A Level AQA Physics

9 Current electricity – answers

Question	Answers	Extra information	Mark	AO Spec reference
01.1	$R = \frac{V}{I}$ 7.00 to be seen either on the table or by the question	Must be written to 3 s.f.	1	3.5.1.1 3.1.2 AO1
01.2	±0.01 A		1	3.1.2 AO1
01.3	Point plotted to within $\frac{1}{2}$ a small square AND suitable line of best fit drawn	Both needed for mark	1	MS 3.2 AO1
01.4	Systematic error Resistance of connecting wires OR Error in measuring length introduced by crocodile clips	Allow any sensible source of systematic error	1 1	3.1.2 AO1
01.5	Large triangle seen or suitable data points from line of best fit Gradient = 12 ± 0.5	MUST NOT be data from table	1 1	MS 3.4 AO2
01.6	Cross-sectional area of wire = π $(0.11\times10^{-3})^2 = 3.8\times10^{-8}$ m^2 Use of $R = \frac{\rho L}{A}$ to give gradient = $\frac{\rho}{A}$ $\rho = 12 \times 3.8\times10^{-8} = 4.6\times10^{-7}$ (Ω m)	Ignore errors in powers of 10 for this mark possible error carried forward from gradient	1 1 1	3.5.1.3 MS 3.1 AO2
01.7	% difference = $\frac{4.9\times10^{-7} - 4.6\times10^{-7}}{4.9\times10^{-7}}$ % difference = 6% (or 7% if you use unrounded numbers) This data is accurate as below 10% difference or not accurate as above 5%	Allow justification for any sensible comment Allow any valid comment	1 1	3.1.2 AO2
02.1	$I = \frac{\Delta Q}{\Delta t}$ $\Delta t = \frac{\Delta Q}{I} = \frac{15\text{ C}}{30\,000\text{ A}} = 5\times10^{-4}$ s		1	3.5.1.1 AO1

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02.2	number of electrons = $\frac{\Delta Q}{\text{charge on 1 electron}}$ Number of electrons = $\frac{15\,\text{C}}{1.6\times10^{-19}\,\text{C}} = 9.4\times10^{19}$		1 1	3.5.1.1 AO2
02.3	$W = VQ = 40\times10^{6} \times 15\,\text{C} = 6.0\times10^{8}\,\text{J}$		1	3.5.1.1 AO1
02.4	Use of $E = mc\Delta\theta$ or $E = mL$ $E = (0.58 \times 830 \times 1800) + (0.58 \times 156\,000) = 9.6\times10^{5}\,\text{J}$ Yes, as $6\times10^{8}\,\text{J} > 9.6\times10^{5}\,\text{J}$	 valid comment consistent with their calculation	1 1 1	3.6.2.1 AO3
03.1	**X** is a resistor The resistance is constant so the voltage and current are directly proportional **Y** is a filament lamp The resistance increases with increasing voltage/current/as temperature increases resistance increases		1 1 1 1	3.5.1.2 AO1
03.2	$R = \frac{V}{I}$ $R = \frac{5.0}{0.3} = 16.7\,\Omega$	Must not draw a tangent here	1 1	3.5.1.1 AO2
03.3	p.d. across **Y** = 2.5 V (read from graph) p.d. across **X** = 5.0 V (read from graph) e.m.f. = 7.5 V	Can also solve by determining resistance of each component with that current and calculating V by multiplying resistance by current	1 1	3.5.1.2 3.5.1.4 AO2
03.4	Current in **Y** = 0.30 A (read from graph) Current in **X** = 0.20 A (read from graph) Total current = 0.50 A		1 1	3.5.1.2 3.5.1.4 AO2

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04.1	Area of 1 strand of cable = $\pi r^2 = \pi(1.665\times10^{-3})^2$ For 1 strand $R = \frac{\rho L}{A} = \frac{2.82\times10^{-8}\times1000}{\pi(1.665\times10^{-3})^2}$ $R = 3.2\ \Omega$ Therefore, for cable $\frac{1}{R_T} = 27\times\left(\frac{1}{R}\right)$ $R_T = 0.12\ \Omega$		1 1 1	3.5.1.3 3.5.1.4 AO2
04.2	R of 1 m = $\frac{0.12}{1000} = 1.2\times10^{-4}\ \Omega$ or use of $P = I^2R$ $I^2 = \frac{P}{R} = 500$ A	Allow e.c.f. from answer to 4.1	1 1	3.5.1.1 3.5.1.4 AO3
04.3	A superconductor has zero resistivity at or below the critical temperature A high temperature superconductor has a higher critical temperature		1 1	3.5.1.3 AO1
04.4	Allow any sensible suggestion here for one mark: • expense of super cooling cables needs to outweigh gains in energy transmission (owtte) • only for high-load cables • less energy lost in transmission preserves energy resources/reduces use of fossil fuels		1	3.5.1.3 AO3
05.1	(As temperature increases) resistance of thermistor decreases p.d. across thermistor decreases or pd across fixed resistor R increases V_{out} increases, (which means it will switch something on when the temperature increases)		1 1 1	3.5.1.3 3.5.1.5 AO2
05.2	This is because the number of charge carriers increases in the thermistor		1	3.5.1.3 AO2
05.3	60°C: 280 Ω 100°C: 190 Ω (allow ±5 Ω)		1 1	3.5.1.3 AO1

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05.4	Variable resistor needed Range: $\frac{R}{5} = \frac{280}{4}$, $R = 350\,\Omega$ $\frac{R}{5} = \frac{190}{4}$, $R = 238\,\Omega$		1 1 1	3.5.1.5 AO2
06.1	Axes labelled – resistance on y-axis and length/cm on x-axis R changing and not constant Graph will be an inverse of shape of paper – when area is large, resistance is small and vice versa		1 1 1	3.5.1.3 AO2
06.2	Resistivity is constant for a material Resistance depends on the length/cross-sectional area/resistivity of the sample		1 1	3.5.1.3 AO2
06.3	Measurements of p.d. and current can be used to determine resistance or $R = \frac{V}{I}$		1	3.5.1.1 3.5.1.3 AO1
06.4	Any sensible suggestions: Wall would have higher resistance than surrounding soil so would show up/well would have concentration of water lower resistance/changes in water content would show up/broken crockery may change resistivity of soil		1 1	3.5.1.3 AO3
07.1	Diode /LED The component only conducts once you are above the threshold voltage/a certain voltage/2.6 V		1 1	3.5.1.2 AO1
07.2	Circuit diagram using either a potential divider arrangement or a variable resistor Voltmeter in parallel and ammeter in series with component Correct diode symbol used with correct orientation		1 1 1	ATg AO2

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07.3	Infinite/allow very large		1	3.5.1.2 3.5.1.1 AO1
07.4	Use of $R = \frac{V}{I}$ $R = \frac{V}{I}$ $R = \frac{4}{0.020\,\text{A}} = 200\,\Omega$	Ignore powers of 10 for this mark	1 1	3.5.1.1 AO2
08.1	$E_k = \frac{1}{2}mv^2$: $20\,\text{keV} = 20\,000 \times 1.6\times10^{-19}\,\text{C} = 3.2\times10^{-15}\,\text{J}$ $\frac{1}{2}mv^2 = 3.2\times10^{-15}$ $v^2 = \frac{2 \times 3.2\times10^{-15}}{9.11 \times 10^{-31}}$ $v = 8.4\times10^{7}\,\text{m s}^{-1}$	Either statement for this mark	1 1	3.4.1.8 3.2.2.2 AO3
08.2	$v = \frac{d}{t}$ and $d = 4.22\times10^{8}\,\text{m}$ $t = \frac{4.22\times10^{8}}{8.4\times10^{7}} = 5.0\,\text{s}$		1 1	3.4.1.3 AO2
08.3	$Q = It$ $ne = 3\times10^{6}\,\text{A} \times 1$ $n = \frac{3\times10^{6}}{1.6\times10^{-19}}$ $n = 1.9\times10^{25}$		1 1	3.5.1.1 AO2
08.4	From Jupiter to Io		1	AO1

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Skills box answers

Question	Answer
1(a)	0.34 mm
1(b)	0.37 mm
2(a)	The reading of 0.351 mm is anomalous, and may have been written incorrectly. Ideally this measurement should be retaken. However, to calculate the mean, this value is discarded. The mean is $\frac{(0.314 + 0.315 + 0.316 + 0.315)}{4} = 0.315$ mm.
2(b)	area $= \pi \frac{(0.315 \times 10^{-3})^2}{4} = 7.79 \times 10^{-8}\ \text{m}^2$.
3	Turn the barrel of the micrometer until the jaws are closed. At this point the scale should be on zero. If not, then there is a zero error.