Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evalution **October/November 2017**

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.

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Question	Answer	Marks
1	**Defining the problem**	
	x is the independent variable and *V* is the dependent variable **or** vary *x* and measure *V*	**1**
	keep current (in the coil P) constant	**1**
	Methods of data collection	
	labelled diagram showing both coils supported	**1**
	two correct circuit diagrams for coil P and coil Q: power supply connected to one coil and voltmeter/c.r.o. connected to other coil	**1**
	method to determine *x*, e.g. use a ruler or drawn labelled horizontal ruler adjacent to coils with *x* indicated	**1**
	method to measure *x* from centre of coil P to centre of coil Q, e.g. measure width of (each) coil and divide by 2 and add to separation of coils	**1**
	Method of analysis	
	plots a graph of ln *V* against *x* [or log *V* against *x* etc.]	**1**
	relationship valid if a straight line produced	**1**
	k = –gradient	**1**

Question	Answer	Marks
	Additional detail including safety considerations	**Max. 6**
	D1 do not touch hot coil/use gloves to position hot coil/heat-proof gloves to position coil	
	D2 use large current/number of turns/iron core (to produce large magnetic field/induced e.m.f.)	
	D3 use high frequency (to produce larger induced e.m.f.)	
	D4 use an a.c. power supply or signal generator (connected to coil P)	
	D5 keep the number of turns (on each coil) constant/frequency constant	
	D6 method described to check that current is constant, e.g. use an ammeter and variable resistor/variable power supply	
	D7 repeat measurements of *x* for different parts of the coil and average	
	D8 method to position ruler horizontally to measure *x* described e.g. use a spirit level or same height from bench at both ends	
	D9 method to keep coils parallel/co-axial e.g. adjust coil Q until maximum reading or use set square to ensure that coils are at right angles to the axis	
	D10 $\ln V = -kx + \ln V_0$	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>gradient = $\dfrac{4\mu L^2 f^2}{g}$</td><td>1</td></tr>
<tr><td>2(b)</td><td>

M / g	$\dfrac{1}{n^2}$
850 ± 85 (90)	0.1 or 0.11 or 0.111 or 0.1111
500 ± 50	0.06 or 0.063 or 0.0625
300 ± 30	0.04 or 0.040 or 0.0400
200 ± 20	0.03 or 0.028 or 0.0278
150 ± 15 (20)	0.02 or 0.020 or 0.0204
100 ± 10	0.02 or 0.016 or 0.0156

First mark for uncertainties in first column correct.
Second mark for all second column correct.</td><td>2</td></tr>
<tr><td rowspan="2">2(c)(i)</td><td>Six points plotted correctly.
Must be within half a small square. Diameter of points must be less than half a small square.</td><td>1</td></tr>
<tr><td>Error bars in M plotted correctly.
All error bars to be plotted. Length of bar must be accurate to less than half a small square and symmetrical.</td><td>1</td></tr>
<tr><td rowspan="2">2(c)(ii)</td><td>Line of best fit drawn.
Line must not pass through plotted point (0.11, 850) or (0.111, 850).

If points are plotted correctly then lower end of line should pass between (0.032, 250) and (0.036, 250) and upper end of line should pass between (0.098, 800) and (0.104, 800).</td><td>1</td></tr>
<tr><td>Worst acceptable line drawn (steepest or shallowest possible line).
All error bars must be plotted.</td><td>1</td></tr>
</table>

Question	Answer	Marks
2(c)(iii)	Gradient determined with a triangle that is at least half the length of the drawn line.	**1**
	uncertainty = gradient of line of best fit – gradient of worst acceptable line **or** uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)	**1**
2(d)(i)	μ determined correctly using gradient. $\mu = \frac{9.81}{4 \times 120^2 \times 1.54^2} \times \text{gradient}$ $\mu = 7.18123 \times 10^{-5} \times \text{gradient}$	**1**
	μ determined using gradient **and** given to 2 or 3 significant figures.	**1**
	μ determined using gradient **and** correct unit g m^{-1} **and** in the range 0.560–0.630 (g m^{-1}).	**1**

Question	Answer	Marks
2(d)(ii)	Percentage uncertainty in μ. $\% \text{ uncertainty} = \left(2 \times \frac{0.01}{1.54} + 2 \times \frac{5}{120} + \frac{\Delta\text{gradient}}{\text{gradient}}\right) \times 100$ $\% \text{ uncertainty} = 9.63\% + \frac{\Delta\text{gradient}}{\text{gradient}} \times 100$ Maximum/minimum methods: $\max \mu = \frac{9.81 \times \text{max gradient}}{4 \times 115^2 \times 1.53^2}$ $\min \mu = \frac{9.81 \times \text{min gradient}}{4 \times 125^2 \times 1.55^2}$ Correct substitution of numbers must be seen.	**1**

Question	Answer	Marks
2(e)	*M* determined correctly using μ from **(d)(i)**. $M = \dfrac{180^2 \times 1.54^2 \times \textbf{(d)(i)}}{9.81 \times 1000} = 7.833 \times \textbf{(d)(i)}$ Correct substitution of numbers must be seen.	**1**
	Absolute uncertainty determined. $\%\text{ uncertainty} = \left(2 \times \dfrac{0.01}{1.54} + 2 \times \dfrac{5}{180}\right) \times 100 + \textbf{(d)(ii)} = 6.9\% + \textbf{(d)(ii)}$ Correct substitution of numbers must be seen. Maximum/minimum methods: $\max M = \dfrac{(4 \times)185^2 \times 1.55^2 \times \max\textbf{(d)(i)}}{(4 \times)9.81 \times 1000} = 8.382 \times \max\textbf{(d)(i)}$ $\min M = \dfrac{(4 \times)175^2 \times 1.53^2 \times \min\textbf{(d)(i)}}{(4 \times)9.81 \times 1000} = 7.308 \times \min\textbf{(d)(i)}$	**1**