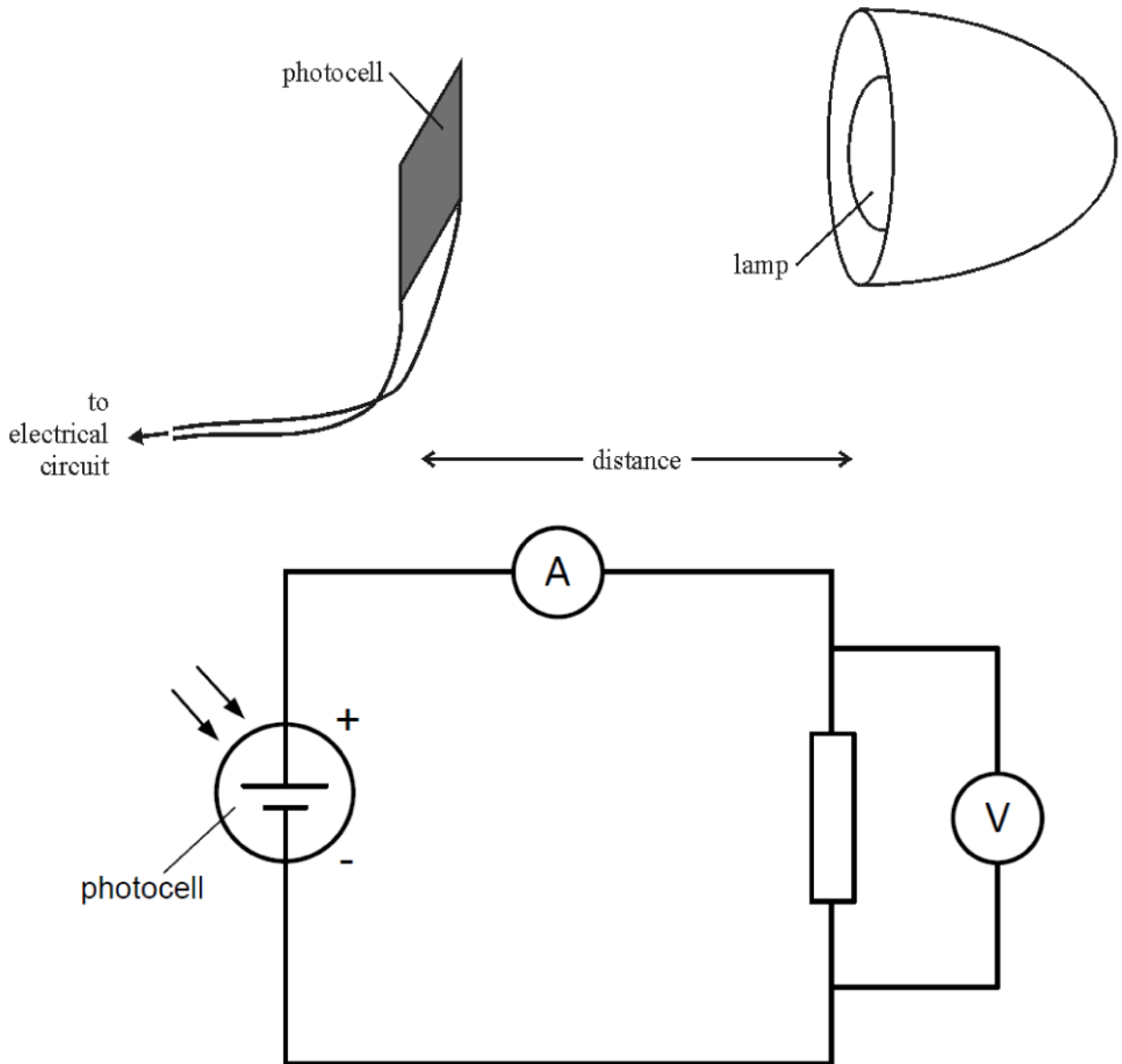1(a). Sam is doing an experiment to investigate the output of a solar panel. She is using a small photocell to model the panel.

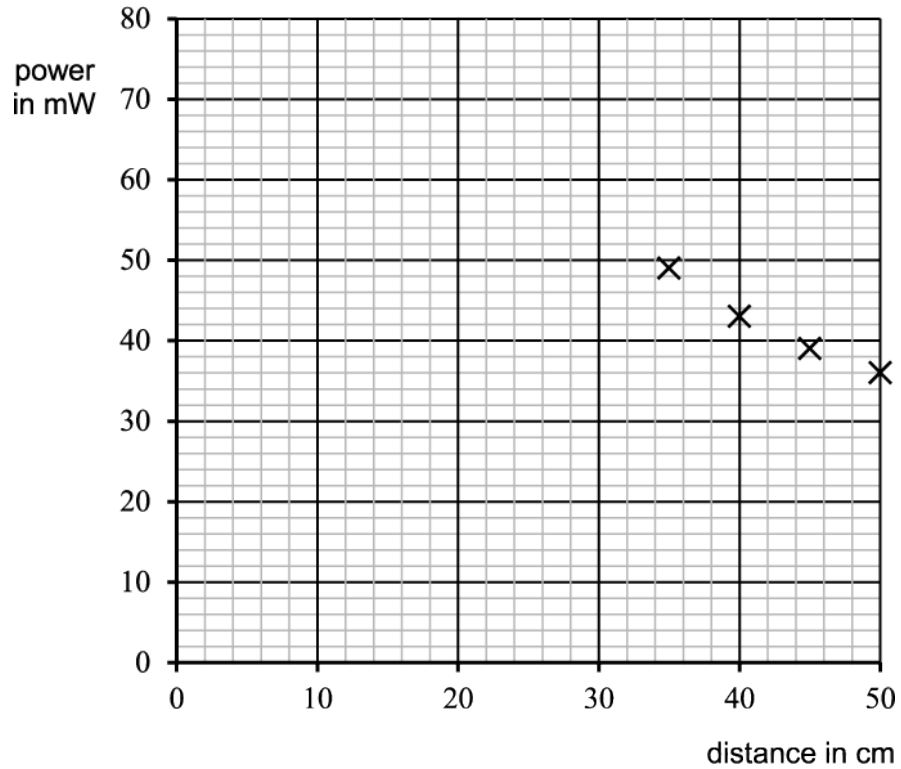She is measuring the power output of the photocell when it is different distances from a lamp, as shown below.

Sam obtained a range of values of power at different distances, as shown in the table below:

distance (cm)	25	30	35	40	45	50
power (mW)	72	57	49	43	39	36

Four data points have been plotted on the graph axes below.

(i) Plot the remaining two data points and add a best-fit curve.

[2]

(ii) What does the graph show?

_____

_____[1]

(iii) At a distance of 25 cm the power was 72 mW. The voltage across the photocell was recorded as 12 V. Using the equation: power = potential difference × current, calculate the current through the photocell.

_____ A [4]

(iv) Calculate the resistance in Ohms of the photocell using the equation: potential difference = current × resistance.

_____ Ω [3]

(b). Describe how this experiment should be completed to get a good, reliable set of data.

_____

_____

_____

_____ **[4]**

(c). Tom has done an identical experiment to Sam's in a **different part** of the same lab.
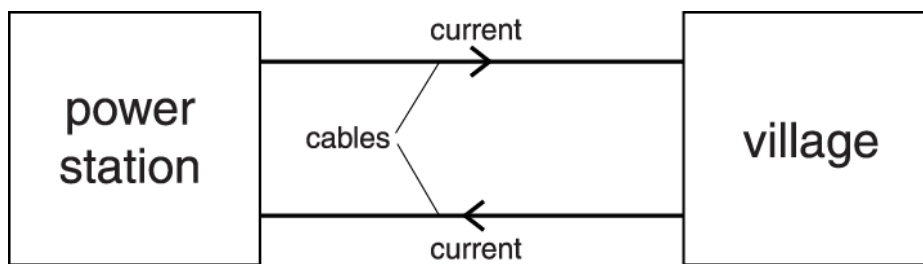
He used an identical lamp, photocell and resistor, but his values of power were much lower than Sam's for the same distances.

He thinks that his part of the lab must have been different from Sam's.

Suggest and explain a reason for the difference in their results.

_____

_____

_____

_____ **[2]**

2. The diagram shows a small village being supplied by electricity from a power station.

Not all of the energy transferred by the power station reaches the village. Some of the energy heats up the cables.

The power station could transfer the energy at 250 V or at 2500 V.

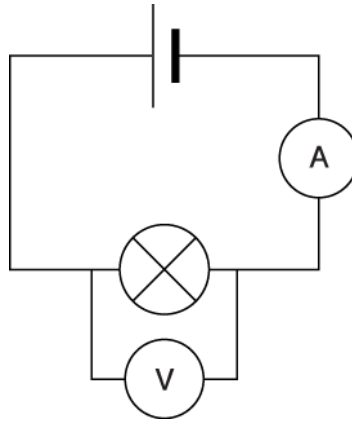For the arrangement shown in the diagram, the power that heats up the cables is given by the equation

power wasted in heating cables in W = 0.2 × (current in A)^2

Use this information to complete the table below.

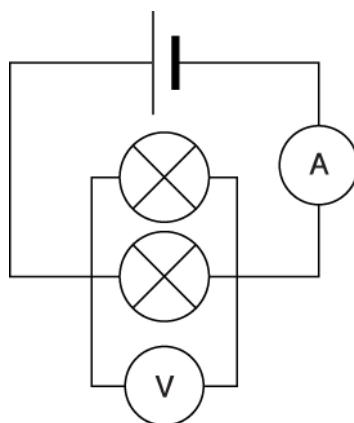| Power produced at power station in W	Voltage generated in V	Current produced in A	Power wasted in heating cables in W	Power delivered to village in W
100 000	250	400	_____	_____
100 000	2500	40	_____	_____

[2]

3(a). Jason sets up the following circuit.

Jason measured the voltage across the lamp to be 1.5 V, and the current through it to be 0.5 A.

Draw a line from each **quantity** to the correct **value**.

quantity	**value**
	0.33
power (W)	0.75
	1.00
resistance (Ω)	2.00
	3.00

[2]

(b). Jason adds another identical lamp to the circuit, in parallel with the first one.

State and explain what happens to the readings on the meters.

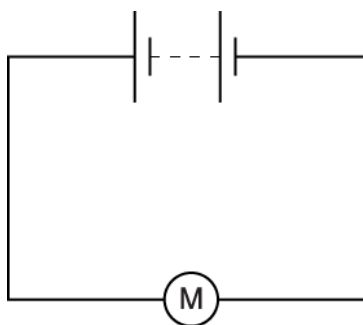-- [3]

4. Tim builds a circuit to test a motor.

He decides to increase the voltage.

(i) He tries adding an identical battery in **parallel** with the first battery.

What will happen to the voltage and the current in the circuit?
Put a tick (✔) in the box next to the correct answer.

voltage increases, current increases ☐

voltage increases, current stays the same ☐

voltage decreases, current increases ☐

voltage stays the same, current stays the same ☐

[1]

(ii) Tim tries using a transformer to change the voltage.
The transformer does not work in this circuit.
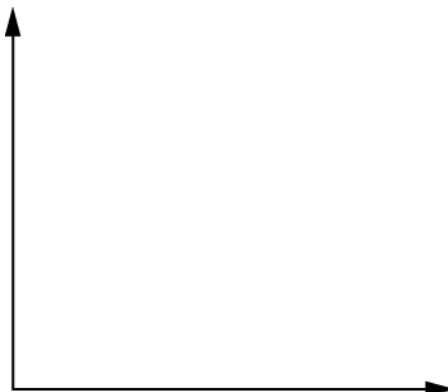Explain why.

---[2]

5(a). This data shows the relationship between the current in a wire and the power lost by the wire.

Current in amps	Power lost in watts
0.5	1
1.0	4
1.5	9
2.0	16

Sketch a graph of these results on the axis below.

You do not need to plot any points.

[3]

(b). Edward looks at the data and draws conclusions.

> There is a correlation between the current and the power lost.
>
> The current is directly proportional to the power lost.

Is Edward correct?

Justify your answer.

--- **[3]**

[Total: 6]

6.   This question is about electric kettles.

A kettle is plugged into a domestic mains socket. It draws a current of 12 A.

What is the power, in **kilowatts**, of this kettle?

Put a (ring) around the value **nearest** to the power in kilowatts.

3   12   230   3000

[1]

7.   A toothbrush uses a rechargeable battery.

The potential difference across the battery is 1.2 V.

During a typical use, 360 C of charge moves through the toothbrush motor over a time of 2 minutes.
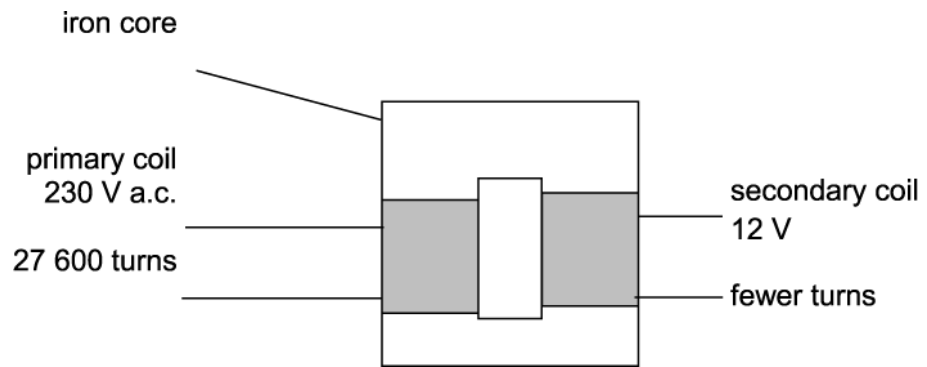
(i) Calculate the total energy transferred by the toothbrush in one day if it is used **two** times a day.

Energy transferred = ... J **[3]**

(ii) Calculate the current in the toothbrush when used for 2 minutes each time.

Current = ... A **[4]**

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8. This is a diagram of a simple transformer.

iron core

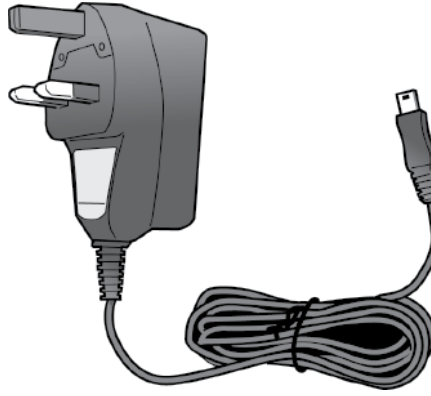primary coil
230 V a.c.

27 600 turns

secondary coil
12 V

fewer turns

The secondary coil produces an output of 12 V.

Calculate the number of turns needed on the secondary coil.

number of turns = _ [2]

9. A mobile phone manufacturer is designing a charger for a new phone.

The charger will plug into the 230 V mains supply, and will change the voltage to 12 V.

The charger consists of a transformer with two coils of wire around an iron core.

The table shows two different pairs of coils which could be used in this transformer.

Complete the table.

Number of turns in primary coil	Number of turns in secondary coil
3450	_____
_____	600

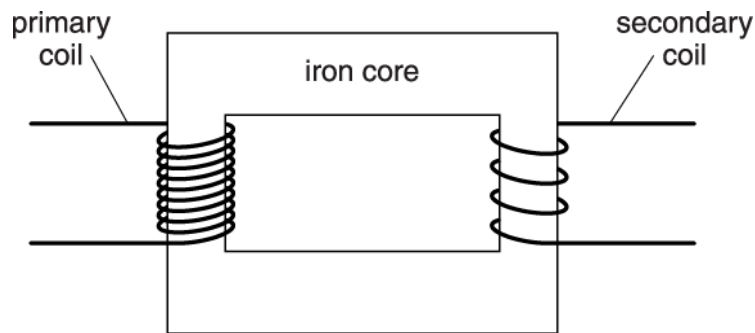[2]

10.

(i) What can transformers do?

Complete the sentence.

Draw **one** line to connect the correct **start** of the sentence to the correct **end** of the sentence.

start

| Transformers can only increase the size … |
| Transformers can only decrease the size … |
| Transformers can either increase or decrease the size … |

end

| … of an alternating voltage. |
| … of a direct voltage. |
| … of an alternating or direct voltage. |

[1]

(ii) The diagram below shows the basic construction of a transformer.

primary coil   iron core   secondary coil

Complete the sentences below to describe how the transformer works.

Choose the correct letters from the list.

One of the letters will not be used.

P	changing voltage across the secondary coil
Q	changing current in the secondary coil
R	changing magnetic field in the core
S	constant magnetic field in the core
T	changing voltage across the primary coil
U	changing current in the primary coil

A _____ causes a _____ which causes a _____ .

This will induce a _____ which causes a _____ .

[3]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1	a	i	Both points correctly plotted (1) Smooth curve drawn (1)	2	
		ii	Power goes down with distance (non-uniformly) (1)	1	**allow** negative correlation correctly described
		iii	**FIRST CHECK ANSWER ON ANSWER LINE** If answer = 6 × 10⁻³ (A) award 4 marks Rearrange equation to give: Current = Power ÷ Potential difference (1) Converts mW to W = 0.072 W (1) = 0.072 (w) ÷ 12 (V) (1) = 6 × 10⁻³ A (1) Or 6 mA	4	
		iv	**FIRST CHECK ANSWER ON ANSWER LINE** If answer = 2000 (Ω) award 3 marks Rearrange equation to give resistance Resistance = Potential difference ÷ current (1) = 12 (v) ÷ 6 × 10⁻³ (A) (1) = 2000 (Ω) (1)	3	
	b		Lamp at fixed distance from photocell and read I and V (1) Repeat reading at each distance (1) Repeat for any outliers (1) Take mean I and V for each distance (1)	4	

Question			Answer/Indicative content	Marks	Guidance
	c		Recognises that Tom's photocell is getting less light (1) Suggested reason (1)	2	e.g. Sam was near a window (so more light) while Tom was in a dark corner; allow systematic mismeasurement of distance by one or the other if correctly justified e.g. the end of Sam's ruler wasn't near the actual lamp but some distance from it, so all her distances are too small. **allow** any situation where Tom would receive less light than Sam.
			Total	16	
2			$0.2 \times 400^2 = 32000$ W so P delivered = 68 000 W $0.2 \times 40^2 = 320$ W so P delivered = 99 680 W (2)	2	one correct calculation of P wasted is enough for (1) all four powers correct for (2) **Examiner's Comments** The calculations of power wasted and power delivered were generally well done, but only the best candidates carried these forward in to the descriptive.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
3	a		power (W) — 0.75 0.33 0.75 1.0 resistance (Ω) — 3.0 2.0 3.0	2	**Examiner's Comments** The descriptions of the calculations were consistently answered correctly by all but the very weakest candidates
	b		V is the same / I gets bigger why voltage stays the same why current goes up (because resistance is lower)	3	e.g. voltage is the same – as the same number of batteries / cells current is higher – as resistance is lower resistance is lower – as more paths (for charges) current is higher as more paths (for charges) gains one mark if no mention of resistance **accept** higher level answers regarding internal resistance / delivery of current **ignore** mention of lamps and brightness **Examiner's Comments** Understanding of parallel circuits was very weak, with many candidates unable to differentiate between the voltage and the current correctly. Almost no responses were seen which considered the effect on the overall resistance of the circuit.
			Total	5	

Mark Scheme

Question			Answer/Indicative content		Marks	Guidance
4		i	voltage increases current increases		1	**Examiner's Comments** The majority of candidates chose an incorrect answer.
			voltage increases current stays the same			
			voltage decreases current increases			
			voltage stays the same current stays the same	?		
		ii	battery produces d.c. / this circuit is d.c. (1) a.c / varying current is required for transformer (to work) (1)		2	**Examiner's Comments** This was poorly answered by most candidates. Many thought that the transformer did not work because it was a series circuit, or the voltage was too low, or because there was a motor in the circuit. Those who gave a correct response usually stated that transformers require ac, but some failed to state that the battery gave dc.
			Total		**3**	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
5	a		axes labelled – power (lost), current	1	units not required, **not** just scales **allow** units instead of quantity i.e. amps instead of current, and joules or J/s or watts for power lost **accept** power or current as vertical axis
			line going up to the right	1	**accept** attempt to plot the points without a line
			curves towards the power axis / away from current axis	1	use scales on axes to identify curvature if no labels line does not have to go through the origin a bar chart can score mp1 and mp3 **Examiner's Comments** Many candidates drew a straight line on the graph. Some candidates thought that sketch meant that axes did not need to be labelled.
	b		**any 3** correlation comment is correct / there is a correlation because as current increases so does power directly proportional is incorrect / it isn't directly proportional because power does not double as current doubles / not a straight line / line is a curve / square relationship	3	**not** just he is correct; **accept** his first comment is correct **not** just he is wrong; **accept** his second comment is wrong **Examiner's Comments** Responses were not explicit enough where the answer 'yes' or 'no' was given. In such questions, where there are two statements to be considered, candidates need to say to which one they are referring. Correlation was better understood than direct proportion. Some candidates tried to give reasons for the relationship rather than answer the question. There were a few good answers that described the square relationship clearly.
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
6			3	1	**Examiner's Comments** This was an objective question, so few candidates left it blank. This question, requiring the candidates to calculate power and then convert from watts to kilowatts, was not well done.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7		i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 864 (J) award 3 marks** recall **and** rearrange equation: energy = p.d. × charge ✓ substitution 2 × 1.2 × 360 ✓ = 864 (J) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	Equations used to calculate energy must have energy as the subject (accept W for E). **ALLOW** E= ItV **and** Q = It / E = Pt **and** P = VI and Q = It / 360 × 1.2 seen Correct substitutions gain m.p 1 also **DO NOT ALLOW** bald '86400' or '1728' or '432'. Credit can only be given for working <u>Examiner's Comments</u> The higher ability candidates recalled the equation: E = QV, converted minutes to seconds and then doubled their answer in recognition of the toothbrush being used twice. Lower ability candidates missed one or more of these steps.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3.0 (A) award 4 marks** Recall **and** rearrange: current = charge / time ✓ Convert 2 minutes = 120 s ✓ = 360 / 120 ✓ = 3.0 (A) ✓	4 (AO 1.2) (AO 2.1) (AO 2.1) (AO 2.1)	**ALLOW** 3 marks for 180 (unit conversion omitted) **ALLOW** '3 (A)' <u>Examiner's Comments</u> The higher ability candidates were able to arrange the equation into the form *I* = Q/t, convert the 2 minutes to 120 seconds and use charge = 360 C to calculate their answer. Many of the responses of lower ability candidates seemed to indicate that they did not understand the question structure ((i), (ii) etc.), which meant that they did not attempt to use the information provided in the stem of 2b.

Question			Answer/Indicative content	Marks	Guidance
			Total	7	
8			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1 440 (turns) award 2 marks $\dfrac{230}{27600} = \dfrac{12}{X}$ (1) **OR** $\dfrac{230 \times 12}{27600}$ / **AW** (1) 1 440 (turns) (1)	2	
			Total	2	
9			<table><tr><td>primary coil</td><td>secondary coil</td></tr><tr><td>(3450)</td><td>180</td></tr><tr><td>11500</td><td>(600)</td></tr></table>	2	**allow** 1 mark for correct numbers in wrong positions **allow** candidate answers which round to the correct answers <u>Examiner's Comments</u> This question was well answered by a minority of candidates, who made good use of the formulae provided and showed evidence of their working out. Rounding errors were not penalised where it was possible to see how the answer was derived. The small number of candidates that calculated the correct values but wrote them in the wrong places were allowed 1 mark.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
10		i	Transformers can only increase the size… — …of an alternating voltage. / Transformers can only decrease the size… — …of a direct voltage. / Transformers can either increase or decrease the size… — …of an alternating or direct voltage. (line from "Transformers can either increase or decrease the size…" to "…of an alternating voltage.")	1	
		ii	TURPQ in correct order (3)	3	TU in correct space 1 mark PQ in correct space 1 mark R in the middle 1 mark **allow** PQSTU 1 mark **allow** PQRTU 2 marks **Examiner's Comments** This question started well for most, but the sequencing of stages in the operation of a transformer proved too challenging for most candidates.
			Total	**4**	