Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2022**

MARK SCHEME

Maximum Mark: 30

Published

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Annotations

✓	Correct point Method of analysis marks in **Question 1**
$✓_{1–10}$	Additional detail marks in **Question 1**
X	Incorrect point
^	Omission
BOD	Benefit of the doubt
NBOD	No benefit of the doubt given
ECF	Error carried forward
P	Defining the problem marks in **Question 1** Power of ten error in **Question 2**
M0	Methods of data collection marks in **Question 1**
SF	Incorrect number of significant figures

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Question	Answer	Marks
1	**Defining the problem**	
	L is the independent variable and I is the dependent variable **or** vary L and measure I	**1**
	keep E constant	**1**
	Methods of data collection	
	labelled diagram of workable experiment including: • circuit diagram with power supply connected to ends C • ammeter in series with power supply and conductors • correct symbol for ammeter and power supply	**1**
	circuit diagram with voltmeter correctly positioned to measure E across the power supply	**1**
	use a rule(r) to measure L **and** x	**1**
	use a micrometer/calipers to measure y	**1**

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Question	Answer	Marks
1	**Method of analysis**	
	plot a graph of $\frac{1}{I}$ against L or equivalent (e.g. L against $\frac{1}{I}$) (Do not accept log graphs.)	**1**
	$P = \frac{\text{gradient} \times AE}{2}$ (for L against $\frac{1}{I}$: $P = \frac{AE}{2 \times \text{gradient}}$)	**1**
	$Q = \frac{y\text{-intercept} \times Ey^2}{x}$ (for L against $\frac{1}{I}$: $Q = -\frac{y\text{-intercept} \times 2Py^2}{Ax}$ **or** $Q = -\frac{y\text{-intercept} \times Ey^2}{\text{gradient} \times x}$)	**1**

Question	Answer	Marks
1	**Additional detail including safety considerations**	**6**
	D1 do not touch/use (heat resistant) gloves to avoid hot conductors/metal bar **or** use a protective resistor/small e.m.f. to reduce the current **or** switch off when not in use/when moving bar	
	D2 keep A **and** y constant	
	D3 keep x constant	
	D4 use of micrometer/calipers to measure diameter of conductor **and** $A = \pi d^2 / 4$.	
	D5 repeat measurements of diameter along conductors/different (perpendicular) directions/different points **and** average **or** repeat measurements of y in different (perpendicular) directions/different points/along bar **and** average	
	D6 method to ensure that L is the same for each conductor, e.g. check both lengths	
	D7 method to determine L e.g. measure to edge and add $y / 2$ **or** method to determine x e.g. measure between the conductors and add diameter	
	D8 method to keep x constant with reason, e.g. adhesive/plasticine/blocks (one either side of each conductor) to prevent cylindrical conductors from moving	
	D9 method of ensuring good electrical contact, e.g. clean metal bar/cylindrical conductors **or** use of solder **or** crocodile clips to connect circuit to the conductors	
	D10 relationship valid if a straight line is produced (not passing through the origin)	

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>gradient = a
y-intercept = $\lg SK$</td><td>1</td></tr>
<tr><td rowspan="2">2(b)</td><td>
<table>
<tr><th>lg (T / days)</th><th>lg (L / 10^{30} W)</th></tr>
<tr><td>1.34 or 1.342</td><td>0.46 or 0.462 $\pm$ 0.03</td></tr>
<tr><td>1.51 or 1.505</td><td>0.69 or 0.690 $\pm$ 0.02</td></tr>
<tr><td>1.62 or 1.623</td><td>0.84 or 0.839 $\pm$ 0.01</td></tr>
<tr><td>1.73 or 1.732</td><td>0.99 or 0.991 $\pm$ 0.01</td></tr>
<tr><td>1.89 or 1.892</td><td>1.20 or 1.204 $\pm$ 0.05 or 0.06</td></tr>
<tr><td>1.99 or 1.987</td><td>1.32 or 1.322 $\pm$ 0.04</td></tr>
</table>
Values of lg (T / days) and lg (L / 10^{30} W) correct as shown above.</td><td>1</td></tr>
<tr><td>Absolute uncertainties in lg (L / 10^{30} W) correct as shown above.</td><td>1</td></tr>
<tr><td rowspan="2">2(c)(i)</td><td>Six points from (b) 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 lg (L / 10^{30} W) plotted correctly.
All error bars must be plotted. Total 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>Straight line of best fit drawn.
Points must be balanced. Do not accept line from top point to bottom point.
Line must pass between (1.43, 0.60) and (1.45, 0.60) and between (1.84, 1.15) and (1.86, 1.15).</td><td>1</td></tr>
<tr><td>Worst acceptable line drawn (steepest or shallowest possible line that passes through all the error bars).
All error bars must be plotted.</td><td>1</td></tr>
</table>

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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 of worst acceptable line determined. 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 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 allow methods using a false origin.	**1**

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Question	Answer	Marks
2(d)	a = gradient = **(c)(iii) and** a and K both given to two or three significant figures.	**1**
	Value of K determined using y-intercept. Correct method must be seen. $K = \dfrac{10^{y\text{-intercept}} \times 10^{30}}{S} = \dfrac{10^{\textbf{(c)(iv)}} \times 10^{30}}{3.85 \times 10^{26}}$ **or** $K = 10^{y\text{-intercept} - \lg S} \times 10^{30}$ **or** $K = 10^{\textbf{(c)(iv)} - \lg 3.85 \times 10^{26}} \times 10^{30}$	**1**
	absolute uncertainty in a = absolute uncertainty in gradient **and** $\Delta K = \dfrac{\left(10^{y\text{-intercept}} - 10^{\text{WAL } y\text{-intercept}}\right) \times 10^{30}}{S}$ Correct substitution of numbers must be seen.	**1**
2(e)	L determined from **(d) or (c)(iii)** and **(c)(iv)** with correct substitution and correct power of ten(s). Do not accept incorrect POT for a or K. $L = 3.85 \times 10^{26} \times$ **(d)** $\times 5.0^{\textbf{(c)(iii)}}$ **or** $\lg L =$ **(c)(iii)** $\times \lg 5.0 + y$-intercept	**1**