



Cambridge International AS & A Level

PHYSICS

9702/52

Paper 5 Planning, Analysis and Evaluation

February/March 2022

MARK SCHEME

Maximum Mark: 30

<p>Published</p>

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 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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

Examples of how to apply the list ruleState **three** reasons.... [3]

A	1	Correct	✓	2
	2	Correct	✓	
	3	Wrong	✗	

B (4 responses)	1	Correct, Correct	✓, ✓	3
	2	Correct	✓	
	3	Wrong	ignore	

C (4 responses)	1	Correct	✓	2
	2	Correct, Wrong	✓, ✗	
	3	Correct	ignore	

D (4 responses)	1	Correct	✓	2
	2	Correct, CON (of 2.)	✗, (discount 2)	
	3	Correct	✓	

E (4 responses)	1	Correct	✓	3
	2	Correct	✓	
	3	Correct, Wrong	✓	

F (4 responses)	1	Correct	✓	2
	2	Correct	✓	
	3	Correct CON (of 3.)	✗ (discount 3)	

G (5 responses)	1	Correct	✓	3
	2	Correct	✓	
	3	Correct Correct CON (of 4.)	✓ ignore ignore	

H (4 responses)	1	Correct	✓	2
	2	Correct	✗	
	3	CON (of 2.) Correct	(discount 2) ✓	

I (4 responses)	1	Correct	✓	2
	2	Correct	✗	
	3	Correct CON (of 2.)	✓ (discount 2)	

Question	Answer	Marks
1	Defining the problem θ is the independent variable and v is the dependent variable, or vary θ and measure v .	1
	Keep d <u>constant</u>	1
	Methods of data collection Labelled diagram of workable experiment including: <ul style="list-style-type: none"> • sheet supported by stand / jack • light gate positioned at X • support, light gate and X labelled. 	1
	Light gate connected to timer / datalogger.	1
	Measure length (L) (of card) interrupted by beam for single light gate.	1
	Method to measure θ , e.g. use protractor or Method to determine θ , e.g. use a rule(r) to measure two appropriate distances to use in a trigonometrical ratio	1
	Method of Analysis Plots a graph of v^2 on y -axis <u>and</u> $\sin \theta$ on x -axis. Allow other valid graphs, e.g. $\sin \theta$ against v^2 Do not accept log graphs.	1
	$p = \frac{\text{gradient}}{2d}$ for v^2 against $\sin \theta$ or $p = \frac{1}{2d \times \text{gradient}}$ for $\sin \theta$ against v^2	1

Question	Answer	Marks
1	$q = -\frac{m \times y - \text{intercept}}{2Bd}$ for v^2 against $\sin \theta$ or $q = \frac{mp \times y - \text{intercept}}{B} = \frac{m \times y - \text{intercept}}{2dB \times \text{gradient}}$ for $\sin \theta$ against v^2	1
	Additional detail including safety considerations Any six from:	6
	D1 Method to <u>stop</u> the trolley once the trolley passes X, e.g. place a block / stop on the bench near the end of the sheet Ignore trolley falls	
	D2 Keep B <u>and</u> m constant	
	D3 Use a rule(r) to measure d	
	D4 Method to keep d constant, e.g. mark distance d on the sheet or the starting position of the trolley on the sheet	
	D5 Method to measure mass of trolley (and magnet), e.g. use balance or use newton meter to measure weight and divide by g <u>and</u> Measure B using a (calibrated) Hall probe	
	D6 Additional detail on use of Hall probe, e.g. adjust probe until <u>maximum</u> value or measure B using Hall probe first in one direction, then in the opposite direction and average	
	D7 Determine v (the velocity at X) from L / t (for a single light gate)	
	D8 Additional detail on measuring θ , e.g. protractor drawn in correct position on diagram, or additional detail on determining θ , e.g. relationship between measured lengths and θ	

Question	Answer	Marks
1	D9 Relationship valid <u>if</u> a straight line is produced (not passing through the origin)	
	D10 Repeat experiment for each θ <u>and</u> average v .	

Question	Answer		Marks														
2(a)	Gradient = $\frac{1}{2\pi fC}$		1														
2(b)		<table><tr><th>$\frac{1}{R} / 10^{-3} \Omega^{-1}$</th><th>$\tan \theta$</th></tr><tr><td>83 or 83.3</td><td>6.17 or 6.174</td></tr><tr><td>63 or 62.5</td><td>4.51 or 4.511</td></tr><tr><td>45 or 45.5</td><td>3.27 or 3.271</td></tr><tr><td>30 or 30.3</td><td>2.16 or 2.164</td></tr><tr><td>26 or 25.6</td><td>1.86 or 1.857</td></tr><tr><td>23 or 23.3</td><td>1.68 or 1.684</td></tr></table>	$\frac{1}{R} / 10^{-3} \Omega^{-1}$	$\tan \theta$	83 or 83.3	6.17 or 6.174	63 or 62.5	4.51 or 4.511	45 or 45.5	3.27 or 3.271	30 or 30.3	2.16 or 2.164	26 or 25.6	1.86 or 1.857	23 or 23.3	1.68 or 1.684	1
		$\frac{1}{R} / 10^{-3} \Omega^{-1}$	$\tan \theta$														
		83 or 83.3	6.17 or 6.174														
		63 or 62.5	4.51 or 4.511														
		45 or 45.5	3.27 or 3.271														
		30 or 30.3	2.16 or 2.164														
		26 or 25.6	1.86 or 1.857														
		23 or 23.3	1.68 or 1.684														
Absolute uncertainties in $\frac{1}{R}$ from ± 4 to ± 1		1															

Question	Answer	Marks
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 $\frac{1}{R}$ 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. Points must be balanced. Do not accept line from top plot to bottom plot. Line must pass between (33.5, 2.5) and (35.0, 2.5) <u>and</u> (74.0, 5.5) and (76.0, 5.5)	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 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 WAL 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 = $\frac{1}{2}$ (steepest worst line gradient – shallowest worst line gradient)	1
2(d)	99 ± 2 (Hz)	1
2(e)(i)	C determined using gradient <u>and</u> C given to two or three significant figures. $C = \frac{1}{2\pi f \times \text{gradient}} = \frac{1}{2\pi \times (\text{d}) \times (\text{c})(\text{iii})}$	1
	C determined using gradient with correct SI unit and power of ten for C: F or s Ω^{-1}	1

PUBLISHED

Question	Answer	Marks
2(e)(ii)	<p>Percentage uncertainty in C determined with method shown.</p> $\% \text{uncertainty} = \left(\frac{\Delta f}{f} + \frac{\Delta \text{gradient}}{\text{gradient}} \right) \times 100$ <p>OR</p> <p>Correct substitution for max/min methods</p> $\text{max } C = \frac{1}{2\pi \times \text{min } f \times \text{min gradient}}$ $\text{min } C = \frac{1}{2\pi \times \text{max } f \times \text{max gradient}}$	1
2(f)	<p>R determined to at least two significant figures with appropriate power of ten from (c)(iii) OR (d) and (e)(i) with correct substitution seen.</p> $R = \frac{\text{gradient}}{\tan \theta} = \frac{\textbf{(c)(iii)}}{0.839}$ <p>OR</p> $R = \frac{1}{2\pi f C \tan \theta} = \frac{1}{2\pi \times \textbf{(d)} \times \textbf{(e)(i)} \times 0.839}$	1
	<p>Absolute uncertainty in R determined.</p> <p>Method must be consistent with determination of R and correct substitution must be seen.</p> <p>For R determined by using the gradient:</p> $\Delta R = \frac{\Delta \text{gradient}}{\text{gradient}} \times R$ <p>OR</p> <p>For R determined by using (d) and (e)(i):</p> $\Delta R = \left(\frac{\Delta f}{f} + \frac{\Delta C}{C} \right) \times R$ <p>OR</p> <p>ΔR determined by max / min methods.</p>	1