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

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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 <u>constant</u>. [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)**

| Part | Mark | Expected Answer | Additional Guidance |
|---|---|---|---|
| **(a)** | A1 | $-\frac{t}{C}$ | Must be negative. Allow $-\frac{15}{C}$. |
| **(b)** | T1<br>T2 | <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> | T1 for 1/*R* column – ignore sf and rounding errors<br>T2 for ln (*V*/V) column – must be values given<br>A mixture is allowed |
| | U1 | From ± 0.05 or ± 0.06 to ± 0.02 or ± 0.03 | Allow more than one significant figure. |
| **(c) (i)** | G1 | Five points plotted correctly | Must be within half a small square; penalise ≥ half a small square. Ecf allowed from table. Penalise 'blobs' ≥ half a small square. |
| | U2 | Error bars in ln(*V*/V) plotted correctly. | All plots to have error bars; penalise ≥ half a small square. Check first and last point. Must be accurate within half a small square. |
| **(ii)** | G2 | Line of best fit | 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. |
| | 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 all error bars are plotted. |
| **(iii)** | C1 | Gradient of best fit line<br>Must be negative | 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. |
| | U3 | Uncertainty in gradient | Method of determining absolute uncertainty. Difference in worst gradient and gradient. |
| **(d) (i)** | C2 | *C* = –15/gradient | Gradient must be used.<br>Allow ecf from **(c)(iii)**. Do not penalise POT. |
| | C3 | $2.14 \times 10^{-3}$ F to $2.24 \times 10^{-3}$ F <u>and</u> to 2 or 3 sf | Must be in range – penalise POT.<br>Allow equivalent unit including s $\Omega^{-1}$, C $V^{-1}$, A s $V^{-1}$ |

| | | | |
|---|---|---|---|
| **(ii)** | U4 | Determines % uncertainty in *C* | Uses worst gradient or worst calculated *C* value.<br>Do not check calculation. |
| **(e)** | C4 | Determines *R* correctly | Expect to see an answer about 3000 Ω.<br>*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. $\Delta R = \left(\frac{\Delta \text{gradient}}{\text{gradient}}\right) R = \left(\frac{\Delta C}{C}\right) R$