UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 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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UNIVERSITY of CAMBRIDGE
International Examinations

1 Planning (15 marks)

Defining the problem (3 marks)

P *A* is the independent variable and *V* is the dependent variable or vary *A* and measure *V*. [1]
P Keep the number of turns on coil Y or coil X constant. [1]
P Keep the current in coil X constant. [1]

Methods of data collection (5 marks)

M1 Two independent coils labelled X and Y; coil Y wound over coil X. [1]
M2 Alternating power supply/signal generator connected to coil X. [1]
M3 Coil Y connected to voltmeter/c.r.o. in a workable circuit. [1]
M4 Measure diameter/radius/lengths with a ruler/vernier callipers. [1]
M5 Method to determine area. [1]

Method of analysis (2 marks)

A Plot a graph of *V* against *A*. [1]
A Relationship valid if straight line through origin. [1]

Safety considerations (1 mark)

S Precaution linked to (large) current in coil/heating, 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 in coil X/large number of turns/high frequency a.c. to produce measurable e.m.f.
2 Detail on measuring e.m.f., e.g. height × *y*-gain on CRO.
3 Keep frequency of power supply constant.
4 Use of rheostat to keep current constant in coil X.
5 Monitor with a.c. ammeter.
6 Avoid other alternating magnetic fields.
7 Repeat measurement for *r* or *d* or lengths and average.

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>2gh</td><td>Allow 2hg.</td></tr>
<tr><td>(b)</td><td>T1
T2</td><td><table><tr><td>0.111 or 0.1111</td><td>1.320 – 1.321</td></tr><tr><td>0.200 or 0.2000</td><td>2.295 – 2.310</td></tr><tr><td>0.273 or 0.2727</td><td>3.189 – 3.204</td></tr><tr><td>0.333 or 0.3333</td><td>3.842 – 3.846</td></tr><tr><td>0.385 or 0.3846</td><td>4.41 – 4.45</td></tr><tr><td>0.429 or 0.4286</td><td>4.84 – 4.94</td></tr></table></td><td>T1 for ratio values: Ignore sf in 2nd row.
T2 for v^2.
Rows 1–4 to 3 s.f. or 4 s.f.
Rows 5–6 to 2 s.f. or 3 s.f.</td></tr>
<tr><td></td><td>U1</td><td>From $\pm$ 0.02 or $\pm$ 0.03, to $\pm$ 0.2</td><td>Allow more than one significant figure.</td></tr>
<tr><td>(c) (i)</td><td>G1</td><td>Six points plotted correctly</td><td>Must be within half a small square. Do not allow 'blobs' (more than half a small square).
Ecf allowed from table.</td></tr>
<tr><td></td><td>U2</td><td>Error bars in v^2 plotted correctly</td><td>All error bars to be plotted. Check third and fourth plot. Must be accurate to less than half a small square.</td></tr>
<tr><td>(c) (ii)</td><td>G2</td><td>Line of best fit</td><td>If points are plotted correctly then lower end of line should pass between (0.10, 1.16) and (0.10, 1.24) and upper end of line should pass between (0.45, 5.12) and (0.45, 5.20). 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 error bars are plotted.</td></tr>
<tr><td>(c) (iii)</td><td>C1</td><td>Gradient of best fit line</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. 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)</td><td>C2</td><td>g = gradient / 2h = gradient / 1.2</td><td>Gradient must be used.
Allow ecf from (c)(iii).</td></tr>
<tr><td></td><td>U4</td><td>Absolute uncertainty in g</td><td>Uses worst gradient.
Do not check calculation.</td></tr>
<tr><td>(e)</td><td>C3</td><td>Ratio = 0.6/(0.6 + 1.8) = 0.25</td><td>Expect to see 1.00 added and largest m.</td></tr>
<tr><td></td><td>C4</td><td>Between 1.66 and 1.70 given to 2 or 3 s.f.</td><td>$v = \sqrt{2 \times 0.25 \times g \times 0.6} = \sqrt{0.3 \times g}$
or $v = \sqrt{\text{gradient} \times 0.25}$
or $v = \sqrt{v^2}$ read from graph for ratio 0.25.
Must be in range. Allow 1.7.</td></tr>
<tr><td></td><td>U5</td><td>Determines absolute uncertainty</td><td>Allow ecf. Expect to see difference between best and worst values.</td></tr>
</table>

[Total: 15]

Uncertainties in Question 2

(c) (iii) Gradient [U3]
Uncertainty = gradient of line of best fit – gradient of worst acceptable line
Uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)

(d) [U4]
Uncertainty = best g – worst g
Uncertainty = uncertainty in gradient / 1.2
Uncertainty = $\frac{\Delta m}{m} g$

(e) [U5]
Uncertainty = best v – worst v
Uncertainty = $\frac{1}{2} \times \frac{\Delta m}{m} v$
Uncertainty = $\frac{1}{2} \times \frac{\Delta g}{g} v$