A Level AQA Physics

1 Measurements and errors – answers

Question	Answers	Extra information	Marks	AO	Spec reference
01.1	$v = 2.54$ $v^2 = 6.43$ (If rounded data used, may have 6.45)	Must be to same number of sig figs as table	2	2	3.4.1.3
01.2	Point plotted to within nearest half grid square Line of best fit drawn – with intercept		1 1	2	MS 3.2
01.3	Systematic Error in measuring height s – needs to be middle of card to middle of light gate/s; measured too short		1 1	3	3.1.2
01.4	Triangle drawn on graph or use of coordinates demonstrated Value for gradient = 17 ± 0.4	Not simply using values from table – must be from graph	1 1	2	MS 3.4
01.5	$v^2 = u^2 + 2as$ and $u = 0$ $v^2 = 2as$ Gradient = $2a$ or $2g$ $g = \frac{17}{2} = 8.5$ (m s^{-2})	Range of values 8.7 to 8.3 from gradient	1 1 1	2	3.3.1.3
01.6	% difference = $\frac{\text{result} - \text{actual}}{\text{actual}} \times 100\%$ % difference = $\frac{1.31}{9.81} \times 100\% = 13\%$	ignore minus sign	1	2	3.1.2
02.1	Max **three** from: • draw round the semi-circular block and mark a point in the centre of the straight edge (measured with ruler) • use a protractor to mark the normal (line perpendicular) from this point • dark lines 5° apart from the normal to 35° (at least 6 suggested) – each entering the glass at 45° • use fine ray of light or laser as source • point along the drawn pathways mark a point to trace the path of the outgoing ray.		max 3	2	Atj

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02.2	Large triangle seen or coordinates used shown $\frac{0.7-0.06}{0.5-0} = 1.3$	triangle is at least half the graph Accept 1.28	1 1	2	3.3.2.3
02.3	Line of worst fit drawn (could be max or min) Gradient of max = $\frac{0.9-0.0}{0.64-0.02} = 1.5$ Absolute uncertainty = 1.5 – 1.3 = 0.2 Gradient of min = $\frac{0.88-0.1}{0.66-0.00} = 1.2$ 1.3 – 1.2 = 0.1	Full 3 marks for steepest as that is line of worst fit Min line gains 2 marks	1 1 1	2	3.1.2
02.4	Experimental value = 1.3 ± 0.2, therefore value does lie within experimental uncertainty	Answer consistent with their results – so if they drew min line of best fit, value does not lie in experimental uncertainty	1	1	3.1.2
03.1	Temperature: • place whole apparatus in water bath making sure trapped air completely submerged • stir regularly to make sure temperature even • leave time at each temperature to ensure air at same temperature as water bath • use thermometer/digital thermometer to record temperature. Volume: • attach apparatus to a ruler • read length of trapped air – make sure eye level with meniscus when reading • do not remove from water bath when reading measurement.	Must have at least one statement from volume and one from temperature for full marks	max 4	2	3.1.2
03.2	Max **two** from: • lowest temperature possible • minimum internal energy (allow zero kinetic energy) • −273 °C • pressure of a gas at this temperature is zero.		max 2	1	3.6.2.2

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03.3	Intercept = 3 Gradient = $\frac{3.9 - 3.0}{80} = 0.011$ Use of $y = mx + c$ when $y = 0$ $0 = 0.011x + 3$ $x = -270$ (272) (°C)		1 1 1 1	2	M3.3 and 3.4 3.6.2.2
03.4	This value is much lower than earlier value This will be because the air was warmer than the surrounding water as the water cooled too quickly/temperature lag This would give a larger intercept and shallower gradient making result too low		1 1 1	3	3.1.2
04.1	Using a micrometer/Vernier callipers Take the diameter along the length in several places and find mean	Idea of several readings along length important for second mark	1 1	2	3.1.2
04.2	$A = \pi r^2 = \pi \times (0.11\times10^{-3})^2 = 3.8 - 10^{-8}$ m² Use of $\rho = \frac{RA}{l} = \frac{7.0\,\Omega\times3.8\times10^{-8}}{0.50} = 5.3\times10^{-7}$ Ω m		1 1 1	2	3.5.1.3
04.3	% length = $\frac{0.001}{0.500} \times 100\% = 0.2\%$ % diameter = $\frac{0.01}{0.22} \times 100\% = 4.5\%$ % $R = \frac{0.4}{7.0} \times 100\% = 5.7\%$ % uncertainty = 0.2 +(2 × 4.5) + 5.7 = 15%	1 mark for calculating any one percentage uncertainty correctly	1 1	2	3.1.2

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OXFORD Revise

Question	Answers	Extra information	Marks	AO	Spec reference
04.4	Any sensible suggestion for graph and how ρ calculated: • plot R against length, and gradient = $\frac{\rho}{A}$ • plot RA against length, and gradient = ρ Why more accurate: • allows you to identify anomalies • systematic errors in measuring length/or resistance of connecting wires will not affect final answer.	Must have explained graph and suggested why more accurate for full marks	max 3	3	3.5.1.3 3.1.2
05.1	Depth: • using a ruler with no zero error/marking levels on side of tray before experiment begins • ensure ruler is read at eye level. Speed: • using a stopwatch • measure the time for wave to travel at least three lengths of tray/or some consideration of increased distance/increased time to reduce uncertainty caused by human reaction time.	Allow any acceptable method for accurate measurements	 1 1 1 1	3	PS1.2
05.2	Any sensible suggestion of graph, what to expect and how to confirm: v against $\sqrt{h}$ should be straight-line graph through the origin gradient = $\sqrt{g}$ or v^2 against h should be straight-line graph through the origin gradient = g		 1 1 1	3	3.1.2 MS3.3
05.3	Students would have to confirm by using a different set of apparatus; or see if another student found the same relationship repeating the experiment		1	1	3.1.2

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06.1	Sensible guess at rooms dimensions, such as: $3\,m \times 10\,m \times 15 = 450\,m^3$ Use of mass = ρV mass = $1.2 \times 450 = 540$ kg	Allow any sensible proposal here	1 1	3	3.1.3
06.2	$80 \times 28 = 2240\,J\,s^{-1}$		1	2	3.4.1.7
06.3	$E = 2240 \times 20 \times 60 = 268\,8000$ J $E = mc\Delta\theta$ $\Delta\theta = \frac{E}{mc} = 5\,°C$	Answers will vary based on mass calculations	1 1	2	3.6.2.1
06.4	No As temperature in room rises, thermal energy will be transferred from the room Or rate of energy transfer dependent on temperature outside/temperature difference/insulation/of walls/windows doors	Sensible answer backed by logical reasoning	1 1	3	3.6.2.1
07.1	Labelled diagram of apparatus – may be marks available here for method depending on detail • method for small amplitudes – for example, protractor (less than 10°) or method of measuring start height accurately each time • timing multiple oscillations to reduce uncertainty from reaction time using stopwatch • fiducial marker at centre point for timing • measuring length from top to middle of bob with metre ruler • lengths chosen so T longer • evidence that clamp stand is clamped to the desk for safety – or bag under bob in case it falls.	1 mark for diagram, 3 further marks for detail on method and accuracy	max 4	2	Atb and d PS2.1 PS4.1
07.2	In first column 2 becomes 2.00 Add units s^2 for third column Values correct in third column: 8.12, 7.67, 7.40, 7.13, 6.60		1 1 1	2	PS2.2

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Question	Answers	Extra information	Marks	AO	Spec reference
07.3	Points plotted correctly within ½ square Line of best fit drawn Gradient calculated = 4.0 ± 0.2		1 1 1	2	MS 3.2
07.4	$T = 2\pi\sqrt{\frac{l}{g}}$ so $T^2 = 4\pi^2\frac{l}{g}$ Gradient = $\frac{4\pi^2}{g}$ $g = 9.9\ \mathrm{m\,s^{-2}}$		1 1	2	3.6.1.3
07.5	The data is precise because the points are close to the line of best fit The data is accurate because the value of g is within 1% of the actual value	For second mark there should be justification of accuracy	1 1	1	3.1.2
08.1	Use of $Q = It$ or $W = VQ$ $W = Fd = mad$ (or other energy equation) $V = \frac{W}{Q} = \frac{W}{It}$ $V = \frac{mad}{it} = \frac{\mathrm{kg\,m\,s^{-2}\,m}}{\mathrm{A\,s}} = \mathrm{kg\,m^2\,A^{-1}\,s^{-3}}$	Must be able to see cancelling and evidence of equations (can be entirely in units)	1 1 1	3	3.1.1
08.2	Simple circuit with one cell, variable resistor and ammeter in series, and voltmeter in parallel with variable resistor or cell	Mark for correct symbols and mark for correct arrangement	1 1	1	3.5.1.6
08.3	E.m.f. is y-intercept – 1.51 ± 0.05 V Internal resistance is the gradient 0.41 ± 0.2 Ω		1 1	2	3.5.1.6
08.4	The actual e.m.f. is lower – or stated value 1.41 – consistent with results Internal resistance will be the same because all points are shifted by same amount	For all 3 marks students must have explained answers	1 1 1	3	3.1.2

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OXFORD Revise

Skills box answers

Question	Answer
1(a)	$\frac{0.1}{6.7} \times 100\,\% = 1.49\%$
1(b)	$\frac{10}{450} \times 100\,\% = 2.22\%$
1(c)	$\frac{1000}{366\,000} \times 100\,\% = 0.27\%$
2(a)	$3.43 \times 6.5\% = 3.43 \times 0.065 = 0.22$ $= 3.43\,W \pm 0.22\,W$
2(b)	$10 \times 10\% = 10 \times 0.1 = 1$ $= 10\,k\Omega \pm 1\,k\Omega$
2(c)	$12\,742 \times 0.3\% = 12\,742 \times 0.003 = 38.2$ $= 12\,742\,km \pm 38.2\,km$
3(a)	volume of cube = $(25.0\times10^{-3}\,m)^3 = 1.56\times10^{-5}\,m^3$ Calculate the percentage uncertainty in each measurement first: $\left(\frac{0.2\times10^{-3}}{25.0\times10^{-3}}\right) \times 100\% = 0.8\%$. Then add the percentage uncertainties for all three measurements, which is 2.4%. So absolute uncertainty = 2.4% of $1.56\times10^{-5}\,m^3 = 4\times10^{-7}\,m^3$. Note: standard form integers must be between ≥ 1 or < 10, so the power of the absolute uncertainty value has changed in this answer. Remember to always check powers when using standard form.
3(b)	density $= \frac{mass}{volume} = \frac{42.19\times10^{-3}\,kg}{1.56\times10^{-5}\,m^3} = 2700\,kg\,m^{-3}$. To calculate uncertainty in density you need to add the percentage uncertainties in volume and mass. % uc mass $= \left(\frac{0.01}{42.19}\right) \times 100\% = 0.024\%$ Adding the % uc = $(0.024 + 2.4)\% = 2.4\%$ Absolute uncertainty = absolute value × % uc = $64.8\,kg\,m^{-3}$ The density of aluminium = $2700\,kg\,m^{-3} \pm 65\,kg\,m^{-3}$.