Cambridge International AS & A Level

PHYSICS **9702/53**

Paper 5 Planning, Analysis and Evaluation **October/November 2025**

MARK SCHEME

Maximum Mark: 30

Published

This document consists of **11** printed pages.

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 *r* and measure *v* **or** *r* is the independent variable and *v* is the dependent variable	**1**
	keep *x* constant	**1**
	Methods of data collection	
	labelled diagram of workable experiment including: • one end of spring resting against block clamped to bench using G-clamp • light gate positioned at P • light gate connected to timer • apparatus shown on bench • labels for light gate **and** P **and** at least one other label from bench, block, stand, spring, ball, timer	**1**
	method to determine *r*, e.g. use calipers or micrometer to measure diameter *d* **and** $r = d / 2$	**1**
	description of method to determine *v*, use diameter of ball (to interrupt beam) ÷ measured time at light gate positioned at P	**1**
	instrument to determine *x*, e.g. rule(r) or calipers	**1**
	Method of Analysis	
	plot a graph of (2 lg *v*) or (lg v^2) against lg *r* **or** plot a graph of (lg *v*) against (lg *r*) or equivalent, e.g. (ln *v*) against (ln *r*)	**1**
	$n = -\text{gradient}$ for (2 lg *v*) or (lg v^2) against lg *r* **or** $n = -2 \times \text{gradient}$ for (lg *v*) against lg *r*	**1**

Question	Answer		Marks
1	$Y = \dfrac{\rho \times 10^{y\text{-intercept}}}{kx^2}$ for (2 lg *v*) or (lg v^2) against lg *r* **or** $Y = \dfrac{\rho \times 10^{2 \times y\text{-intercept}}}{kx^2}$ for (lg *v*) against lg *r*		**1**
	Additional detail including safety considerations		**6**
	D1	precaution to <u>prevent ball leaving bench</u>, e.g. screens around apparatus / cushions on bench (to stop the ball)	
	D2	keep *k* **and** ρ constant	
	D3	description of method to determine *k*, e.g. add mass to spring and *k* = *mg* / extension **or** use newton meter to measure force applied to spring and *k* = force / extension **or** take several readings of force and extension, plot a force–extension graph and *k* = gradient	
	D4	description of experimental method to determine ρ, e.g. measure mass of ball using a balance **and** $\rho = \dfrac{m}{\frac{4}{3}\pi r^3}$	
	D5	repeat measurements of <u>diameter</u> or <u>*d*</u> in different directions <u>and</u> determine the average value of *d*	
	D6	method to keep *x* constant, e.g. use a pin / ruler / card to indicate the starting point each time <u>to keep *x* constant</u>	
	D7	*x* = original length of spring – <u>compressed</u> length of spring	
	D8	adjust (vertical) position of light gate so that the diameter of (each) ball cuts the beam	
	D9	repeat experiment for the same value of *r* **and** determine the average *v*	

Question	Answer	Marks
1	D10 relationship valid <u>if</u> a straight line is produced (with y-intercept = $\lg\left(\frac{Ykx^2}{\rho}\right)$ or $\frac{1}{2}\lg\left(\frac{Ykx^2}{\rho}\right)$). Do not accept line through the origin.	

Question	Answer	Marks
2(a)	gradient = $H\lambda_0$ y-intercept = λ_0	**1**
2(b)	$\frac{d}{c}$ / 10^{15} s (1.6 or 1.60) ± 0.40 (3.47 or 3.467) ± 0.40 (4.83 or 4.833) ± 0.40 (6.00 or 6.000) ± 0.40 (9.50 or 9.500) ± 0.40 (12.5 or 12.50) ± 0.40 Values of $\frac{d}{c}$ correct as shown above.	**1**
	Uncertainties in $\frac{d}{c}$ correct as shown above.	**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 $\frac{d}{c}$ 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**
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 (2.5, 660.0) and (2.9, 660.0) **and** between (11.2, 676.0) and (11.6, 676.0).	**1**
	Worst acceptable 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* 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**

Question	Answer	Marks
2(d)	λ_0 determined using y-intercept **and** λ_0 given to 3 or 4 significant figures **and** H given to 2, 3 or 4 significant figures. $\lambda_0 = y$-intercept	**1**
	H determined using gradient **and** λ_0 and H given with SI units with appropriate powers of ten. $H = \dfrac{\text{gradient}}{y\text{-intercept}}$ **or** $H = \dfrac{\text{gradient}}{\lambda_0}$ Unit of λ_0: m, nm, μm Unit of H: s^{-1}	**1**
2(e)	Value of T determined to a minimum of two significant figures from **(d) and** correct power of ten. $T = \dfrac{1}{H}$	**1**
	Absolute uncertainty determined with correct substitution. $\Delta T = \left(\dfrac{\Delta y\text{-intercept}}{y\text{-intercept}} + \dfrac{\Delta\text{gradient}}{\text{gradient}}\right) \times T$ **or** $\Delta T = \left(\dfrac{\max \lambda_0}{\min\ \text{gradient}}\right) - T$ **or** $\Delta T = \left(\dfrac{\max y\text{-intercept}}{\min\ \text{gradient}}\right) - T$ **or** $\Delta T = \left(\dfrac{\min \lambda_0}{\max\ \text{gradient}}\right) - T$ **or** $\Delta T = \left(\dfrac{\min y\text{-intercept}}{\max\ \text{gradient}}\right) - T$	**1**