A Level OCR Physics

Chapter 3 Making measurements and analysing data

Question	Answers	Extra information	Mark	AO	Spec reference
1(a)	data on table: 2.54 6.43 (If rounded data used may have 6.45)	must be to same number of sig figs as table	1	2	3.1.1a
(b)	point plotted to within nearest half grid square line of best fit drawn – with intercept		1 1	2	1.1.3d
(c)	systematic error in measuring height *s* – needs to be middle of card to middle of light gate/s measured too short		1 1	1	2.2.1
(d)	triangle drawn on graph or use of coordinates demonstrated value for gradient = 17	not simply using values from table – must be from graph accept values from 16.6 to 17.4	1 1	2	1.1.3dii
(e)	$v^2 = u^2 + 2as$ and $u = 0$ $v^2 = 2as$ gradient = $2a$ $g = \frac{17}{2} = 8.5$ (m s^{-2})	range of values 8.7 to 8.3 from gradient	1 1 1	2	3.1.2a
(f)	$\%\text{difference} = \frac{\text{result} - \text{actual}}{\text{actual}} \times 100\%$ $\%\text{difference} = \frac{1.31}{9.81} \times 100\% = 13\%$	range of values 11.3 to 15.4% from value of g obtained	1	2	2.2.1c
2(a)	any 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		max 3	1	1.1.2

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	• mark lines 5° apart from the normal to 35° (at least 6 suggested) – each entering the curved part of the block perpendicular to the surface for the angles of incidence • use fine ray of light or laser as source and point along marked angles of incidence • mark points along outgoing ray to mark its path • connect the points along the marked path and use a protractor to measure the angle of refraction				
(b)	large triangle seen or coordinates used shown gradient = $\frac{0.66 - 0.06}{0.6 - 0.1}$ = 0.83 n = 1/gradient = 1/0.83 = 1.2		1 1 1	3	4.4.2d 1.1.3dii
(c)	line of worst fit drawn (could be max or min) gradient of max = $\frac{0.58 - 0}{0.60 - 0}$ = 0.97 so n = 1.0 absolute uncertainty = 1.2 – 1.0 = 0.2 gradient of min = $\frac{0.60 - 0.06}{0.68 - 0.00}$ = 0.79 so n = 1.26 absolute uncertainty = 0.06		1 1 1	2	2.2.1d
(d)	experimental value = 1.2 ± 0.2 (or 0.06) therefore value does not lie within experimental uncertainty	answer consistent with their results – so if they drew min line of best fit values does not lie in experimental uncertainty	1	2	3.1.2

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3(a)	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: • length is directly proportional to 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 Record atmospheric pressure on the day.	must be at least one statement from volume and temperature for full marks	max 4	1	5.1.4d
(b)	any 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	5.1.2e
(c)	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	1.1.3dii 5.1.4d
(d)	This value is much lower than earlier value.		1	3	2.2.1a

Question	Answers	Extra information	Mark	AO	Spec reference
	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		
4(a)	Using a micrometer/Vernier callipers take the diameter <u>along the length in several places</u> and find mean.	idea of several readings along length important for second mark	1 1	1	1.1.2
(b)	$A = \pi r^2 = \pi \times (0.11\times10^{-3})^2 = 3.8\times10^{-8}$ m^2 use of $\rho = \frac{RA}{l} = \frac{7.0\ \Omega \times 3.8 \times 10^{-8}}{0.50} = 5.3\times10^{-7}$ Ωm		1 1 1	2	4.4.2a
(c)	% 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	2.2.1c
(d)	any sensible suggestion for graph and how ρ calculated: plot R versus length and gradient = $\frac{\rho}{A}$ plot RA versus 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	4.4.2a

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5(a)	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	max 4	3	1.1.2
(b)	$v^2 = gh$ v^2 = m^2 s^{-2} gh = m s^{-2} m units the same		1	3	2.1.2d
(c)	any sensible suggestion of graph. what to expect and how to confirm: v versus $\sqrt{h}$ should be straight-line graph through the origin gradient = $\sqrt{g}$ or v^2 versus h should be straight-line graph through the origin gradient = g		 1 1 1	3	1.1.3b and d
(d)	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	3	2.2.1b
6(a)	sensible guess at room's dimensions: e.g. 3 m × 10 m × 15 m = 450 m^3 use of mass = ρV M = 1.2 × 450 = 540 kg	allow any sensible proposal here	1 1	3	2.1.1

Question	Answers	Extra information	Mark	AO	Spec reference
(b)	$E = P \times t$ = 80 × 28 × 1 s = 2240 J		1	2	3.3.3a
(c)	E = 2240 × 20 × 60 = 268 8000 J $E = mc\Delta\theta$ $\Delta\theta = \frac{E}{mc}$ = 5° K	answers will vary based on mass calculations	1 1	2	5.1.3a
(d)	no as temperature in room rises, thermal energy will be transferred from the room. rate of energy transfer dependent on temperature outside / temperature difference / insulation / of walls / windows doors	sensible answer backed by logical reasoning	1 1	3	5.1.3
7(a)	units $T^2 = s^2$ idea that $4\pi^2$ are dimensionless or $k = \frac{F}{x}$ $F = ma$ or N = kg m s^{-2} so $k = \frac{\text{kg m s}^{-2}}{\text{m}}$ = kg s^{-2} substituted in and cancelling seen $= \frac{\text{kg}}{\text{kg s}^{-2}} = \frac{1}{\text{s}^{-2}} = \text{s}^2$		1 1 1	2	2.1.2d
(b)	**Level 3 (5–6 marks)** Clear method, including how to obtain high quality data and analyse for accuracy *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Clear description and some analysis or	Labelled diagram of apparatus – may be marks available here for method depending on detail Method • spring attached to clamp stand • clamped to the table with G-clamp • use of stopwatch to measure oscillations	max 6	2	1.1.1 1.1.2

Question	Answers	Extra information	Mark	AO	Spec reference
	attempt at each heading *There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Limited method or suggestions for high quality or analysis *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks**	• timing multiple oscillations to reduce uncertainty from reaction time using stop watch • use of scales to check mass of masses • vary mass and measure *T* • *safety – wear googles in case spring breaks and watch for falling masses* Quality of data • use of fiducial marker • timing from centre point • measuring length from top to middle of bob with meter ruler • masses chosen so *T* longer Additional experiment • finding spring constant of spring by measuring extension for increasing mass – using gradient of graph Accuracy T^2 versus m graph should be straight line through origin Compare value of *k* from both experiments gradient of graph = $\frac{4\pi^2}{k}$			
(c)	column 2 1.1 becomes 1.10 add units s^2 for third column		1 1	2	2.1.2f

Question	Answers	Extra information	Mark	AO	Spec reference
	values correct in third column: 0.34, 0.61, 0.94, 1.21, 1.54		1		
(d)	points plotted correctly within ½ square line of best fit drawn gradient calculated gradient 3.0	Accept values from 2.8 to 3.2	1 1 1	2	2.2.1d
(e)	$T^2 = \frac{4\pi^2 m}{k}$ gradient = $\frac{4\pi^2}{k}$ k = 13.2 N m^{-1}	Accept values from 12.3 to 14.1	1 1	2	2.2.1d
(f)	There are no repeats displayed in the table and so the precision of the data is unknown The data is accurate because the value of g is close to the true value Calculation of % uncertainty (7%)	for second mark there should be justification of accuracy depends on their results – anything within 10% could be called accurate.	1 1 1	3	2.2.1
8(a)	Use of $Q = It$ or $W = VQ$ $W = Fd = mad$ (or other energy equation) $V = \frac{W}{Q} = \frac{W}{It}$ $V = \frac{mad}{It} = \frac{\text{kg m s}^{-2}\text{ m}}{\text{A s}} = \text{kg m}^2\text{ A}^{-1}\text{ s}^{-3}$.	must be able to see cancelling and evidence of equations (can be entirely in units)	1 1 1	2	2.2.2b
(b)	simple circuit with one cell and 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	4.3.2c

Question	Answers	Extra information	Mark	AO	Spec reference
(c)	e.m.f. is *y* intercept – 1.44 ± 0.05 V internal resistance is the gradient 0.41 ± 0.2 Ω	Accept range from 1.39 to 1.49V	1 1	2	4.3.2c
(d)	the actual e.m.f. is lower by 0.1V – or stated value 1.34 – consistent with results internal resistance will be the same since all points are shifted by same amount / gradient doesn't change	for all 3 marks students must have explained answers	1 1 1	3	2.2.1.b