CAMBRIDGE
International Education

Cambridge International AS & A Level

PHYSICS **9702/53**

Paper 5 Planning, Analysis and Evaluation **May/June 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 May/June 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
BOD	benefit of the doubt given
1	correct awarding one mark from additional detail 1. similar numbered ticks are used for additional detail 2, 3, 4 etc.
	correct point or mark awarded
P	defining the problem mark
ECF	error carried forward applied
SF	error in number of significant figures
I	incorrect or insufficient point ignored while marking the rest of the response
	incorrect point or mark not awarded
U	incorrect unit
^	information missing or insufficient for credit

Annotation	Meaning
MO	methods of data collection mark
SEEN	point has been noted, but no credit has been given or blank page seen
R	repeat of point previously awarded mark

Question	Answer	Marks
1	**Defining the problem**	
	vary f and measure V **or** f is the independent variable and V is the dependent variable	**1**
	keep E constant	**1**
	Methods of data collection	
	labelled diagram of workable experiment including: • circuit with a.c. supply • oscilloscope connected in parallel with the resistor • workable circuit • oscilloscope and a.c. supply labelled	**1**
	labelled signal generator or variable frequency power supply connected across the terminals	**1**
	method to determine V or E from oscilloscope, e.g. multiply amplitude / height of wave by y-gain on oscilloscope	**1**
	method to determine f from oscilloscope, e.g. determine period T by multiplying number of divisions in 1 cycle or horizontal distance in 1 cycle by the time base **and** $f = 1/T$	**1**
	Method of Analysis	
	plot a graph of $\frac{1}{V}$ against f or equivalent, e.g. f against $\frac{1}{V}$ Allow logarithms e.g. lg V against lg f.	**1**
	relationship valid if a straight line is produced passing through the origin (for lg V against lg f: relationship valid if a straight line is produced with gradient = -1)	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1</td><td>
<table>
<tr><td>$\frac{1}{V}$ against f</td><td>f against $\frac{1}{V}$</td></tr>
<tr><td>$K = \frac{lES}{AN^2} \times$ gradient</td><td>$K = \frac{lES}{AN^2} \times \frac{1}{\text{gradient}}$</td></tr>
</table>
(for lg V against lg f: $K = \frac{ElS}{AN^2} \times 10^{-y\text{-intercept}}$).
</td><td>1</td></tr>
<tr><td></td><td>Additional detail including safety considerations</td><td>6</td></tr>
<tr><td></td><td>D1 precaution linked to hot coil or hot resistor or prevention of burns from coil or resistor, e.g. use gloves / switch off power supply when not measuring V to prevent burns from coil / resistor</td><td></td></tr>
<tr><td></td><td>D2 keep N and A and l and S constant</td><td></td></tr>
<tr><td></td><td>D3 method to keep S constant, e.g. switch off power supply between readings to prevent heating of resistor or to allow resistor to cool</td><td></td></tr>
<tr><td></td><td>D4 method to determine A, e.g. use calipers / micrometer to measure diameter (of coil) / d and $A = \frac{\pi d^2}{4}$</td><td></td></tr>
<tr><td></td><td>D5 repeat measurements of diameter d along the length of the coil / in different directions and determine the average value of d</td><td></td></tr>
<tr><td></td><td>D6 method to determine the value of S, e.g. separate circuit diagram showing resistor connected to ohmmeter, or circuit diagram showing resistor connected to a power supply with an ammeter and voltmeter and $S = V / I$</td><td></td></tr>
<tr><td></td><td>D7 measure l with a ruler / calipers</td><td></td></tr>
<tr><td></td><td>D8 oscilloscope drawn connected across terminals / across signal generator and description to determine E</td><td></td></tr>
<tr><td></td><td>D9 adjust y-gain for maximum amplitude
or
adjust time base for length of one wave or measure n waves and divide measured time by n</td><td></td></tr>
</table>

Question	Answer	Marks
1	D10 method to keep *E* constant, e.g. check p.d. and alter supply **or** method to keep l constant, e.g. tape coil **or** method to keep *A* constant, e.g. wind wire on a cylinder	

Question	Answer	Marks
2(a)	gradient = $\frac{R}{E}$ *y*-intercept = $\frac{Z}{E}$	**1**
2(b)	$\frac{1}{I}$ / 10^3 A^{-1} 2.20 or 2.198 1.90 or 1.905 1.72 or 1.724 1.57 or 1.575 1.46 or 1.460 1.31 or 1.307 Values of $\frac{1}{I}$ / 10^3 A^{-1} correct as shown above.	**1**

Question	Answer	Marks
2(b)	Uncertainties in $\frac{1}{I}$ / 10^3 A^{-1} from $\pm$ 0.02 or $\pm$ 0.03 decreasing to $\pm$ 0.01.	**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 $\frac{1}{I}$ 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. Thickness of the line must be less than half a small square. Do not accept line from top point to bottom point. Line must pass between (0.101, 1.40) and (0.104, 1.40) **and** between (0.189, 2.10) and (0.194, 2.10)	**1**
	Worst acceptable straight line drawn (steepest or shallowest possible line that passes through all the error bars). Thickness of the line must be less than half a small square. All error bars must be plotted.	**1**
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**

Question	Answer	Marks
2(c)(iv)	*y*-intercept determined by substitution of correct point with consistent power of ten in *m* and *y* 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)	*R* determined using gradient **and** *R* and *Z* given to 2 or 3 significant figures. *R* = gradient × 5.8	**1**
	Z determined using *y*-intercept **and** *R* and *Z* given with units with appropriate powers of ten. *Z* = *y*-intercept × 5.8 unit of *R*: Ω or $V\,A^{-1}$ unit of *Z*: Ω or $V\,A^{-1}$	**1**
2(d)(ii)	Percentage uncertainty determined using $\Delta E = 0.2$ (V) with method shown. $\Delta R\% = \left(\frac{\Delta E}{E} + \frac{\Delta\text{gradient}}{\text{gradient}}\right) \times 100$ **or** $\Delta R\% = \left(\frac{0.2}{5.8} + \frac{\Delta\text{gradient}}{\text{gradient}}\right) \times 100$	**1**

Question	Answer	Marks
2(e)	I determined to a minimum of 2 significant figures from **(c)(iii)** and **(c)(iv)** or **(d)(i)** with correct substitution. $I = \dfrac{1}{\dfrac{\text{gradient}}{20} + y\text{-intercept}}$ **or** $I = \dfrac{E}{\left(\dfrac{R}{20} + Z\right)}$	**1**