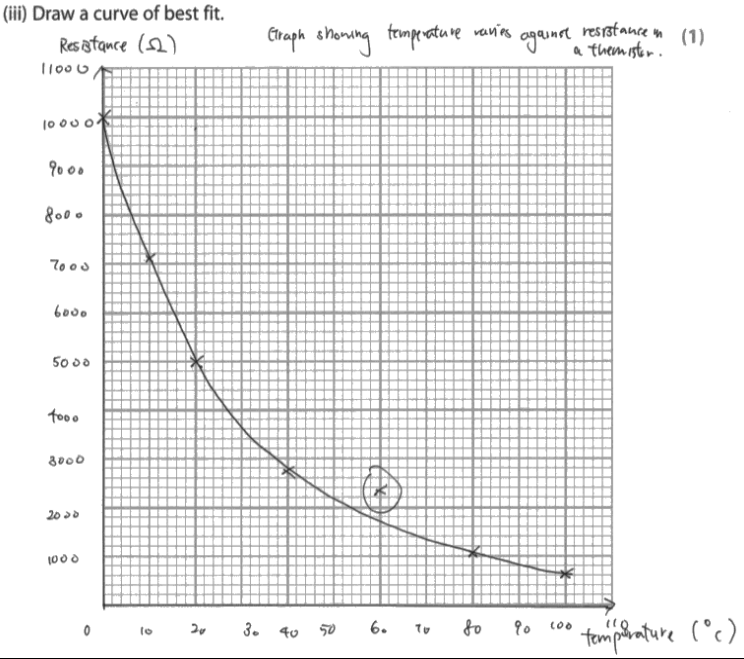
Question number			Answer	Notes	Marks
1	a		D 		1
	b	i	Any two ideas from: MP1. it acts as water bath; MP2. gives more gradual heating or cooling OR gives (easier/better) control of temperature; MP3. protects the thermistor against direct heating/prevents intense heating;	allow water distributes temperature (more) evenly /RA for air very high temperature	2
		ii	B; in parallel across the thermistor in series with the thermistor		1
	c	i	ignore orientation of the graph suitable scales marked on both axes (> 50% of grid used); both axes labelled with quantity and unit; points within ± ½ small square;;		4
		ii	anomalous point at 60, 2350;		1
		iii	LOBF; should go through 60, 1750 approx no obvious abrupt changes of gradient		1

			(iii) Draw a curve of best fit.  **Temperature in °C** / **Resistance in Ω** 0 / 10 000 10 / 7 060 20 / 5 000 40 / 2 670 60 / 2 350 80 / 1 080 100 / 609		
	d	i	water boils at 100°C/OWTTE;		1
		ii	any sensible **method** to get temp between 0 and 20; e.g. add ice to water use cold water from tap/fridge	doing experiment in a fridge is not sensible, but allow if 'walk-in' fridge is mentioned	1
				total = 12 marks	

Question Number	Answer	Notes	Marks
2 (a) (i)	input power = output power; OR $I_pV_p = I_sV_s$; OR $I_{in}V_{in} = I_{out}V_{out}$;	A dimensionally correct power equation is required. Accept - Power in = Power out $I_1V_1 = I_2V_2$ **input power = output power** $V_P I_P = V_S I_S$	1
(ii)	Substitution in correctly rearranged equation; Calculation; e.g. $I_s = \frac{(2 \times 230)}{110}$ 4 (A)	Full marks for bald correct answer Accept more s.f. e.g. 4.2, 4.18, 4.1818	2
(b) (i)	$(V_P/V_S) = (N_P/N_S)$; $\frac{\text{input (primary) voltage}}{\text{output (secondary) voltage}} = \frac{\text{primary turns}}{\text{secondary turns}}$ $\frac{V_P}{V_S} = \frac{n_P}{n_S}$	Allow • equation in words with turns ratio shown as a fraction • standard abbreviations :- s, p, in, out, 1, 2 • N, n or T for number of turns • "number of coils" for number of turns Rearrangements also to include turns ratio as a fraction $(V_S/V_P) = (N_S/N_P)$ [equation inverted] $V_S = (V_P)(N_S/N_P)$ [V_S as subject] $V_P = (V_S)(N_P/N_S)$ [V_P as subject]	1

(ii)	Substitution into correctly rearranged equation; Calculation; e.g. $N_S = \frac{(110 \times 1200)}{230}$ 570	Accept • 2 or more s.f. e.g. 574, 573.9 • Answers which round to 570	2
2 (c)	Any 5 from MP1. it steps up or steps down the voltage; MP2. current in (primary) coil produces magnetic field; MP3. the current is changing /has frequency of 50 Hz; MP4. causing a (changing) magnetic field in the core; MP5. the core strengthens the magnetic field; MP6. field lines interact with (secondary) coil; MP7. which induces a voltage in the secondary coils; MP8. transformer won't work with (steady) d.c.	allow flux for magnetic field Allow increases or decreases voltage Allow concentrates for strengthens Allow flux changes in secondary coil Allow induces a current/eq	5

(Total for Question 2 = 11 marks)

Question number		Answer	Notes	Marks
3 (a)	(i)	Power (rating) or watt(s); Rate of energy transfer / joule per second / J/s ;	 Ignore equation from p2: energy (transferred) / time (taken)	2
	(ii)	Any two of MP1 Idea of a fault causing a hazard; MP2 Idea that current goes to Earth / not to user; MP3 Idea of fuse action, e.g. blows /melts / breaks circuit; MP4 idea of a low resistance path;	 Ignore: current surge, fire Allow: • prevents electrocution / shock • flow of charge as current • **current** to ground Ignore: electricity / energy goes to earth Allow case at earth potential	2
(b) (i)		Agree / disagree - no mark Any three of MP1 Statement of an appropriate equation e.g. power = current x voltage; MP2 At least one appropriate current value calculated, e.g. 2.92 (A) or 0.13 (A); MP3 Idea that fuse rating must be more than working current; MP4 EITHER Idea that 2.92 A is close to 3A, making 3A fuse a poor choice for soldering iron 'B'; OR Idea that 3A is much larger than 0.13 A, making 3A fuse a poor choice for soldering iron 'A'	 Allow abbreviation and rearrangements e.g. P=IV, I=P/V Ignore s.f. 30 ÷ 230 = 0.13 (A) 70 ÷ 24 = 2.9 (A) Allow 70 ÷ 230 = 0.30 (A) Allow reverse arguments, e.g. "lower value fuse would melt" Allow ecf from incorrect calculation	3

(ii)		Any three of MP1 primary **AND** secondary (coils); MP2 (soft) iron core; MP3 primary/input (coil) has more turns; MP4 further **structural** detail e.g. insulated wire, core laminations;	May be shown on a labelled diagram Ignore equations Allow input and output (coils) Ignore: magnet Allow: • reverse argument • clear indication of relative turns on diagram (judge by eye) • appropriate numbers	3

Total for question 3 = 10 marks

Question number			Answer	Notes	Marks
4	(a)	(i)	C (the same speed in free space)		1
		(ii)	B (there must be a current in the circuit)		1
	(b)	(i)	Voltmeter connected in **parallel** with any circuit component; Component chosen is the **LED**;	Ignore a line through the voltmeter symbol	2
		(ii)	**Axes labelled**- quantity and unit ;	voltage in V (or V/V) AND all bars (or points) labelled	4
			Linear scale such that longest bar occupies at least half the grid;	Ignore orientation Allow non-zero origin	
			Plotting---ignore order of bars 5 bars correctly plotted;; If only 3 bars correctly plotted allow 1 mark for plotting	Bar length plotted to nearest ½ small square ALL data plotted correctly as floating "x's" gets only one mark for plotting Reject both **plotting** marks if a **line** graph is drawn (only scale and axes marks are available in this case)	
					
		(iii)	Student is right/wrong – no mark		
			Any two of MP1 idea that the visible spectrum is a sequence, with the end colours identified; MP2 Colour correctly related to wavelength (e.g. red has longest wavelength); MP3 Colour correctly related to voltage (e.g. blue needs highest voltage);	Red to blue (start either end) Allow ROYGBIV etc Wavelength (or frequency) correctly related to voltage = 2 marks, e.g. f increases with V λ increases with 1/V	2

Colour of light from LED	Minimum voltage in V
Red	1.7
Blue	3.6
Yellow	2.1
Orange	2.0
Green	3.0

Total for question 4 = 10 marks

Question number	Answer	Notes	Marks
5 (a)	C Silver		1
(b)	Must be in the correct context Any **two** from: • negative charge moves or electrons move; • (charge moves through wire) from plate B / to lifting sheet A; • therefore produces unbalanced /net charge on A/B;	*Do not award marks for repeat of stem* Accept: lifting sheet for A, metal plate for B charge is not enough for first MP A has gained electrons /B has lost electrons for 2 marks Ignore references to 'poles' 'current' Reject ideas about positive charge moving	2

Question number	Answer	Notes	Marks
5 (c)	Must be in the correct context Any two from • (top of) dust becomes positive; • negative **charge** on lifting sheet A **attracts** dust; • force of attraction > weight of dust;	Ignore unqualified 'opposite charges attract' allow an answer in terms of charge separation e.g. induced charge on dust ('top' positive 'bottom' negative)	2
(d)	Answers must be in the context of the stream of water and charged rod • the water (molecules) have a charge; • opposite charges attract / like charges repel;	do not credit repeat of stem allow (negatively) charged rod attracts (positively) charged water	2
		Total	**7**

Question number	Answer	Accept	Reject	Marks
6 (a) (i)	voltage = current x resistance;	V = I x R Accept rearrangements		1
(ii)	Substitution and rearrangement (of correct equation); Answer given to at least 3 s.f.; e.g. 230 / 22 = 10.45 (A) (≈ 10 A)	Ignore calculations of voltage or resistance 10.5 A (= 10 A)		2
(b) (i)	Any two of: MP1 As a safety device / reduces danger /reduces hazards; MP2 In case of fault / short; MP3 Idea of excessive current; MP4 Prevents (wires or appliance) overheating/fire;	Ignore any reference to electric shock More than 13A		2 2
(ii)	MP1 Because total current (in motor and heater) is more than 2A; MP2 A 2 A fuse would blow / melt / would need to be replaced / circuit would be broken;	Accept reverse arguments		

Total 7 marks

Question number	Answer	Notes	Marks
7	any 5 from: MP1. increased voltage (with step up transformer); MP2. (therefore) reduced current; MP3. current linked to heating; MP4. (therefore) less {energy / power} is lost / wasted (in transmission); MP5. reference to $P=I^2R$ equation; MP6. example of an efficiency enhancing detail of cables; MP7. example of an efficiency enhancing detail of transformer construction; MP8. step down transformer reduces voltage / increases current;	 allow 'steps up voltage' allow $P=IV$ if clear that V is the voltage drop across the cables. e.g. good conductor, low resistance, large diameter e.g. low resistance coils, coils wrapped on top of each other, soft iron core, laminated core allow 'steps down voltage'	5

Total 5 marks

Question number			Answer	Accept	Reject	Marks
8	(a)		B			1
	(b)	(i)	Word equation or $V_pI_p = V_sI_s$;	$V_p/V_s = I_s/I_p$ or $V_s/V_p = I_p/I_s$ or $I_1V_1 = I_2V_2$		1
		(ii)	Correct equation substituted OR rearranged; Answer; Vp/Vs = Is/Ip or Vs/Vp = Ip/Is e.g. 230 x 0.25 = 12 x I_s , so I_s = (230 x 0.25) ÷ 12 = 4.8 (A)	Bald answer;; 4.79 (A) , 4.792 (A)		2
	(c)		Two of MP1 Idea of energy / power lost; MP2 Idea of efficiency ≠ 100%; MP3 Idea of less available energy/power/voltage/current; MP4 Idea of resistance increasing (with temperature);			2
					Total	**6**