Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/51**

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

MARK SCHEME

Maximum Mark: 30

Published

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 should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

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 <u>bottom</u> 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 <u>measure *B*</u>, 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**

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.	

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.	1
	All second column correct. Allow a mixture of significant figures.	1
	Uncertainties in X from ± 0.4 to ± 0.07 (± 0.1). Allow more than one significant figure.	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

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 <u>and</u> 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**