

Mark Scheme

Q1.

Question Number	Answer	Mark
	C is the correct answer A is not the correct answer as these are units of charge. B is not the correct answer as these are units of power. D is not the correct answer as these are units of the Planck constant, which is not equivalent to a volt.	(1)

Q2.

Question Number	Answer	Mark
	The only correct answer is C ($5 \times 10^{-3} \times 480$) A is not correct because this is current divided by time B is not correct because this is current divided by time D is not correct because time is not in seconds	1

Q3.

Question Number	Answer	Mark
	A is the correct answer as $R = V/I$, and V is measured in JC^{-1} and I is measured in Cs^{-1}. B is not the correct answer as the units of resistance are not JC^2s^{-1} C is not the correct answer as the units of resistance are not $\text{JC}^{-1}\text{s}^{-1}$ D is not the correct answer as the units of resistance are not JC	(1)

Q4.

Question Number	Answer	Mark
	A is the correct answer B is not the correct answer as it appears in neither of the definitions C is not the correct answer as it only appears in the definition for current D is not the correct answer as it only appears in the definition for p.d.	(1)

Q5.

Question Number	Answer	Mark
	C is the correct answer as the resistance of both listed components decreases as the applied potential difference increases. A is not the correct answer as the resistance of an ohmic conductor remains constant when the applied potential difference increases. B is not the correct answer as the resistance of a filament lamp increases when the applied potential difference increases. D is not the correct answer as the resistance of a filament lamp increases when the applied potential difference increases.	(1)

Q6.

Question Number	Answer	Mark
	D is the correct answer as $P = V^2/R$, so for a constant resistance, doubling V results in P quadrupling. A is not the correct answer as this suggests that P is constant regardless of V B is not the correct answer as this suggests that P is directly proportional to V C is not the correct answer as this suggests that doubling P quadruples V	(1)

Q7.

Question Number	Answer	Mark
	The only correct answer is D - $\frac{It}{e}$ A is not correct because the charge passing in time t should be divided by the charge on an electron. B is not correct because the charge passing in time t should be current divided by time. C is not correct because the charge passing in time t should be current multiplied by time and should be divided by the charge on an electron.	1

Q8.

Question Number	Answer	Mark
	The only correct answer is B (stays the same increase) A is not correct because voltmeter reading stays the same and ammeter reading increases C is not correct because ammeter reading increases D is not correct because voltmeter reading stays the same	1

Q9.

Question Number	Answer	Mark
	A is the correct answer (Both points X and Y represent positions on the graph where there is infinite resistance as the current is zero) B is not the correct answer as there is a non-infinite resistance at Z C is not the correct answer as there is also infinite resistance at Y D is not the correct answer as there is a non-infinite resistance at Z	(1)

Q10.

Question Number	Answer	Mark
	C is the correct answer as $V = W/Q$ A is not the correct answer as volts are not equivalent to energy/time B is not the correct answer as volts are not equivalent to power/time D is not the correct answer as volts are not equivalent to power/charge	(1)

Q11.

Question Number	Answer
	C is the correct answer A is not correct because this describes an energy of 1 J B is not correct because this describes a current of 1 A D is not correct because this describes a charge of 1 C

Q12.

Question Number	Answer	Mark
	The only correct answer is B (J V^{-1}) A is not correct because a coulomb is a J V^{-1} C is not correct because a coulomb is a J V^{-1} D is not correct because a coulomb is a J V^{-1}	1

Q13.

Question Number	Answer	Mark
	The only correct answer is C (4000 C) A is not correct because this is $1.5 \text{ V} / 6 \text{ J}$ B is not correct because this is $6 \text{ J} / 1.5 \text{ V}$ D is not correct because this is $6 \text{ KJ} \times 1.5 \text{ V}$	1

Q14.

Question Number	Answer	Mark
	A is the correct answer as the graph shown is a V-I graph for a diode B is not the correct answer as the graph is not that for a filament lamp C is not the correct answer as the graph is not that for an ohmic conductor D is not the correct answer as the graph is not that for a thermistor	(1)

Q15.

Question Number	Answer	Mark
	D is the correct answer as $Q = It$ where t is time in seconds. A is not the correct answer as $Q = It$ where t is time in seconds. B is not the correct answer as $Q = It$ where t is time in seconds. C is not the correct answer as $Q = It$ where t is time in seconds.	(1)

Q16.

Question Number	Answer	Mark
	B is the correct answer as energy transferred = VQ A is not the correct answer as energy transferred does not = VQt C is not the correct answer as energy transferred does not = VQ/t D is not the correct answer as energy transferred does not = v/Qt	(1)

Q17.

Question Number	Answer	Mark
	C is the correct answer A is not the correct answer as the I-V graph for a diode is not a straight line through the origin. B is not the correct answer as the I-V graph for a filament lamp is not a straight line through the origin. D is not the correct answer as the I-V graph for a thermistor is not a straight line through the origin.	(1)

Q18.

Question Number	Answer	Mark
	A is the correct answer B is not the correct answer as the total charge ($1.25 \times 45 \text{ C}$) is divided by e to establish the number of electrons passing in 45 seconds. C is not the correct answer as the total charge ($1.25 \times 45 \text{ C}$) is divided by e to establish the number of electrons passing in 45 seconds. D is not the correct answer as the total charge ($1.25 \times 45 \text{ C}$) is divided by e to establish the number of electrons passing in 45 seconds.	(1)

Q19.

Question Number	Answer	Mark
	D is the correct answer as it is the graph for a thermistor A is not the correct answer as it is not a graph for a diode B is not the correct answer as it is not a graph for a filament lamp C is not the correct answer as it is not a graph for a resistor	(1)

Q20.

Question Number	Answer	Mark
	The only correct answer is A (diode) B is not correct because current would increase at a decreasing rate C is not correct because this would be a straight line through the origin D is not correct because this would be an exponential curve	1

Q21.

Question Number	Answer	Mark
	The only correct answer is B (filament bulb) A is not correct because a diode would only show a current in one direction C is not correct because a resistor would give a straight line through the origin D is not correct because a thermistor would produce an curve	1

Q22.

Question Number	Answer	Mark
	C is the correct answer A is not the correct answer as this is the graph for a fixed resistor B is not the correct answer as this is the graph for a filament lamp D is not the correct answer as this graph does not match any component	(1)

Q23.

Question Number	Answer	Mark
	B is the correct answer as it is a V-I graph for a filament lamp A is not the correct answer as it is not a V-I graph for a diode C is not the correct answer as it is not a V-I graph for an ohmic conductor D is not the correct answer as it is not a V-I graph for a thermistor	(1)

Q24.

Question Number	Answer	Mark
	C is the correct answer A is not the correct answer as the graph on the right is that of a diode. B is not the correct answer as the graph in the middle is that of a filament bulb. D is not the correct answer as the graph on the left is that of an ohmic conductor.	(1)

Q25.

Question Number	Answer	Mark
	C is the correct answer A is not the correct answer as there is a small current In the reverse direction correct answer as there is a small current In the reverse direction D is not the correct answer as there is a small current when the p.d. $< 0.7 \text{ V}$	1

Q26.

Question Number	Answer	Mark
	D is the correct answer as this is the graph for a thermistor A is not the correct answer as this is not the graph for a diode B is not the correct answer as this is not the graph for a filament lamp C is not the correct answer as this is not the graph for an ohmic conductor	(1)

Q27.

Question Number	Answer	Mark
	Use of $R = \frac{V}{I}$ (1) Use of $I = \frac{\Delta Q}{\Delta t}$ (1) Time taken = 4.2 s (1) Or Use of $P = \frac{V^2}{R}$ (1) Use of $P = \frac{W}{t}$ and $V = \frac{W}{Q}$ (1) Time taken = 4.2 s (1) <u>Example calculation</u> $I = \frac{8.9 \text{ V}}{7.5 \Omega} = 1.19 \text{ A}$ $\Delta t = \frac{5.0 \text{ C}}{1.19 \text{ A}} = 4.20 \text{ s}$	3
	Total for question	3

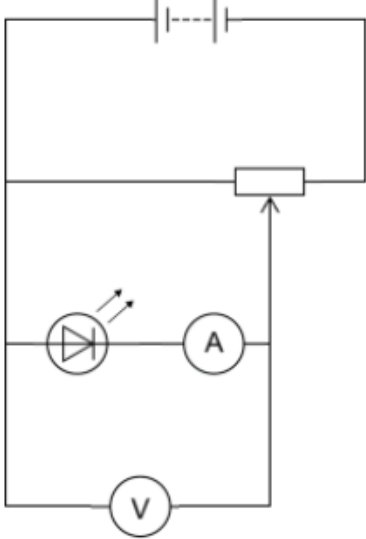
Q28.

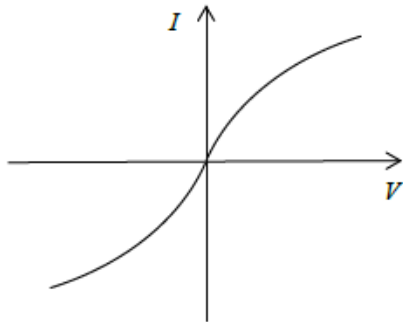
Question Number	Answer	Mark																																								
	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content. <table><tr><th>IC points</th><th>IC mark</th><th>Max linkage mark</th><th>Max final mark</th></tr><tr><td>6</td><td>4</td><td>2</td><td>6</td></tr><tr><td>5</td><td>3</td><td>2</td><td>5</td></tr><tr><td>4</td><td>3</td><td>1</td><td>4</td></tr><tr><td>3</td><td>2</td><td>1</td><td>3</td></tr><tr><td>2</td><td>2</td><td>0</td><td>2</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr></table> The following table shows how the marks should be awarded for structure and lines of reasoning. <table><tr><th></th><th>Number of marks awarded for structure of answer and sustained line of reasoning</th></tr><tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr><tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr><tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr></table>	IC points	IC mark	Max linkage mark	Max final mark	6	4	2	6	5	3	2	5	4	3	1	4	3	2	1	3	2	2	0	2	1	1	0	1	0	0	0	0		Number of marks awarded for structure of answer and sustained line of reasoning	Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2	Answer is partially structured with some linkages and lines of reasoning	1	Answer has no linkages between points and is unstructured	0	
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	Indicative content - For filament bulb, resistance increases (as p.d. increases) Or For filament bulb, p.d. increases at a greater rate than current Or rate of increase of current decreases. - Increased temperature leads to increased vibration of ions/atoms/lattice - Increased rate of collision between electrons and ions/atoms/lattice - For a thermistor, resistance decreases (as p.d. increases) Or For a thermistor, current increases at a greater rate than p.d. Or rate of increase of current increases - Increased number of conduction electrons $I = nAqv$, so current increases. (For IC1 & IC4 accept symbols for p.d. and current) (Ignore references to the gradient of the graph as $1/R$)	6
	Total for Question	6

Question Number	Answer	Mark
a	Use of $V=W/Q$ (1) $W = 7.92 \times 10^5 \text{ J}$ (1) <u>Example of calculation</u> $W = V \times Q = 22 \times 36,000 = 792,000 \text{ J}$	(2)
bi	Use of speed = distance/time (1) Time = 0.45 s (1) (Accept 7.5×10^{-3} minutes or 1.25×10^{-4} hours) <u>Example of calculation</u> $16 \text{ km hr}^{-1} = 16,000 \text{ m} / 3,600 \text{ s} = 4.4 \text{ m s}^{-1}$ Time = distance / speed = $2.0 \text{ m} / 4.4 \text{ m s}^{-1} = 0.45 \text{ seconds}$.	(2)
bii	Use of $I = Q / t$ (1) Calculates total charge used in 2.00 m (1) Number of electrons = 4.2×10^{19} (1) (e.c.f. from (i)) OR Use of speed = distance / time (1) Calculates total charge used in 2.00m (1) Number of electrons = 4.2×10^{19} (1) (no e.c.f. required from (i) for this method) <u>Example of calculation</u> $I = Q / t = 36,000 \text{ C} / (40 \times 60) \text{ s} = 15 \text{ A}$ Total charge used in 2.00m = $I \times t = 15 \text{ A} \times 0.45 \text{ s} = 6.75 \text{ C}$ number of electrons = $6.75 \text{ C} / 1.6 \times 10^{-19} \text{ C} = 4.2 \times 10^{19}$	(3)
	Total for question	7

Q30.

Question Number	Answer	Mark
(a)	LED, power supply and ammeter, in series (1) (allow diode for LED) (1) Method to vary the potential difference across the LED LED connected in forward bias and voltmeter connected in parallel with LED (1) <u>Example circuit</u> 	3
(b)	Current = 37 (mA) read from graph (1) (allow range 36 to 38 mA) Use of $P = VI$ (1) Power of LED = 0.0814 W (1) (allow range 0.079 to 0.084 W) <u>Example calculation</u> $P = 2.2 \text{ V} \times 37 \times 10^{-3} \text{ A} = 0.0814 \text{ W}$	3
(c)	Between 0 V and 1.6 V the resistance of the LED was (almost) infinite (1) (As p.d. increased) above 1.6 V, the resistance of the LED decreased (1) Max 1 mark for statement that resistance is initially (almost) infinite and then decreases	2
Total for question		8

Question Number	Answer	Mark
a	Correct shape of graph for positive quadrant Correct symmetry in negative quadrant 	(1) (1) 2
13bi	Use of $A = \pi r^2$ Use of $I = nqvA$ $v = 1.3 \times 10^{-2} \text{ m s}^{-1}$ <u>Example of calculation</u> $A = \pi r^2 = \pi \times (0.023 \times 10^{-3} \text{ m})^2 = 1.66 \times 10^{-9} \text{ m}^2$ $v = \frac{I}{nAq} = \frac{0.44 \text{ A}}{(1.26 \times 10^{29} \text{ m}^{-3})(1.66 \times 10^{-9} \text{ m}^2)(1.60 \times 10^{-19} \text{ C})} = 0.0131 \text{ m s}^{-1}$	(1) (1) (1) 3
bii	Use of $R = V/I$ Use of $R = \rho l/A$ $\rho = 9.1 \times 10^{-7} (\Omega \text{ m})$, so approximately 2700°C (MP2 e.c.f. for A value from part b(i)) <u>Example of calculation</u> $R = \frac{140 \text{ V}}{0.44 \text{ A}} = 318 \Omega$ $\rho = \frac{RA}{l} = \frac{(318 \Omega)(1.66 \times 10^{-9} \text{ m}^2)}{0.580 \text{ m}} = 9.1 \times 10^{-7} \Omega \text{ m}$, so this most closely matches the resistivity value at 2700°C.	(1) (1) (1) 3
Total for question		8