CAMBRIDGE
International Education

Cambridge International AS & A Level

PHYSICS **9702/54**

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 θ and measure d **or** θ is the independent variable and d is the dependent variable	**1**
	keep z constant	**1**
	Methods of data collection	
	labelled diagram of workable experiment including: • sheet supported with stand or block(s) • path of ball (from sheet to bench) **or** distance d indicated • at least two labels from ball, bench, sheet, block/clamp/stand/support	**1**
	description of method to determine position of ball as it makes contact with the bench, e.g. paint ball, sand, video and playback in slow motion / frame by frame (with rule in view)	**1**
	measure d with a rule **and** measure z with a rule or calipers	**1**
	measure θ with a protractor **or** determine θ using (a rule for) appropriate distances with correct trigonometric relationship	**1**
	Method of analysis	
	plot a graph of d against $\sin(4\theta)$ or equivalent Do not accept logarithms.	**1**

Question	Answer	Marks
1		

d against $\sin(4\theta)$	$\sin(4\theta)$ against d
$P = \dfrac{g \times \text{gradient}}{v^2}$	$P = \dfrac{g}{v^2 \times \text{gradient}}$

1

d against $\sin(4\theta)$	$\sin(4\theta)$ against d
$Q = \dfrac{y\text{-intercept}}{\sqrt{z}}$	$Q = -\dfrac{Pv^2 \times y\text{-intercept}}{g\sqrt{z}}$ **or** $Q = -\dfrac{y\text{-intercept}}{\text{gradient} \times \sqrt{z}}$

1

Additional detail including safety considerations **6**

D1 precaution linked to prevent <u>ball rolling</u> (off surface), e.g. use of cushion / sand box / barrier <u>to stop ball</u> (rolling onto the floor)
or
precaution linked to (bouncing) <u>ball</u> or <u>sand (</u>spray) e.g. use of goggles <u>to protect eyes</u>

D2 keep v <u>constant</u>

D3 method to keep v constant, e.g. keep the distance the ball falls constant to <u>keep v constant</u>

D4 method to determine v or v^2, e.g. use of
$v = \sqrt{2g \times (\text{height ball falls})}$
or
$v^2 = 2g \times (\text{height ball falls})$

Question	Answer		Marks
1	D5	set square correctly positioned between rule and bench to ensure that rule is vertical to measure ***z*** or determine initial height of ball	
	D6	method to ensure ***z*** is constant, e.g. as θ is changed, (re-)mark point of contact or change release point of ball	
	D7	description of method to ensure ball is released above point of contact on sheet, e.g. use a plumb line from the ball through point of contact with sheet or (vertical) rule (and set square)	
	D8	drop ball from large height to obtain greater values of *d*	
	D9	repeat experiment for each θ **and** average *d*	
	D10	relationship valid <u>if</u> a straight line produced (with *y*-intercept of e.g. $\left(Q\sqrt{Z}\right)$). Do not accept line passing through the origin.	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>gradient = n

y-intercept = lg k</td><td>1</td></tr>
<tr><td>2(b)</td><td><table><tr><th>lg μ</th><th>lg λ</th></tr><tr><td>0.66 or 0.663 $\pm$ 0.04</td><td>2.70 or 2.699</td></tr><tr><td>0.73 or 0.732 $\pm$ 0.03</td><td>2.90 or 2.903</td></tr><tr><td>0.92 or 0.924 $\pm$ 0.02</td><td>3.51 or 3.505</td></tr><tr><td>1.04 or 1.041 $\pm$ 0.04</td><td>3.85 or 3.845</td></tr><tr><td>1.20 or 1.204 $\pm$ 0.03</td><td>4.40 or 4.398</td></tr><tr><td>1.26 or 1.255 $\pm$ 0.02 or $\pm$ 0.03</td><td>4.58 or 4.580</td></tr></table>Values of lg μ and lg λ correct as shown above.</td><td>1</td></tr>
<tr><td></td><td>Uncertainties in lg μ correct as shown above.</td><td>1</td></tr>
<tr><td>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></td><td>Error bars in lg μ 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>
</table>

Question	Answer	Marks
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 (0.82, 3.20) and (0.84, 3.20) **and** between (1.13, 4.20) and (1.16, 4.20).	**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**
2(c)(iv)	*y*-intercept determined by substitution of correct point with consistent power of ten in *m* and *x* 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**

Question	Answer	Marks
2(d)	Value of k determined using y-intercept. $k = 10^{y-\text{intercept}}$	**1**
	$n =$ gradient **and** n and k given to 2 or 3 significant figures.	**1**
	absolute uncertainty in n = absolute uncertainty in gradient **and** absolute uncertainty in k = $(10^{y\text{-intercept}} - 10^{y\text{-intercept of WAL}})$ Correct method must be seen.	**1**
2(e)	M determined to a minimum of 2 significant figures from **(d)** or **(c)(iii)** and **(c)(iv)** with correct substitution **and** correct power(s) of ten. Do not accept incorrect POT for n or k. Correct substitution must be seen. $\mu = \sqrt[n]{\frac{\lambda}{k}} = \text{gradient}\sqrt{\frac{0.46}{\textbf{(d)}}}$ **or** $\lg\mu = \frac{\lg 0.46 - y\text{-intercept}}{\text{gradient}}$ **or** $\lg\mu = \frac{\lg 0.46 - \lg k}{\text{gradient}}$ **and** $M = \mu \times 2.0 \times 10^{30}$	**1**