CAMBRIDGE
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Cambridge International AS & A Level

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **October/November 2024**

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**	
	L is the independent variable and $\Delta\theta$ or <u>temperature change/increase</u> is the dependent variable **or** vary L and measure $\Delta\theta$ or <u>temperature change/increase</u>	**1**
	keep t <u>constant</u>	**1**
	Methods of data collection	
	labelled diagram of workable experiment including: • oil in a beaker/container (on a bench) • coil fully submerged in oil • (bulb of) thermometer in the oil • at least three labels from thermometer, coil or resistance wire, oil, beaker/container, clamp/stand, bench Do not accept other heating sources.	**1**
	method to determine V – diagram of workable circuit including: • power supply connected to wire • voltmeter positioned to measure V across the coil	**1**
	measure the initial and final temperature <u>and</u> find the difference $\Delta\theta$	**1**
	method to determine t, e.g. use stopwatch/timer **and** method to determine L e.g. use a rule(r) to measure L / length of wire **or** e.g. using number of turns and measure the diameter of the coil with rule(r) / calipers	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td rowspan="4">1</td><td>Method of Analysis</td><td></td></tr>
<tr><td>plot a graph of $\Delta\theta$ against $\frac{1}{L}$ or equivalent, e.g. $\frac{1}{L}$ against $\Delta\theta$
Do not accept logarithms.</td><td>1</td></tr>
<tr><td><table><tr><td>for $\Delta\theta$ against $\frac{1}{L}$</td><td>for $\frac{1}{L}$ against $\Delta\theta$</td></tr><tr><td>$K = \frac{AtV^2}{m \times \text{gradient}}$</td><td>$K = \frac{AtV^2 \times \text{gradient}}{m}$</td></tr></table></td><td>1</td></tr>
<tr><td><table><tr><td>for $\Delta\theta$ against $\frac{1}{L}$</td><td>for $\frac{1}{L}$ against $\Delta\theta$</td></tr><tr><td>$Z = -mK \times y\text{-intercept}$
or
$Z = -\frac{AtV^2 \times y\text{-intercept}}{\text{gradient}}$</td><td>$Z = AtV^2 \times y\text{-intercept}$</td></tr></table></td><td>1</td></tr>
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Question	Answer	Marks
1	**Additional detail including safety considerations**	**6**
	D1 precaution linked to <u>hot</u> oil / beaker / wire, e.g. use of gloves to prevent burns from oil **or** precaution linked to spillage of oil, e.g. perform experiment in a tray	
	D2 keep A **and** m **and** V <u>constant</u>	
	D3 use a micrometer to measure the <u>diameter</u> (d) of the <u>wire</u> **and** $A = \frac{\pi d^2}{4}$	
	D4 repeat measurements of d <u>along the wire</u> <u>and</u> average	
	D5 method to reduce heat loss e.g. add insulation around the container / add a lid to the container	
	D6 method to keep V constant, e.g. adjust / change a variable resistor / power supply to keep V or voltmeter reading constant	
	D7 use a balance to determine the mass of the oil **and** mass of oil = mass of (beaker + oil) – mass of beaker **or** place beaker on balance and zero balance, then add oil and read balance	
	D8 stir the oil for uniform temperature **or** keep the initial temperature (of oil) constant	
	D9 repeat the experiment for the same value of L and average <u>$\Delta\theta$</u> / average temperature <u>change</u>	
	D10 relationship valid <u>if</u> a straight line is produced (passing through $\left(-\frac{Z}{mK}\right)$) Do not accept line passing through the origin.	
	D11 method to determine L accurately, e.g. measure length of unwound coil	

Question	Answer	Marks
2(a)	gradient = Bn^2 y-intercept = – B	**1**
2(b)	d^2 / cm^2 615 or 615.0 458 or 458.0 292 or 292.4 216 or 216.1 166 or 166.4 139 or 139.2 Values correct as shown above.	**1**
	Uncertainties in d^2 decreasing from ±10 to ±4 or ±5.	**1**
2(c)(i)	Six points from **(b)** plotted correctly. Must be within half a small square. Diameter of points must be less than half a small square.	**1**
	Error bars in d^2 plotted correctly. All error bars to be plotted. Total length of bar must be accurate to less than half a small square and symmetrical.	**1**
2(c)(ii)	Straight line of best fit drawn. Do not accept line from top point to bottom point. Points must be balanced. Line must pass between (1.90, 250) and (2.00, 250) **and** between (3.55, 500) and (3.65, 500).	**1**
	Worst acceptable line drawn (steepest or shallowest possible line that passes through all the error bars). All error bars must be plotted.	**1**

Question	Answer	Marks
2(c)(iii)	Gradient determined with clear substitution of data points into $\Delta y / \Delta x$. Distance between data points must be greater than half the length of the drawn line.	**1**
	Gradient determined of worst acceptable line with clear substitution of data points into $\Delta y / \Delta x$. 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(c)(iv)	*y*-intercept determined by substitution of correct point with consistent power of ten in *m* and *x* into $y = mx + c$.	**1**
	y-intercept of worst acceptable line determined by substitution into $y = mx + c$. 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) Do not accept ECF from false origin method.	**1**
2(d)(i)	*B* determined using *y*-intercept (*B* = – *y*-intercept) **and** *B* and *n* given to 2 or 3 or 4 significant figures.	**1**
	n determined using gradient **and** *B* and *n* given with SI units with correct powers of ten. $n = \sqrt{\frac{\text{gradient}}{B}}$ **or** $n = \sqrt{\frac{\text{gradient}}{-y\text{-intercept}}}$ Unit for *B*: cm^2 No unit for *n*.	**1**

Question	Answer	Marks
2(d)(ii)	Percentage uncertainty in *n* determined with method shown. $\text{percentage uncertainty} = \frac{1}{2}\left(\frac{\Delta y\text{-intercept}}{y\text{-intercept}} + \frac{\Delta\text{gradient}}{\text{gradient}}\right) \times 100$ **or** correct substitution for max/min methods.	**1**
2(e)	θ determined to a minimum of two significant figures from **(c)(iii)** and **(c)(iv)** or **(d)(i)** with correct substitution **and** correct power of ten. $\theta = \sin^{-1}\sqrt{\frac{\text{gradient}}{-y\text{-intercept} + 900}}$ **or** $\theta = \sin^{-1}\sqrt{\frac{n^2 B}{B + 900}}$	**1**