Cambridge International AS & A Level

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PHYSICS **9702/51**

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. 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
	λ = – gradient	1
	$v_0 = e^{y\text{-intercept}}$	1

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

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Question	Answer	Marks
2 (a)	gradient = $\frac{1}{YE}$ y-intercept = $\frac{1}{E}$	1
(b)	2.7 or 2.70 | 0.833 or 0.8333 1.4 or 1.35 | 0.513 or 0.5128 0.90 or 0.900 | 0.426 or 0.4255 0.68 or 0.675 | 0.364 or 0.3636 0.54 or 0.540 | 0.345 or 0.3448 0.45 or 0.450 | 0.328 or 0.3279 All first column correct. Allow a mixture of significant figures. All second column correct. Allow a mixture of significant figures. Uncertainties in X from ± 0.4 to ± 0.07 (± 0.1). Allow more than one significant figure.	 1 1 1
(c) (i)	Six points plotted correctly. Must be within half a small square. No "blobs".	1
	All error bars in X plotted correctly. 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. Line must not be drawn from top point to bottom point. 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. Steepest or shallowest possible line that passes through <u>all</u> the error bars. 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. Read-offs must be accurate to half a small square.	1
	Method of determining absolute uncertainty. uncertainty = gradient of line of best fit – gradient of worst acceptable line *or* uncertainty = ½(steepest worst line gradient – shallowest worst line gradient)	1
(iv)	y-intercept determined correctly by substitution into $y = mx + c$. Read-offs must be accurate to half a small square.	1

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Question	Answer	Marks
	Method of determining absolute uncertainty. uncertainty = *y*-intercept of line of best fit – *y*-intercept of worst acceptable line *or* uncertainty = ½(steepest worst line *y*-intercept – shallowest worst line *y*-intercept) 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* $\frac{y - \text{intercept}}{\text{gradient}}$ *Y* in the range (0.90 to 1.20) × 10^{-3} F. Appropriate unit required. Correct substitution of numbers must be seen.	**1**
(ii)	Percentage uncertainty in *Y* $= \left(\frac{\Delta m}{m} + \frac{\Delta c}{c}\right) \times 100$ *or* $= \left(\frac{\Delta m}{m} + \frac{\Delta E}{E}\right) \times 100$ *or* $= \frac{\Delta Y}{Y} \times 100$ Maximum/minimum methods: $\max Y = \frac{1}{\min E \times \min \text{gradient}} = \frac{\max y - \text{intercept}}{\min \text{gradient}}$ $\min Y = \frac{1}{\max E \times \max \text{gradient}} = \frac{\min y - \text{intercept}}{\max \text{gradient}}$	**1**

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