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**	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>2</td><td>[Level 3]
truth table all correct
AND
An explanation about how logic system is used to display different numbers
AND
numbers (eg. 2) used to illustrate answer
Quality of written communication does not impede communication of the science at this level
(5 – 6 marks)
[Level 2]
truth table all correct
AND EITHER
explanation about how logic system is used to display different numbers
OR
Numbers (eg. 2) used to illustrate answer
Quality of written communication partly impedes communication of the science at this level
(3 – 4 marks)
[Level 1]
at least two rows in truth table correct
OR
explanation about how logic system is used to display different numbers
OR
numbers (eg. 2) used to illustrate answer
Quality of written communication impedes communication of the science at this level
(1 – 2 marks)
[Level 0]
Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</td><td>6</td><td>This question is targeted at grades up to A.

completed truth table:

<table><tr><td>1</td><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>
how his logic system is used to display different numbers may include:
• Signals / states can be 0 / low / off or 1 / high / on
• logic system made of three OR gates and one NOT gate
• logic gates work to give different combinations of 0 and 1
• when the output / G is 1 then the shaded segment is switched on / ora

numbers to illustrate the answer may include:
• numbers 1 3 4 5 6 7 8 9 0 need G to be 1 to be correctly displayed
• number 2 need G to be 0 to be correctly displayed
• numbers 1, 7 and 0 need the middle bar to be 0

Use the L1, L2, L3 annotations in scoris.
Do not use ticks.</td></tr>
<tr><td></td><td>Total</td><td>6</td><td></td></tr>
</table>

Question	Answer	Marks	Guidance
3 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
4 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**	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>5 a</td><td><table><tr><th>X</th><th>Y</th><th>Z</th></tr><tr><td>(0)</td><td>(0)</td><td>1</td></tr><tr><td>(0)</td><td>(1)</td><td>0</td></tr><tr><td>1</td><td>(0)</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>[2]</td><td>2</td><td>all correct for 2 marks

2 or 3 rows correct for 1 mark</td></tr>
<tr><td>b</td><td><table><tr><th>E</th><th>F</th><th>G</th></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr></table>[2]</td><td>2</td><td>all correct for 2 marks

2 or 3 rows correct for 1 mark</td></tr>
<tr><td></td><td>Total</td><td>4</td><td></td></tr>
</table>

Question	Answer	Marks	Guidance
6 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
7	(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
8	(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**	