Cambridge International AS & A Level

**Cambridge International Examinations**
Cambridge International Advanced Subsidiary and Advanced Level

**PHYSICS** **9702/53**

Paper 5 Planning, Analysis and Evaluation **October/November 2016**

MARK SCHEME

Maximum Mark: 30

**Published**

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| Question | Answer | Marks |
|---|---|---|
| 1 | **Defining the problem** | |
| | *B* is the independent variable and *v* is the dependent variable, or vary *B* measure *v*. | 1 |
| | Keep starting position of magnet constant/magnet always released from rest. | 1 |
| | **Methods of data collection** | |
| | Labelled diagram showing a magnet and the vertical copper tube supported. | 1 |
| | Method to ensure that copper tube is vertical, e.g. set square, spirit level, plumb line. | 1 |
| | Method to determine time at bottom of tube e.g. use of light gate(s)/motion sensor attached to timer/datalogger/computer or distance between two fixed marks at bottom of tube and stopwatch.<br>Do not allow time over length of tube. | 1 |
| | Method to measure *B*, e.g. Hall probe. | 1 |
| | **Method of analysis** | |
| | Plot a graph of ln *v* against *B*. | 1 |
| | $\lambda$ = – gradient | 1 |
| | $v_0 = e^{y\text{-intercept}}$ | 1 |

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|---|---|---|
| | **Additional detail including safety considerations** | **6** |
| | 1. Keep mass of magnet constant.<br>2. Measurement of an appropriate length to determine $v$ at bottom of tube, e.g. use ruler to measure distance between light gates/length of magnet/between two fixed marks.<br>3. $v = d / t$ for appropriate lengths (**not** length of tube)<br>4. Adjust Hall probe until maximum reading obtained/perpendicular to field/pole<br>*or*<br>Use Hall probe to take readings for both poles and average.<br>5. Method to calibrate Hall probe using a known field.<br>6. Safety precaution linked to falling magnets/use sand tray/cushion to soften fall.<br>7. Repeat experiment with magnets reversed and average<br>*or*<br>Repeat $v$ (or $t$) for same $B$ and average.<br>8. $\ln v = -\lambda B + \ln v_0$<br>9. Relationship is valid if the graph is a straight line.<br>10. Method to vary $B$, e.g. re-magnetise in a coil. | |

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|---|---|---|
| 2 (a) | gradient = $\frac{1}{YE}$<br>$y$-intercept = $\frac{1}{E}$ | 1 |
| (b) | <table><tr><td>2.7 or 2.70</td><td>0.833 or 0.8333</td></tr><tr><td>1.4 or 1.35</td><td>0.513 or 0.5128</td></tr><tr><td>0.90 or 0.900</td><td>0.426 or 0.4255</td></tr><tr><td>0.68 or 0.675</td><td>0.364 or 0.3636</td></tr><tr><td>0.54 or 0.540</td><td>0.345 or 0.3448</td></tr><tr><td>0.45 or 0.450</td><td>0.328 or 0.3279</td></tr></table><br>All first column correct. Allow a mixture of significant figures.<br>All second column correct. Allow a mixture of significant figures.<br>Uncertainties in $X$ from ± 0.4 to ± 0.07 (± 0.1). Allow more than one significant figure. | 1<br>1<br>1 |
| (c) (i) | Six points plotted correctly.<br>Must be within half a small square. No “blobs”. | 1 |
| | All error bars in $X$ plotted correctly.<br>All error bars to be plotted. Length of bar must be accurate to less than half a small square and symmetrical. | 1 |
| (ii) | Line of best fit drawn.<br>Line must not be drawn from top point to bottom point.<br>The lower end of line should pass between (0.95, 0.45) and (1.1, 0.45) **and** upper end of line should pass between (2.10, 0.70) and (2.25, 0.70). | 1 |
| | Worst acceptable line drawn correctly.<br>Steepest or shallowest possible line that passes through <u>all</u> the error bars.<br>Mark scored only if all error bars are plotted. | 1 |
| (iii) | Gradient determined with a triangle that is at least half the length of the drawn line.<br>Read-offs must be accurate to half a small square. | 1 |
| | **Method** of determining absolute uncertainty.<br>uncertainty = gradient of line of best fit – gradient of worst acceptable line<br>*or*<br>uncertainty = ½(steepest worst line gradient – shallowest worst line gradient) | 1 |
| (iv) | $y$-intercept determined correctly by substitution into $y = mx + c$.<br>Read-offs must be accurate to half a small square. | 1 |

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|---|---|---|
| | **Method** of determining absolute uncertainty.<br>uncertainty = *y*-intercept of line of best fit – *y*-intercept of worst acceptable line<br>*or*<br>uncertainty = ½(steepest worst line *y*-intercept – shallowest worst line *y*-intercept)<br>No ECF from false origin method. | **1** |
| **(d) (i)** | $E = 1/y$-intercept and given to 2 or 3 s.f. | **1** |
| | $Y = \frac{1}{E \times \text{gradient}}$ *or* $\frac{y - \text{intercept}}{\text{gradient}}$<br>$Y$ in the range (0.90 to 1.20) $\times 10^{-3}$ F.<br>Appropriate unit required.<br>Correct substitution of numbers must be seen. | **1** |
| **(ii)** | Percentage uncertainty in $Y$<br>$= \left(\frac{\Delta m}{m} + \frac{\Delta c}{c}\right) \times 100$ *or*<br>$= \left(\frac{\Delta m}{m} + \frac{\Delta E}{E}\right) \times 100$ *or*<br>$= \frac{\Delta Y}{Y} \times 100$<br><br>Maximum/minimum methods:<br><br>$\max Y = \frac{1}{\min E \times \min \text{gradient}} = \frac{\max y - \text{intercept}}{\min \text{gradient}}$<br><br>$\min Y = \frac{1}{\max E \times \max \text{gradient}} = \frac{\min y - \text{intercept}}{\max \text{gradient}}$ | **1** |

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