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

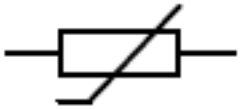
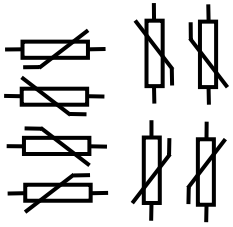
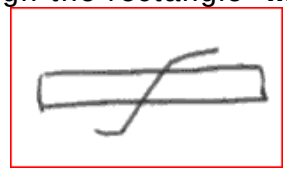
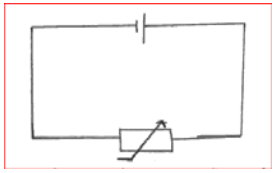
Question number	Answer	Notes	Marks
1 (b) (i)	X – series, Y – parallel	BOTH REQUIRED for the mark	1
(ii)	THREE SUITABLE, e.g.- series advantage – fewer wires; series advantage – lower resistance values; series disadvantage – one fails, circuit fails; series disadvantage – no independent control;	ALLOW 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

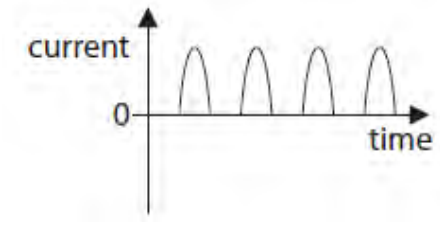
<table>
<tr><td>2 (e) (i)</td><td><table><tr><th>S_1 position</th><th>S_2 position</th><th>lamp is lit</th></tr><tr><td>W</td><td>X</td><td>(yes)✓</td></tr><tr><td>W</td><td>Y</td><td>(no) ×</td></tr><tr><td>Z</td><td>X</td><td>(no) ×</td></tr><tr><td>Z</td><td>Y</td><td>(yes)✓</td></tr></table>any three 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

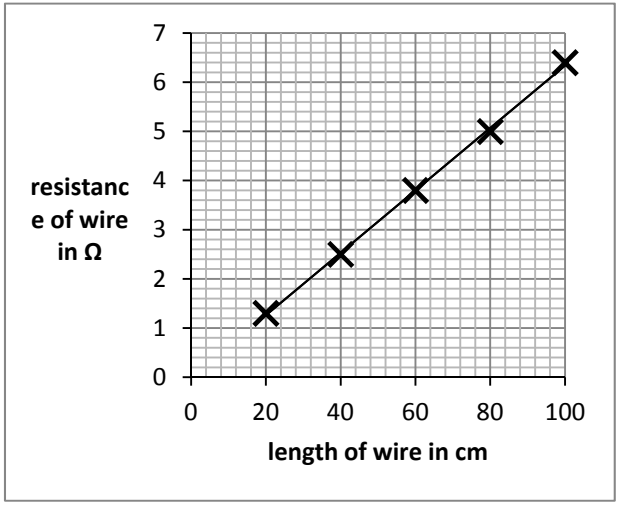
Question number	Answer	Notes	Marks
3 (c)	Any **five** of *ABOUT A* 1. Resistance of A decreases with temperature; 2. For A, {largest slope / rate of change} is at lower temperature ORA {smallest slope /rate of change} is at higher temperature; 3. A is a thermistor (ntc); *ABOUT B* 4. Resistance of B 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;	Points to plot 20 1.3 40 2.5 60 3.8 80 5.0 100 (6.4) 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**