Question	Answers	Extra information	Mark	AO / Specification reference
01.1	the potential difference of the mains electricity in the UK is – about 230 V the frequency of mains electricity in the UK is – 50 Hz the mains supply in the UK produces a current that is – alternating		1 1 1	AO1 4.2.3.1
01.2	Earth **or** neutral Earth; neutral in any order live; neutral in any order	either order either order	1 1 1	AO1 4.2.3.1
01.3	if the casing on an appliance becomes live, the earth wire conducts the current safely to earth	do not accept 'for safety' do not accept 'to protect the user'	1	AO1 4.2.3.1
02.1	power = potential difference × current = 6 V × 1.5 A (= 9 W)	accept P = I × V	1 1	AO1 AO2 4.2.4.1
02.2	power = $\frac{\text{energy}}{\text{time}}$		1	AO1 4.1.1.4
02.3	$9 = \frac{\text{energy}}{30}$ energy = 9 × 30 = 270 (J)	accept 270 with no working for three marks	1 1 1	AO2 4.2.4.2
02.4	both devices transfer the same amount of energy		1	AO2 4.2.4.2

Question	Answers	Extra information	Mark	AO / Specification reference
03.1	a fault can be caused by the live wire touching the case of the fan the earth wire is connected to the case providing a (low resistance) path to 'earth' so the current flows through the earth wire and not through the person touching the case a large current flows, so the fuse melts so the current stops flowing		1 1 1 1 1	AO1 AO2 4.2.3.2
03.2	make the case of the fan out of plastic/non-conducting material if the live wire touches the case the current will not travel through the case to the person		1 1	AO1 AO2 4.2.3.2
03.3	power = potential difference × current = 230 × 4.5 = 1035 W = 1000 W (to two significant figures)		1 1 1	AO1 AO2 4.2.4.1

Question	Answers	Extra information	Mark	AO / Specification reference
03.3	power = current^2 × resistance energy = power × time energy = current^2 × resistance × time 5.4 = 5^2 × resistance × 0.63 resistance = $\frac{5.4}{5^2 \times 0.63}$ = 0.3428 = 0.34 Ω (to two significant figures) **or** $P = \frac{E}{t}$ and $P = I^2 \times R$ $\left(P = \frac{5.4}{0.63}\right)$ = 8.57 W $\left(R = \frac{P}{I^2}\right) = \frac{8.57}{5^2}$ = 0.3428 R = 0.34 Ω (to two significant figures)	one mark for evidence of combination of two equations	1 1 1 1 1 **or** 1 1 1 1 1	AO1 AO2 4.2.4.1
04.1	a transformer changes the potential difference/steps a potential difference up or down		1	AO1 4.2.4.3
04.2	**Level 3**: Detailed explanation of why the National Grid uses a higher potential difference. Calculation of the current in each wire. Calculation of power loss in each wire.		5-6	AO3 4.2.4.3
	Level 2: Explanation of why the National Grid uses a higher potential difference. Calculation of the current in each wire or an attempt at calculation of power loss in each wire		3-4	

Question	Answers	Extra information	Mark	AO / Specification reference
	Level 1: Basic comments about a higher potential difference means a smaller current/less energy wasted as heat **or** attempt at calculating the current in one wire.		1-2	
	No relevant content.		0	
	Indicative content: • transmitting power at a higher potential difference means that the current is smaller • the wires have a resistance, so they will get hot • so there is less energy transferred to the thermal store of the surroundings • at a power of 80×10^6 W and a potential difference of 400 000V the current in the wire is: • current = $\frac{\text{power}}{\text{potential difference}} = \frac{80\times10^6}{400000}$ = 200 A • and power loss is: $P = I^2 \times R = 200^2 \times 4 = 1.6 \times 10^5$ W • At a power of 80×10^6 W and a potential difference of 4000 V, the current in the wire is: current = $\frac{\text{power}}{\text{potential difference}} = \frac{80\times10^6}{4000}$ = 20 000 A • and power loss is: $P = I^2 \times R = 20\,000^2 \times 4 = 1.6\times10^9$ W			

Question	Answers	Extra information	Mark	AO / Specification reference
05.1	power = current × potential difference	accept P = V × I	1	AO1 4.1.1.4
05.2	potential difference of the mains = 230 V power = 2 kW = 2000 W 2000 = current × 230 current = $\frac{2000}{230}$ = 8.69 A = 8.7 A (to two significant figures)		1 1 1 1 1 1	AO1 AO2 4.2.4.2
05.3	potential difference = current × resistance	accept V = IR	1	AO1 4.2.1.3
05.4	230 = 8.69 × resistance resistance = $\frac{230}{8.69}$ = 26.47 Ω = 26 Ω (2 sf) **or** 2000 = $(8.69)^2$ × resistance resistance = $\frac{2000}{8.69^2}$ = 26.48 Ω = 26 Ω (to two significant figures)		1 1 1 1 **or** 1 1 1 1	AO2 4.2.1.3 4.2.4.1
05.5	energy transferred by kettle = power × time	accept E = P × t	1	AO1 4.2.4.2

Question	Answers	Extra information	Mark	AO / Specification reference
05.6	E = 2000 × 2 × 60 = 240 000 J for toaster: 240 000 = 1200 × time time = $\frac{240000}{1200}$ = 200 seconds = 3 minutes 20 seconds.		1 1 1 1 1 1	AO1 AO2 4.2.4.2
05.7	yes they both transfer energy from a chemical/nuclear energy store (in the power station) to the thermal energy store (of the surroundings) by an electric current	no mark for 'yes'	1 1	AO1 AO2 4.2.4.2
06.1	2000 W means 2000 joules of energy are transferred per second/unit time		1	AO1 4.2.4.2
06.2	230 V means 230 joules of energy are transferred by each coulomb of charge (that flows in the circuit)		1	AO1 4.2.4.2
06.3	energy = power × time	accept E = P × t	1	AO1 4.2.4.2
06.4	E = 2000 W × 5 mins × 60 s = 600 000 (J)	accept 600 000 with no working for two calculation marks	1 1	AO1 4.2.4.2
06.5	energy = charge × potential difference	accept E = Q × V	1	AO1 4.2.4.2

Question	Answers	Extra information	Mark	AO / Specification reference
06.6	600 000 = charge × 230 charge = $\frac{600000}{230}$ = 2608.7 (C)	accept 2609 with no working for three marks	1 1 1	AO2 4.2.4.2
07.1	National Grid		1	AO1 4.2.4.3
07.2	both transformers change the potential difference the transformer near the power station/transformer 1 is a step-up transformer/increases the potential difference the transformer near the house/transformer 2 is a step-down transformer/decreases the potential difference		1 1 1	AO1 4.2.4.3
07.3	(the energy is transferred at a high potential difference so) the current is small so the energy/power/heat lost is small		1 1	AO1 4.2.4.3
08.1	230 V for all appliances this is the potential difference of the mains		1 1	AO1 4.2.3.1 4.2.4.1
08.2	thermal (energy store)		1	AO1 4.2.3.1 4.2.4.1

Question	Answers	Extra information	Mark	AO / Specification reference
08.3	iron → hairdryer → toaster the current is proportional to the power if the potential difference is constant or $I = \frac{P}{V}$		1 1	AO2 4.2.4.1
08.4	$2000 = 8.7^2 \times$ resistance resistance = $\frac{2000}{8.7^2}$ = 26.4 = 26 (Ω)		1 1 1 1	AO2 4.2.4.1
09.1	the energy from the Sun will not run out (in the immediate future)		1	AO1 4.1.3
09.2	4×10^{26} (W)		1	AO1 4.2.4.2
09.3	energy per year = power × time $= 500 \times 3.1\times10^7$ $= 1.55 \times 10^{10}$ (J)		1 1	AO2 4.2.4.2
09.4	area needed = $\frac{7\times10^{18}}{1.55\times10^{10}}$ $= 4.5\times10^8$ (m^2)		1 1	AO2 4.1.3

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Specification reference</th></tr>
<tr><td>10.1</td><td>power = potential difference × current
9000 = 230 × current
oven current = $\frac{9000}{230}$
= 39 A</td><td></td><td>1
1
1</td><td>AO1
AO2
4.2.4.1</td></tr>
<tr><td>10.2</td><td>toaster current = $\frac{2000}{230}$
= 8.7 A
the current in the oven is over four times bigger</td><td></td><td>1+1
1
1</td><td>AO2
AO3
4.2.4.1</td></tr>
<tr><td>10.3</td><td>the current is very large, so the heating effect is very big
the wire needs to be thicker so that there is less resistance and so less heating in the wire/the wire does not melt</td><td></td><td>1
1</td><td>AO2
4.2.4.1</td></tr>
<tr><td>10.4</td><td>there is an earth wire connected to the casing of an appliance
through which current flows if the casing becomes live/connected to the live wire</td><td></td><td>1
1</td><td>AO1
AO2
4.2.3.2</td></tr>
<tr><td>11.1</td><td><table><tr><th>Metal rod</th><th>Time for nail to fall off in s</th><th>Time for nail to fall off in s</th><th>Time for nail to fall off in s</th><th>Mean time for nail to fall off in s</th></tr><tr><td>1</td><td></td><td></td><td></td><td></td></tr></table></td><td>one mark for evidence of metal rod as independent variable/in the first column
one mark for evidence of repeat readings
one mark for evidence of calculation of mean</td><td>3</td><td>AO1
AO2
4.1.2.1</td></tr>
</table>

Question	Answers	Extra information	Mark	AO / Specification reference
11.2	**two** from: • distance of nail from end of rod • Bunsen burner, type/air hole position/position on rod • amount of wax on nail • size/material/mass of nail • initial temperature of nail	one mark for each correct answer up to a maximum of two marks	2	AO3 4.1.2.1
11.3	the control variables are difficult to control leading to a big uncertainty in the data produced		1 1	AO3 4.1.2.1
11.4	use a different method for working out when the end of the rod has got hot e.g., thermal paint, temperature sensor attached to the rod		1	AO3 4.1.2.1
12.1	($E_p = 0.5 \times k \times e^2$) $= 0.5 \times 500 \times 0.01^2$ = 0.025 J	accept 0.025 (J) with no working for two marks	1 1	AO2 4.1.1.2
12.2	at the top of the first bounce there is more energy in the gravitational potential energy store at the top of the second bounce the energy has been transferred to a gravitational potential energy store and the thermal energy store of the surroundings there is less energy in the gravitational potential energy store, so the second bounce is not so high		1 1 1	AO1 AO2 4.1.1.1 4.1.1.2
12.3	energy is transferred by forces/mechanically and by heating		1 1	AO1 AO2 4.1.1.1