A-Level Physics: **w25 13**

Multiple Choice Answers

Q4: C
Q25: B

A-Level Physics: **w25 14**

Multiple Choice Answers

Q5: A
Q6: B

A-Level Physics: **w25 41**

1(a)	velocity and acceleration both have constant magnitude
	velocity is (always) perpendicular to acceleration
1(b)(i)	$v = R\omega$
1(b)(ii)	$a = R\omega^2$ **or** $a = v^2 / R$
	$a = v\omega$
1(c)(i)	$x = R \sin \theta$
1(c)(ii)	$\theta = \omega t$
1(c)(iii)	clear substitution of $\theta = \omega t$ into $x = R \sin \theta$ leading to $x = R \sin \omega t$
1(c)(iv)	equation is of the form $x = x_0 \sin \omega t$ (so simple harmonic motion)
1(d)(i)	amplitude = 0.46 / 2 = 0.23 m
1(d)(ii)	$\omega = 2\pi / T$
	period = 2π / 1.9 = 3.3 s
1(d)(iii)	$a_0 = \omega^2 x_0$
	$= 1.9^2 \times 0.23$ $= 0.83$ m s^{-2}
1(e)	shadow on screen, labelled A, above left-hand edge of the circular path

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A-Level Physics: **s25 11**

Multiple Choice Answers

Q19: A

A-Level Physics: **s25 12**

Multiple Choice Answers

Q7: A
Q16: A
Q32: A

A-Level Physics: **s25 13**

Multiple Choice Answers

Q1: A
Q15: D
Q21: D

A-Level Physics: **s25 14**

Multiple Choice Answers

Q37: B

A-Level Physics: **s25 31**

2(a)	At least two values of raw d all to the nearest mm **and** final d in the range 5.9–6.1 cm.
2(b)(i)	Value of T_A on answer line in the range 2.0–10.0 s with unit.
	Repeats: At least two measurements of T_A.
2(b)(ii)	Percentage uncertainty based on absolute uncertainty in T_A in range 0.5–3.0 s. Correct method of calculation to find percentage uncertainty e.g. (absolute uncertainty / value from **(b)(i)**) × 100. If repeated readings have been taken, then the uncertainty can be half the range (but not zero) if the working is clearly shown.
2(c)(i)	Value of T_B.
2(c)(ii)	Correct calculation of W with no unit **and** $W > 1$.
2(c)(iii)	Justification for significant figures in W linked to significant figures in T_A and T_B (only).
2(d)	Second value of d.
	Second values of T_A and T_B.
	Second value of $W >$ first value of W.
2(e)	Two values of k calculated correctly. The final k values must not be written as fractions or given to only one significant figure.
2(f)	Calculation of percentage difference between candidate's two k values. Comparison of percentage difference with 20%, leading to a consistent conclusion.

2(g)(i)	A Two (sets of) readings are not enough to draw a (valid) conclusion (**not** “not enough for accurate results”, “few readings”). B Reason for difficulty in producing the rectangle of paper e.g. hard to make the sides parallel (or perpendicular) / hard to cut the sides straight / difficult to cut lengths accurately / cutting by hand with scissors (produces wavy sides) / paper twists / folds when cutting (because it is thin). C Difficulty with measuring T with reason e.g. two edges are not parallel when they meet / difficult to ensure the stopwatch is started at the same time as the paper is placed (or dropped) on to the water / experiment cannot be repeated using the same piece of paper. D Difficulty with the paper staying central in the bowl e.g. paper floats / moves and touches the edge of bowl. E Reason for difficulty with placing the paper onto the water surface e.g. paper is tilted / is dropped / hard to lower the paper parallel to the water / water surface is disturbed / ripples when placing paper / paper gets wet before entering water / paper is curled before placing on water. *1 mark for each point up to a maximum of 4.*
2(g)(ii)	A Take more readings (for different values of d) and plot a graph **or** take more readings and compare k values (**not** “repeat readings” on its own). B (To produce the rectangles) use a template / a grid **or** place tracing paper on graph paper **or** use a set square to draw (the rectangle) **or** use a guillotine / paper or box cutter / knife / scalpel with a straight edge (or ruler). C Video / film / record with timer in view. D Use wider bowl **or** have the water surface further down from the top of the bowl. E Place paper on a flat sheet of metal / glass / filter paper and place that sheet on surface of water **or** valid method of flattening the paper before putting into the water e.g. place weight on paper. *1 mark for each point up to a maximum of 4.*

A-Level Physics: **s25 53**

2(a)	gradient = $\frac{R}{E}$ y-intercept = $\frac{Z}{E}$
2(b)	$\frac{1}{I}$ / 10^3 A^{-1}: 2.20 or 2.198; 1.90 or 1.905; 1.72 or 1.724; 1.57 or 1.575; 1.46 or 1.460; 1.31 or 1.307 Values of $\frac{1}{I}$ / 10^3 A^{-1} correct as shown above.

2(b)	Uncertainties in $\frac{1}{I}$ / 10^3 A^{-1} from ± 0.02 or ± 0.03 decreasing to ± 0.01.
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.
	Error bars in $\frac{1}{I}$ plotted correctly. All error bars to be plotted. Total length of bar must be accurate to less than half a small square and symmetrical.
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 (0.101, 1.40) and (0.104, 1.40) **and** between (0.189, 2.10) and (0.194, 2.10)
	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.
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.
	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)

2(c)(iv)	*y*-intercept determined by substitution of correct point with consistent power of ten in m and y into $y = mx + c$.
	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.
2(d)(i)	R determined using gradient **and** R and Z given to 2 or 3 significant figures. R = gradient × 5.8
	Z determined using *y*-intercept **and** R and Z given with units with appropriate powers of ten. Z = *y*-intercept × 5.8 unit of R: Ω or V A^{-1} unit of Z: Ω or V A^{-1}
2(d)(ii)	Percentage uncertainty determined using $\Delta E = 0.2$ (V) with method shown. $\Delta R\% = \left(\frac{\Delta E}{E} + \frac{\Delta \text{gradient}}{\text{gradient}}\right) \times 100$ **or** $\Delta R\% = \left(\frac{0.2}{5.8} + \frac{\Delta \text{gradient}}{\text{gradient}}\right) \times 100$

2(e)	I determined to a minimum of 2 significant figures from **(c)(iii)** and **(c)(iv)** or **(d)(i)** with correct substitution. $I = \dfrac{1}{\frac{\text{gradient}}{20} + y\text{-intercept}}$ **or** $I = \dfrac{E}{\left(\frac{R}{20} + Z\right)}$

<table>
<tr><td>1</td><td>Defining the problem</td></tr>
<tr><td></td><td>vary θ and measure d or θ is the independent variable and d is the dependent variable</td></tr>
<tr><td></td><td>keep z constant</td></tr>
<tr><td></td><td>Methods of data collection</td></tr>
<tr><td></td><td>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</td></tr>
<tr><td></td><td>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)</td></tr>
<tr><td></td><td>measure d with a rule
and
measure z with a rule or calipers</td></tr>
<tr><td></td><td>measure θ with a protractor
or
determine θ using (a rule for) appropriate distances with correct trigonometric relationship</td></tr>
<tr><td></td><td>Method of analysis</td></tr>
<tr><td></td><td>plot a graph of d against sin (4θ) or equivalent
Do not accept logarithms.</td></tr>
<tr><td>1</td><td><table><tr><td>d against sin (4θ)</td><td>sin (4θ) against d</td></tr><tr><td>$P = \dfrac{g \times \text{gradient}}{v^2}$</td><td>$P = \dfrac{g}{v^2 \times \text{gradient}}$</td></tr></table></td></tr>
<tr><td></td><td><table><tr><td>d against sin (4θ)</td><td>sin (4θ) against d</td></tr><tr><td>$Q = \dfrac{y\text{-intercept}}{\sqrt{z}}$</td><td>$Q = -\dfrac{Pv^2 \times y\text{-intercept}}{g\sqrt{z}}$
or
$Q = -\dfrac{y\text{-intercept}}{\text{gradient} \times \sqrt{z}}$</td></tr></table></td></tr>
<tr><td></td><td>Additional detail including safety considerations</td></tr>
<tr><td></td><td>D1 precaution linked to prevent ball rolling (off surface), e.g. use of cushion / sand box / barrier to stop ball (rolling onto the floor)
or
precaution linked to (bouncing) ball or sand (spray) e.g. use of goggles to protect eyes</td></tr>
<tr><td></td><td>D2 keep v constant</td></tr>
<tr><td></td><td>D3 method to keep v constant, e.g. keep the distance the ball falls constant to keep v constant</td></tr>
<tr><td></td><td>D4 method to determine v or v^2, e.g. use of
$v = \sqrt{2g \times (\text{height ball falls})}$
or
$v^2 = 2g \times (\text{height ball falls})$</td></tr>
</table>

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.