Question	Answer	Marks	Guidance
1 a i	0.72 (volts) (2) **but if answer incorrect** 0.7185 or 0.718 or 0.719 or 0.7 (volts) (1)	2	 **Allow** 0.15 x 4.79 (1)
ii	**D** (1)	1	if answer line blank allow correct answer circled or underlined more than one answer = 0 marks
b	**Any two from:** increase the current by one from - moving the slider clockwise or upwards or to the left - having less wire / fewer coils in circuit [1] decrease the current by one from - moving the slider anticlockwise or downwards or to the right - having more wire / coils in circuit [1] increasing length increases resistance / increasing resistance decreases current / ORA [1]	2	**allow** labelled arrows or indications on diagram to indicate correct directions for upwards **allow** towards the power supply for downwards **allow** away from the power supply **Allow** changing length changes resistance [1] **But** increasing length decreases resistance / ORA [0] **Allow** changing resistance changes current [1] **But** increasing resistance increases current / ORA [0]
	Total	**5**	

Question	Answer	Marks	Guidance
2 a COMMON	82 104 128 (1)	1	all correct for 1 mark
COMMON b i	I_b is (always much) smaller than I_c / ORA [1]	1	
COMMON ii	(idea that) a small base current is needed to switch on the transistor (1) (this allows) a large current through the transistor (1)	2	**allow** higher level answers e.g. transistors have a high gain (1)

Question	Answer	Marks	Guidance
c	**max two from any of these advantages:** robot can do jobs that are more: boring / dangerous / unpleasant / intricate / labour intensive / hygienic / take longer Other advantages are that robots are safer / stronger / more efficient / faster Other advantages that robots don't get sick / don't take holidays / don't get paid / don't make human errors / don't take breaks / don't need feeding / don't get tired **max two from any of these disadvantages:** robots may be limited in decision making / need reprogramming / expensive to buy or maintain / robots take peoples jobs / may take over (the world) / dangerous to humans if a fault develops (1)	3	**Ignore** can do repetitive work **Ignore** robots do jobs that humans don't want to do
	Total	**7**	

Question	Answer	Marks	Guidance
3 a	**LDR** resistance decreases as light (level) increases / AW [1] **Thermistor (NTC)** resistance decreases as temperature increases / AW [1]	2	**allow** ORA [1] **allow** ORA [1] **allow** heat for temperature **allow** Thermistor PTC resistance increases as temperature increases [1]
b	**Any two from current passes:** Idea of threshold voltage reached / AW [1] in one direction / AW [1] when the voltage is positive / resistance is low/AW [1]	2	 e.g. if voltage is high enough/ 0.6V **Allow** (the idea that) current is correct direction for the diode [1] **allow** no current when voltage is negative [1] **allow** (idea that) circuit diagram shows diode in forward bias / current direction is L to R / anticlockwise for this diode [1]
	Total	**4**	

Question	Answer	Marks	Guidance
4 a	7.5 (ohms) [2] **but if answer incorrect** correct values of voltage and current from graph [1]	2	 correct values e.g. 3 and 0.4 or 6 and 0.8
b	**E** (no marks) Idea that longer conductors have a greater resistance [1] (idea that) the line with the shallowest / least gradient has the greatest resistance [1]	2	If E **NOT** chosen [0] Longer length has lower current [1] allow credit for candidates who calculate the resistance of E as 200 (Ω) [1]
c	**mistakes are:** **electrons** not protons are the charge carriers atoms vibrate **more** not less **increases** the resistance of the conductor not decreases it	2	**allow mistakes indicated on the text** three mistakes corrected [2] one or two mistakes corrected [1]
	Total	**6**	

Question			Answer	Marks	Guidance
5	(a)	(i)	0.15 (amps) (3) **but if answer incorrect** (I =) 0.75 / 5 (2) **or** 5 or 4.8 to 5.2 (ohms stated as the resistance) (1)	3	**allow** answer in the range of 0.144 – 0.156 (amps) (3) **allow** 5 in range of 4.8 – 5.2 **allow** 5 (ohms) seen (even in an incorrect calculation) (1) eg. 5 / 0.75 (1) eg. 5 (taken from graph / slope of graph) (1)
		(ii)	as length increases current reduces / AW / ora (1)	1	**allow** inversely proportional **ignore** resistance / faster or stronger current
	(b)		straight line (by eye) on graph starting at / pointing towards (0,0) with a steeper gradient than original line (1)	1	curved line (by eye) scores (0)
			Total	**5**	

Question			Answer	Marks	Guidance
6	(a		resistance decreases (1) brightness of lamp / current increases (1)	2	**ignore** weaker resistance **ignore** faster / stronger current But resistance increases (0) so brightness of lamp / current decreases (1)
	(b)	(i)	0.92 (Ω) (2) **but if answer is incorrect** $\frac{1}{R_T} = \frac{1}{2} + \frac{1}{3}$ (1) **or** $\frac{1}{R_T} = 0.5 + 0.33 + 0.25$ (1)	2	**allow** 0.92(307692) (2) **allow** 0.9 (2) **allow** $\frac{12}{13}$ (Ω) (2)
		(ii)	4.3 (amps) (2) **but** $\frac{4}{0.92}$ (1)	2	allow 4.30 to 4.45 (2) allow ecf from bi (2) eg for ecf of 1.08 - allow 3.7 (2) eg for ecf of 9 - allow 0.44 or 0.4 (2) allow 4 / answer to bi (1) eg 4/1.08 (1) **allow** 4.30 to 4.45 (2) **allow** $\frac{4}{\text{answer to b(i)}}$ (1)
	(c)		I_e = 0.60 mA (1)	1	**Allow** 0.6 (1)
			Total	**7**	