Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/52**

Paper 5 Planning, Analysis and Evaluation **October/November 2021**

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.

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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**	
	θ is the independent variable and x is the dependent variable **or** vary θ and measure x	**1**
	keep (angle) β constant	**1**
	Methods of data collection	
	labelled diagram of workable experiment including: • spring attached at both ends e.g. one end connected to a clamp and stand • strip free to move • at least two labels from: clamp, stand, wire, strip, spring, bench (Do not accept extra masses added to strip.)	**1**
	use a rule to measure L and d	**1**
	use a protractor to measure θ **or** use a rule to measure appropriate distances to determine θ by trigonometry methods	**1**
	measure original length of spring and new length of spring using rule/calipers	**1**
	Method of analysis	
	plot a graph of x against cos θ **or** cos θ against x (Allow log x against log (cos θ).)	**1**
	relationship is valid if a straight line passing through the origin is produced (Allow straight line with gradient = 1 for log-log graph.)	**1**
	for x against cos θ: $W = \frac{\text{gradient} \times 2kd \sin\beta}{L}$ **or** for cos θ against x: $W = \frac{2kd \sin\beta}{\text{gradient} \times L}$	**1**

Question	Answer	Marks
1	**Additional detail including safety considerations**	**6**
	D1 wear goggles <u>to prevent spring/wire/strip entering into eyes</u> **or** (retort) stand used to support spring is clamped to bench	
	D2 keep distance *d* <u>constant</u>	
	<u>D3 description</u> of (separate) experiment to determine *k*, e.g. weigh mass and measure extension	
	D4 *k* = weight / extension **or** *mg* / extension **or** gradient of weight–extension graph for candidate's workable (separate) experiment	
	D5 method to prevent strip at point P sliding, e.g. use adhesive putty/hinge (Do not accept methods that prevent rotation at point P.)	
	D6 use fiducial markers on spring at both ends **or** measure length of spring on both sides and average	
	D7 method to attach wire to strip, e.g. wire wrapped around the strip/(strong) tape/drill hole and tie wire	
	D8 determine *x* by subtracting original length of spring from new length	
	D9 adjust support of spring to keep β constant	
	D10 protractor correctly positioned on diagram to measure θ **or** correct trigonometric relationship given for θ	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>gradient = $-\mu$
y-intercept = ln R_0</td><td>1</td></tr>
<tr><td rowspan="2">2(b)</td><td><table><tr><th>average t / mm</th><th>ln (R / s^{-1})</th></tr><tr><td>0.16 ± 0.03</td><td>3.865 or 3.8649</td></tr><tr><td>0.25 ± 0.03</td><td>3.784 or 3.7842</td></tr><tr><td>0.42 ± 0.03</td><td>3.643 or 3.6428</td></tr><tr><td>0.56 ± 0.02</td><td>3.535 or 3.5351</td></tr><tr><td>0.66 ± 0.02</td><td>3.456 or 3.4563</td></tr><tr><td>0.76 ± 0.02</td><td>3.391 or 3.3911</td></tr></table>Values of average t and ln R correct as shown above.</td><td>1</td></tr>
<tr><td>Absolute uncertainties in average t correct as shown above.</td><td>1</td></tr>
<tr><td rowspan="2">2(c)(i)</td><td>Six points plotted correctly.
Must be accurate to nearest half a small square. Diameter of points must be less than half a small square.</td><td>1</td></tr>
<tr><td>Error bars in average t 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)	Line of best fit drawn. Points must be balanced. Do not accept line from top point to bottom point. Line must pass between (0.22, 3.80) and (0.24, 3.80) **and** between (0.60, 3.50) and (0.62, 3.50).	**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)	Negative 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 = ½ (steepest worst line gradient – shallowest worst line gradient)	**1**
2(c)(iv)	y-intercept determined by substitution of point on line into $y = mx + c$.	**1**
	y-intercept of worst acceptable line determined by substitution of point on line 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)	μ = – gradient value Do not accept negative values (from a negative gradient).	**1**
	R_0 determined using *y*-intercept **and** μ and R_0 both given with valid SI unit. $R_0 = e^{y\text{-intercept}}$ unit of μ: mm^{-1} unit of R_0: s^{-1}	**1**
	absolute uncertainty in μ = absolute uncertainty in gradient **and** absolute uncertainty in R_0 = $e^{y-\text{intercept of WAL}} - R_0$ Correct substitution of numbers must be seen.	**1**
2(e)	Value of *t* determined to two or three significant figures from **(d) or (c)(iii)** and **(c)(iv)** with correct substitution and correct power of ten(s). Do not accept ECF for POT from **(c)(iii)**, **(c)(iv)** or **(d)**. $t = \frac{\ln R - \ln R_0}{-\mu} = \frac{\ln 20 - \ln R_0}{-\mu}$ **or** $t = \frac{\ln 20 - y\text{-intercept}}{\text{gradient}} = \frac{2.996 - \textbf{(c)(iv)}}{\textbf{(c)(iii)}}$	**1**