CAMBRIDGE
International Education

Cambridge International AS & A Level

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **February/March 2025**

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 International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the February/March 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
^	information missing or insufficient for credit
BOD	benefit of the doubt given
	incorrect point or mark not awarded
ECF	error carried forward applied
M0	methods of data collection mark
P	defining the problem mark
SEEN	blank page seen
SF	error in number of significant figures

Annotation	Meaning
✓	correct point or mark awarded
I	ignore the response
R	repeat of point previously awarded mark
U	incorrect unit
✓ 1	correct awarding one mark from additional detail 1. similar numbered ticks are used for additional detail 2, 3, 4 etc.

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td rowspan="11">1</td><td>Defining the problem</td><td></td></tr>
<tr><td>Vary p and measure B OR p is the independent variable and B is the dependent variable.</td><td>1</td></tr>
<tr><td>Keep V constant or potential difference between the ends of each conductor constant.</td><td>1</td></tr>
<tr><td>Methods of data collection</td><td></td></tr>
<tr><td>Labelled diagram of workable experiment including:
• conductors in parallel connected in series to power supply and resistor
• circuit symbols for (variable) resistor and power supply
• X labelled and one other label from L, P, Q, p and q.</td><td>1</td></tr>
<tr><td>Voltmeter connected in parallel with conductors (to measure V) and conductors in parallel connected to a power supply.</td><td>1</td></tr>
<tr><td>Method to measure L and p and q e.g. use a rule / ruler / calipers.</td><td>1</td></tr>
<tr><td>Method to measure B, e.g. use a (calibrated) Hall probe and adjust / rotate probe until maximum value.</td><td>1</td></tr>
<tr><td>Method of Analysis</td><td></td></tr>
<tr><td>Plots a graph of B against $\frac{1}{p}$ or equivalent.
Do not accept logarithms.</td><td>1</td></tr>
<tr><td><table><tr><td>B against $\frac{1}{p}$</td><td>$\frac{1}{p}$ against B</td></tr><tr><td>$Y = \frac{L \times \text{gradient}}{AV}$</td><td>$Y = \frac{L}{AV \times \text{gradient}}$</td></tr></table></td><td>1</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1</td><td>
<table>
<tr><td>B against $\frac{1}{p}$</td><td>$\frac{1}{p}$ against B</td></tr>
<tr><td>$Z = \frac{q \times y\text{-intercept}}{\text{gradient}}$
OR
$Z = \frac{Lq \times y\text{-intercept}}{YAV}$</td><td>$Z = -q \times y$-intercept</td></tr>
</table>
</td><td>1</td></tr>
<tr><td></td><td>Additional detail including safety considerations
Any six from:</td><td>6</td></tr>
<tr><td></td><td>D1 precaution linked to <u>high current</u> / <u>hot conductors</u>, e.g. use gloves / switch off power supply when not measuring B / between measurements / allow conductors to cool</td><td></td></tr>
<tr><td></td><td>D2 keep A and L and q constant</td><td></td></tr>
<tr><td></td><td>D3 use calipers / micrometer to measure diameter / d of conductor and $A = \frac{\pi d^2}{4}$</td><td></td></tr>
<tr><td></td><td>D4 repeat measurements of d <u>in different positions</u> and <u>average</u> d</td><td></td></tr>
<tr><td></td><td>D5 method to determine the position of X in relation to the conductors, e.g. divide L by two to find the midpoint of P / Q and use a set square / protractor / plumb line to mark X
OR
divide L by two to find the midpoint of P / Q and use a grid to mark X</td><td></td></tr>
<tr><td></td><td>D6 measure B (using Hall probe) first in one direction and then in the opposite direction and average B
OR
Measure B with current / p.d. in one direction and then in the opposite direction and average B</td><td></td></tr>
<tr><td></td><td>D7 additional detail on measuring p and / or q, e.g. measure to the conductor and add on the radius</td><td></td></tr>
</table>

Question	Answer	Marks
1	D8 description of method to keep *q* constant, e.g. tape / adhesive putty to fix conductor Q to the bench OR for vertical methods fix conductor Q in clamp(s) attached to stand(s) to keep *q* constant	
	D9 method to keep P and Q parallel, e.g. measure the separation (between the conductors) at different points	
	D10 relationship valid <u>if</u> a straight line is produced (with a *y*-intercept = $\frac{YZAV}{Lq}$). Do not accept passing through the origin.	
	D11 method to keep *V* constant, e.g. adjust / change variable resistor / power supply to keep voltmeter reading constant.	

Question	Answer	Marks
2(a)	gradient = $-\frac{1}{K}$ *y*-intercept = $\ln(\theta_0 - \theta_R)$	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td rowspan="3">2(b)</td><td>
<table>
<tr><th>$(\theta - \theta_R)$ / °C</th><th>ln $((\theta - \theta_R)$ / °C)</th></tr>
<tr><td>56.5 ± 1.0</td><td>4.034 or 4.0342 ± 0.018</td></tr>
<tr><td>46.0 ± 1.0</td><td>3.829 or 3.8286 ± 0.022</td></tr>
<tr><td>38.5 ± 1.0</td><td>3.651 or 3.6507 ± 0.026</td></tr>
<tr><td>31.5 ± 1.0</td><td>3.450 or 3.4500 ± 0.032</td></tr>
<tr><td>26.0 ± 1.0</td><td>3.258 or 3.2581 ± 0.038</td></tr>
<tr><td>22.5 ± 1.0</td><td>3.114 or 3.1135 ± 0.044</td></tr>
</table>
</td><td></td></tr>
<tr><td>Values of $(\theta - \theta_R)$ / °C and ln $((\theta - \theta_R)$ / °C)</td><td>1</td></tr>
<tr><td>Uncertainties in $(\theta - \theta_R)$ and ln $((\theta - \theta_R)$ / °C)</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 ln $((\theta - \theta_R)$ / °C) plotted correctly.
All error bars to be plotted. Total length of bar must be accurate to less than half a small square and symmetrical.</td><td>1</td></tr>
</table>

Question	Answer	Marks
2(c)(ii)	Straight line of best fit drawn. Do not accept line from top plot to bottom plot. Line must pass between (31.5, 3.2) and (33.0, 3.2) **and** between (16.0, 3.7) and (17.0, 3.7)	**1**
	Worst acceptable line drawn. Steepest or shallowest possible line that passes through all the error bars. All error bars must be plotted.	**1**
2(c)(iii)	Gradient must be negative. Gradient determined with clear substitution of data 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 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 unit of time 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**

Question	Answer	Marks
2(d)(i)	*K* determined using gradient **and** *K* and θ_0 given to 3 or 4 sf. $K = -\dfrac{1}{\text{gradient}}$	**1**
	θ_0 determined using *y*-intercept **and** *K* and θ_0 given with units with appropriate powers of ten $\theta_0 = e^{y\text{-intercept}} + 18.5$ Unit of *K*: min or minute(s) unit of θ_0: °C	**1**
2(d)(ii)	Absolute uncertainty determined with clear method shown. $\Delta\theta_0 = \left(e^{\max y\text{-intercept}} + 19\right) - (e^{y\text{-intercept}} + 18.5)$ OR $\Delta\theta_0 = (e^{y\text{-intercept}} + 18.5) - \left(e^{\min y\text{-intercept}} + 18\right)$ OR $\Delta\theta_0 = \dfrac{\left(e^{\max y\text{-intercept}} + 19\right) - \left(e^{\min y\text{-intercept}} + 18\right)}{2}$	**1**
2(e)	*t* determined to a minimum of 2sf from **(c)(iii)** and **(c)(iv)** OR **(d)(i)** with correct substitution and correct power of ten. $t = \dfrac{\ln(25.0 - 18.5) - y\text{-intercept}}{\text{gradient}}$ OR $t = -K \times \left(\ln(25.0 - 18.5) - y\text{-intercept}\right)$ OR $t = -K \times \ln\left(\dfrac{25.0 - 18.5}{\theta_0 - 18.5}\right)$	**1**