g. use electrodes of at least same dimension as c or d or t or conducting paint methods. Do not allow crocodile clips, unless it is clear that the whole area of the end of the strip is covered. [1]

M5 Method to determine resistance. [1]

Method of analysis (2 marks)

A1 Plot a graph of R against c, $1/d$ or $1/A$ depending on orientation. Other alternatives possible, e.g. R against $1/c$ depending on orientation [1]

A2 Must be consistent with A1: $\rho = A \times$ gradient or $t \times$ gradient/c [1]
Other alternatives possible, e.g. $\rho = d \times$ gradient/t

Safety considerations (1 mark)

S1 Reference sharp edges or cutting metals, e.g. wear gloves. [1]

Additional detail (4 marks)

D1/2/3/4 Relevant points might include [4]

1. Insulate aluminium strip
2. Take many readings of t or d and average
3. Use a protective resistor/circuit designed to reduce current
4. Rearrange equation to determine graph using c, d and t or A
5. Determine typical resistance of aluminium strip
6. Likely meter range of ammeter/voltmeter/ohmmeter
7. Detail on cutting strip e.g. mark using set square

Do not allow vague computer methods.

[Total: 15]

2 Analysis, conclusions and evaluation (15 marks)

<table>
<tr><th>Part</th><th>Mark</th><th>Expected Answer</th><th>Additional Guidance</th></tr>
<tr><td>(a)</td><td>A1</td><td>$-\frac{t}{C}$</td><td>Must be negative. Allow $-\frac{15}{C}$.</td></tr>
<tr><td>(b)</td><td>T1
T2</td><td><table><tr><td>150</td><td>1.28 or 1.281</td></tr><tr><td>100</td><td>1.61 or 1.609</td></tr><tr><td>66.7</td><td>1.86 or 1.856</td></tr><tr><td>50.0</td><td>1.97 or 1.974</td></tr><tr><td>33.3</td><td>2.08 or 2.079</td></tr></table></td><td>T1 for 1/R column – ignore sf and rounding errors
T2 for ln (V/V) column – must be values given
A mixture is allowed</td></tr>
<tr><td></td><td>U1</td><td>From ± 0.05 or ± 0.06 to ± 0.02 or ± 0.03</td><td>Allow more than one significant figure.</td></tr>
<tr><td>(c) (i)</td><td>G1</td><td>Five points plotted correctly</td><td>Must be within half a small square; penalise ≥ half a small square. Ecf allowed from table. Penalise 'blobs' ≥ half a small square.</td></tr>
<tr><td></td><td>U2</td><td>Error bars in ln(V/V) plotted correctly.</td><td>All plots to have error bars; penalise ≥ half a small square. Check first and last point. Must be accurate within half a small square.</td></tr>
<tr><td>(ii)</td><td>G2</td><td>Line of best fit</td><td>If points are plotted correctly then upper end of line should pass between (20, 2.16) and (20, 2.18) and lower end of line should pass between (160, 1.20) and (160, 1.225). Allow ecf from points plotted incorrectly – examiner judgement.</td></tr>
<tr><td></td><td>G3</td><td>Worst acceptable straight line.
Steepest or shallowest possible line that passes through <u>all</u> the error bars.</td><td>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 all error bars are plotted.</td></tr>
<tr><td>(iii)</td><td>C1</td><td>Gradient of best fit line
Must be negative</td><td>The triangle used should be at least half the length of the drawn line. Check the read offs. Work to half a small square; penalise ≥ half a small square. Do not penalise POT.</td></tr>
<tr><td></td><td>U3</td><td>Uncertainty in gradient</td><td>Method of determining absolute uncertainty.
Difference in worst gradient and gradient.</td></tr>
<tr><td>(d) (i)</td><td>C2</td><td>C = –15/gradient</td><td>Gradient must be used.
Allow ecf from (c)(iii). Do not penalise POT.</td></tr>
<tr><td></td><td>C3</td><td>2.14×10^{-3} F to 2.24×10^{-3} F
<u>and</u> to 2 or 3 sf</td><td>Must be in range – penalise POT.
Allow equivalent unit including s Ω^{-1}, C V^{-1}, A s V^{-1}</td></tr>
</table>

(ii)	U4	Determines % uncertainty in *C*	Uses worst gradient or worst calculated *C* value. Do not check calculation.
(e)	C4	Determines *R* correctly	Expect to see an answer about 3000 Ω. *R* = 6.514/candidate's *C*; allow ecf from **(d)(i)**
	U5	Determines absolute uncertainty	Determines worst value of *R* or **(d)(ii)** × *R*

[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) (ii) [U4]

1. Works out worst *C* then determines % uncertainty
2. Works out percentage uncertainty in gradient

(e) [U5]

1. Works out worst *R* then determines difference
2. $\Delta R = \left(\frac{\Delta\text{gradient}}{\text{gradient}}\right) R = \left(\frac{\Delta C}{C}\right) R$