



Cambridge International AS & A Level

PHYSICS

9702/53

Paper 5 Planning, Analysis and Evaluation

May/June 2021

MARK SCHEME

Maximum Mark: 30

Published

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This document consists of **10** printed pages.

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

Question	Answer	Marks
1	Defining the problem	
	R is the independent variable and t is the dependent variable or vary R and measure t	1
	keep the number of turns on the coil/ N <u>constant</u>	1
	Methods of data collection	
	labelled diagram or correct symbols including: - labelled (d.c.) power supply - switch in series with power supply, resistor and coil - complete <u>workable</u> circuit	1
	circuit diagram to measure R , e.g. ammeter and voltmeter correctly positioned or R connected to ohmmeter with no other connections (not ohmmeter in main circuit)	1
	method to determine t (of a few milliseconds) e.g. use (storage) oscilloscope or current/voltage sensor connected to datalogger/computer	1
	method to determine A , e.g. micrometer/calipers to determine <u>diameter</u> of coil and $A = \pi d^2 / 4$	1
	Method of analysis	
	plot a graph of t against $1/R$ (allow $\log t$ against $\log R$)	1
	relationship valid if a straight line passing through the origin is produced (allow gradient = -1 for graph of $\log t$ against $\log R$)	1
	$K = \frac{\text{gradient} \times L}{AN^2}$.	1

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Question	Answer	Marks
1	Additional detail including safety considerations	6
D1	open switch/switch off (high voltage) circuit before changing the resistor/touching components or ensure no bare wires/use shrouded connectors	
D2	wear (insulating) gloves to prevent electric shock/electrocution	
D3	keep A <u>and</u> L constant	
D4	use ruler/calipers to measure L	
D5	repeat measurements of <u>diameter</u> in different directions/at points along the coil <u>and</u> average	
D6	method to determine R e.g. $R = V/I$ linked to correct circuit diagram for ammeter/voltmeter method or measure resistance using ohmmeter	
D7	repeat experiment for each value of R and average t	
D8	method to determine t : use of time-base from oscilloscope explained or use of time axis of output from data logger/computer explained	
D9	use smaller values of R to <u>increase</u> I	
D10	reduce L or increase N or increase A to <u>increase</u> t	

Question	Answer	Marks														
2(a)	$\text{gradient} = \frac{1}{uA}$ $y\text{-intercept} = \frac{1}{u}$	1														
2(b)	<table><tr><th>$(M + m) / \text{g}$</th><th>$\frac{1}{v} / \text{s cm}^{-1}$</th></tr><tr><td>380</td><td>0.226 or 0.2262</td></tr><tr><td>480</td><td>0.255 or 0.2551</td></tr><tr><td>580</td><td>0.294 or 0.2941</td></tr><tr><td>680</td><td>0.331 or 0.3311</td></tr><tr><td>830</td><td>0.388 or 0.3876</td></tr><tr><td>930</td><td>0.429 or 0.4292</td></tr></table> Values of $(M + m)$ and $\frac{1}{v}$ as shown above.	$(M + m) / \text{g}$	$\frac{1}{v} / \text{s cm}^{-1}$	380	0.226 or 0.2262	480	0.255 or 0.2551	580	0.294 or 0.2941	680	0.331 or 0.3311	830	0.388 or 0.3876	930	0.429 or 0.4292	1
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	Absolute uncertainties in $(M + m)$ from $\pm (19 \text{ or } 20)$ to $\pm (46.5 \text{ or } 47 \text{ or } 50)$.	1														
2(c)(i)	Six points plotted correctly. Must be accurate to the nearest half a small square. Diameter of points must be less than half a small square.	1														
	Error bars in $(M + m)$ plotted correctly. All error bars must be plotted. Total length of bar must be accurate to less than half a small square and symmetrical.	1														

Question	Answer	Marks
2(c)(ii)	Line of best fit drawn covers all points. Points must be balanced. Do not allow line from top point to bottom point. Line must pass between (425, 0.240) and (440, 0.240) and between (850, 0.400) and (865, 0.400).	1
	Worst acceptable line drawn (steepest or shallowest possible line that passes through all error bars). 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 at least 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 = $\frac{1}{2}$ (steepest worst line gradient – shallowest worst line gradient)	1
2(c)(iv)	y-intercept determined by substitution of correct point 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 = $\frac{1}{2}$ (steepest worst line y-intercept – shallowest worst line y-intercept) Do not allow ECF from false origin method.	1
2(d)(i)	u determined using y-intercept and u <u>and</u> A given to two or three significant figures. $u = \frac{1}{y\text{-intercept}}$	1
	A determined using gradient with correct substitution and units with correct power of ten for u <u>and</u> A . $A = \frac{y\text{-intercept}}{\text{gradient}}$ or $A = \frac{1}{u \times \text{gradient}}$	1

Question	Answer	Marks
2(d)(ii)	Percentage uncertainty in A determined, e.g. $\text{percentage uncertainty in } A = \left(\frac{\Delta \text{gradient}}{\text{gradient}} + \frac{\Delta y\text{-intercept}}{y\text{-intercept}} \right)$ or Δu clearly determined using the value of u <u>and</u> $\text{percentage uncertainty in } A = \left(\frac{\Delta \text{gradient}}{\text{gradient}} + \frac{\Delta u}{u} \right) \times 100$ or correct substitution for max/min methods e.g. $\text{max } A = \frac{1}{\text{min } u \times \text{min gradient}}$ $\text{min } A = \frac{1}{\text{max } u \times \text{max gradient}}$	1
2(e)	Value of m determined from (d)(i) or (c)(iii) and (c)(iv), with correct number substitution <u>and</u> correct power of ten. $m = \frac{A \times u}{2} - (330 + A)$ or $m = \frac{0.5 - y\text{-intercept}}{\text{gradient}} - 330$	1