Question number	Answer	Notes	Marks
1 (a) (i)	voltage = current x resistance	ACCEPT equivalent rearrangement ACCEPT suitable abbreviations e.g. V = I x R REJECT V = I x REJECT equation 'triangles' alone	1
(ii)	1.2 x 4.0; 4.8 (V);		2
(iii)	12 – 4.8; 7.2 (V);	ECF on (ii)	2
(iv)	E = VIt (NO MARK) time conversion to seconds (5.0 x 60); 7.2 x 1.2 x (5.0 x 60); 2600 (J);	ECF on (iii) Allow 2592 or 2590 ALLOW 2500/2520 (J) for full marks (using 7 V) ALLOW 42 (J) or 43.2 (J) for 2 marks (using 5 mins)	3
(v)	idea of energy losses rate of energy loss = rate of energy supply (at steady temp)	 NB this statement alone scores (2) as it includes idea of energy loss	2

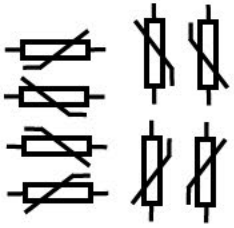
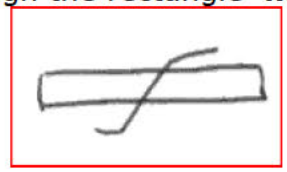
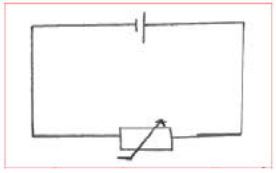
Question number	Answer	Notes	Marks
1 (b) (i)	X – series, Y – parallel	BOTH REQUIRED for the mark	1
(ii)	THREE SUITABLE, e.g.- series advantage – fewer wires; series advantage – lower resistance values; series disadvantage – one fails, circuit fails; series disadvantage – no independent control;	ALLOW REVERSE ARGUMENTS in terms of parallel circuits but do not award the same mark twice IGNORE refs to efficiency ACCEPT correct answers that link to battery voltage / current, etc	Max 3

Question number	Answer	Notes	Marks
2 (a)	any 2 of: MP1. so that lamps work independently; MP2. so that they all get mains/same voltage/230V; MP3. so that different areas/rooms can have different brightness/power/light intensities of lamps;	 so that can light some rooms without all being on or off/each lamp has its own switch/if 1 lamp blows the others will still work allow no reduction in light output for main voltage allow different currents	2
(b)	D 1.38 A;		1
(c)	any 3 of: MP1. **current** increases over max value of fuse; MP2. fuse wire melts; MP3. cuts off current; MP4. prevents wire(s) in circuit from overheating;	 allow **current** gets too high blows/breaks breaks circuit ignore 'stops electricity' ignore electric shocks	3
(d) (i)	power = voltage x current	allow in standard symbols or in words	1
(ii)	substitution into correct equation; evaluation; **e.** 0.26 X 230 60 (W)	allow 240 V for mains but not incorrect current (62.4 W) allow 59.8 (W) condone 317(.4) (W) for 1 mark	2
(iii)	answer from (d)(ii) x **180** ; evaluation; unit; **e.** 60 X 180 11000 joules/J	accept correct use of E = V x I x t allow ecf from (d)(ii) mark independently allow 10800, 10764	3

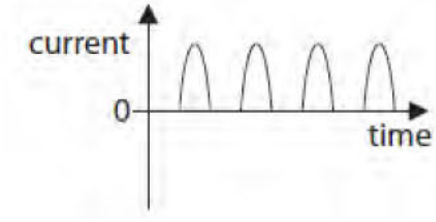
<table>
<tr><td>2 (e) (i)</td><td><table><tr><th>S_1 position</th><th>S_2 position</th><th>lamp is lit</th></tr><tr><td>W</td><td>X</td><td>(yes)✓</td></tr><tr><td>W</td><td>Y</td><td>(no) ×</td></tr><tr><td>Z</td><td>X</td><td>(no) ×</td></tr><tr><td>Z</td><td>Y</td><td>(yes)✓</td></tr></table>any three correct;
all 4 correct;;</td><td>allow 1 mark when middle two rows blank, but otherwise correct

allow 1 mark when top and bottom rows blank but otherwise correct</td><td>2</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>(ii)</td><td>any sensible suggestion of 2 way switching;
e.
on a corridor
on stairs
basement/cellar
bedroom/kitchen light
room with 2 doorways</td><td>allow clear description of 2 switches controlling the same light</td><td>1</td></tr>
</table>

Total 15 marks

Question number	Answer	Notes	Marks
3 (a)	 Symbol can be in any orientation, e.g. 	the line through the rectangle **must** be correct  =0 Ignore the size Ignore the rest of the circuit  e.g. =0 as the line through is incorrect Allow without the connection leads  =1	1
(b) (i)	Voltage = current x resistance;	Allow V = IR Allow rearrangements ignore a bald 'triangle'	1
(ii)	Convert milliamps to amps OR kilo-ohms to ohms; Substitution into *correct* equation & rearrangement; Calculation to greater than 1SF; 2.6 mA = 0.0026 A (R) = $\frac{13.2}{0.0026}$ = 5077 (Ω)	'show that' question, working must be shown for full mark Allow 5080, 5076 (truncation) 5.080 with working is worth 2 marks 5.08 with no working is worth 1 mark	3

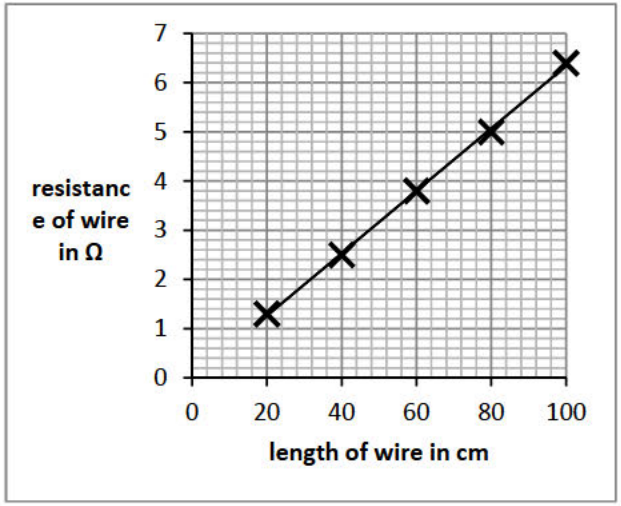
Question number	Answer	Notes	Marks
3 (c)	Any **five** of *ABOUT A* 1. Resistance of A decreases with temperature; 2. For A, {largest slope / rate of change} is at lower temperature ORA {smallest slope /rate of change} is at higher temperature; 3. A is a thermistor (ntc); *ABOUT B* 4. Resistance of B increases with temperature; 5. For B, {largest slope / rate of change} is at higher temperature(s) ORA {smallest slope /rate of change} is at lower temperature; 6. For B, resistance is constant below 50 °C; *ABOUT BOTH* 7. More results for B/ fewer results for A; 8. stated both relationships are non-linear; 9. Range of (temperature/resistance) values for both is similar; 10. data comparison e.g. both have the same resistance at 80 °C;	**Accept** • (MP1) for A, when the temperature is low, the resistance is high, ORA • (MP4) for B, when the temperature is low, the resistance is low, ORA **Allow** component B is a ptc thermistor ORA Up to 60 °C **Ignore:** inversely proportional positive/negative correlation Do **not** take implication of MP8 when MP 1,2,4,5 is given	5
		Total	**10**

Question number	Answer	Notes	Marks
4 (a) (i)	MP1. series circuit containing lamp and some form of power supply; MP2. ammeter in series (with lamp/battery); MP3. voltmeter in parallel across lamp;	correct symbols only condone cell for battery	(3)
(ii)	V=I.R;	accept in words rearrangements NOT the 'triangle'	(1)
(iii)	current reading from graph; calculation; unit; e.g. 1.5 (A) 4 Ω /ohms	 do not accept V/A for Ω	(3)
(iv)	correct shape; correct end position/size;		(2)
(b)	 D ;		(1)

Total for Question 4 = 10 marks

Question number	Answer	Notes	Marks
5 (a)	CIRCUIT DIAGRAM – Correct symbols for ammeter, voltmeter and battery; Ammeter in series with cells; Voltmeter in parallel with wire / as shown in photograph;	ALLOW three separate cells in series ALLOW anything reasonable for the wire (e.g. straight line, variable resistor, resistor)	1 1 1
(b) (i)	(independent variable) – length (of wire) (dependent variable) - resistance	BOTH NEEDED	1
(ii)	ANY FIVE APPROPRIATE, e.g. Connect the circuit / connect (crocodile) clip to wire; Read ammeter; Read voltmeter; For known /particular / quoted value length; measure length with a ruler; Repeat readings / average (in different places along the wire); Take readings for different lengths; Check meters for zero errors; Disconnect/switch off between readings; To avoid heating the wire;	IGNORE references to calculating resistance, plotting graphs –	5

Question Number	Answer		Marks
5 (c) (i)	Voltage = current x resistance;	ALLOW standard symbols, V = I X R ALLOW correct rearrangements DO NOT ALLOW equation given as unit symbols	1
(ii)	6.4;	ALLOW correct answer if it follows an equation given in unit symbols IGNORE s.f. BUT must be correctly rounded from 6.4285...	1

Question Number	Answer		Marks
5 (d) (i)	Sample graph –  scale; at least half the paper axes labelled including units; Plotting; Plotting; Best fit line;	<table><tr><td>20</td><td>1.3</td></tr><tr><td>40</td><td>2.5</td></tr><tr><td>60</td><td>3.8</td></tr><tr><td>80</td><td>5.0</td></tr><tr><td>100</td><td>.4)</td></tr></table> Points to plot IF AXES REVERSED, LOSE THE AXES MARK Ignore (100 cm, 6.4) ALLOW as length increases resistance increases ALLOW conclusions in terms of resistance per metre etc	5

Question Number		Answer		Marks
5 (d	(ii)	MARK (ii) and (iii) together, credit points wherever seen (directly) proportional;	IGNORE 'as length increases current decreases' / conclusions relating to current	1
	MARK tog With			
			ALLOW constant gradient ALLOW positive correlation	1
	(iii)	any TWO of Straight line; Through (0,0); line slopes upwards; quoting appropriate values from the graph;		1
			Total	**19**