Mark scheme

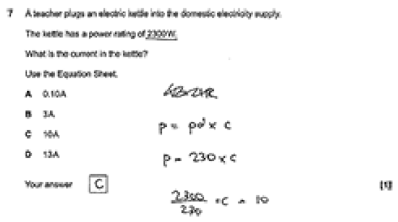
Question			Answer/Indicative content	Marks	Guidance
1	a		Mistake: filament lamp ✓ Correction: diode ✓ **AND** Mistake: thermistor ✓ Correction: light dependent resistor / LDR ✓ **OR** Mistake: light intensity ✓ Correction: temperature ✓	4 (AO 3.2a) (AO 1.1) (AO 3.2a) (AO 1.1)	**ALLOW** light emitting diode or LED **ALLOW** Thermistor changes with temperature not with light ✓✓ **ALLOW** light for light intensity **ALLOW** thermal energy for temperature __**Examiner's Comments**__ Candidates should be encouraged to read the question carefully - in this case reference was made to the components. The majority of candidates identified that the thermistor should be replaced with a light dependent resistor or the thermistor changes as the temperature changes. Heat intensity did not gain credit. Identifying the diode for the filament lamp appeared to be more challenging. In a number of scripts, 'no current' was suggested as the mistake with 'a little current' as the correction.
	b		**First check the answer on the answer line** **If answer = 15 (A) award 3 marks** (P = IV) (I =) P ÷ V ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**ALLOW** 1 mark for correct substitution into unrearranged equation

			(I =) 180 ÷ 12 ✓ (I =) 15 (A) ✓		**<u>Examiner's Comments</u>** This was very well answered. Candidates should be encouraged to show their working.
	c		**First check the answer on the answer line** **If answer = 240 (J) award 3 marks** (Energy transferred =) VQ ✓ (E =) 12 x 20 ✓ (E =) 240 (J) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**<u>Examiner's Comments</u>** This question was very well answered. Candidates should be encouraged to show their working
			Total	**10**	
2			B	1 (AO 2.2)	**<u>Examiner's Comments</u>** There were two common responses to this question. The correct answer option B and the incorrect option D. It is expected the candidates should understand the conduction in both diodes and light emitting diodes.
			Total	**1**	
3	a		(Idea that) the cells are facing each other / the cells cancel each other out / a (left) cell is connected the wrong way around ✓ Arrange the cells to face in the same direction / turn one / left cell around ✓ <u>Voltmeter</u> is in the incorrect place / not across the diode ✓ Place voltmeter in parallel / across the diode (instead) ✓	4 (4 ×AO 3.3b)	**ALLOW** answers in either order but correction must match the mistake **DO NOT ALLOW** cells incorrectly set up unless qualified **ALLOW** remove the (left) cell **IGNORE** diode in wrong position **ALLOW** swap diode and variable resistor **<u>Examiner's Comments</u>** There were many vague

					responses to this question, for example the diode should have a circle around it. Other incorrect responses included 'the diode is pointing the wrong way' and the ammeter is in the wrong position. High scoring candidates often stated that the cells in the battery were facing each other and that the left hand cell needed to be reversed. Other candidates discussed the position of the voltmeter.
	b	i	0.6 V ✓	1 (AO 2.2)	**Examiner's Comments** The majority of the candidates read the graph correctly as 0.6 V.
		ii	For gradient calculated **First check the answer on answer line** **If answer = 5(.0) (Ω) award 4 marks** Sensible non-zero value from graph ✓ Gradient = 0.2 ✓ Resistance = 1 ÷ gradient / 1 ÷ 0.2 ✓ Resistance = 5(.0) (Ω) ✓ **Or** For direct R = V / I method Sensible non-zero values from graph ✓ Resistance calculation, e.g. 1.1 ÷ 0.1 ✓✓ Value of resistance, e.g. 11 (Ω) ✓	4 (AO 1.2) (AO 2.1) (AO 2.1) (AO 2.1)	Sensible values from graph V / V, I / A, R / Ω: 0.65, 0.01, 65 0.70, 0.02, 35 0.75, 0.03, 25 0.80, 0.04, 20 0.85, 0.05, 17 0.90, 0.06, 15 0.95, 0.07, 13.6 1.00, 0.08, 12.5 1.05, 0.09, 11.6 1.10, 0.10, 11 No **ECF** from incorrect read-off error **Examiner's Comments**

V / V	I / A	R / Ω
0.65	0.01	65
0.70	0.02	35
0.75	0.03	25
0.80	0.04	20
0.85	0.05	17
0.90	0.06	15
0.95	0.07	13.6
1.00	0.08	12.5
1.05	0.09	11.6
1.10	0.10	11

					Many candidates correctly determined the gradient but then did not invert their value to determine the (dynamic) resistance of the diode. Other candidates used the ratio of V / I to determine the (static) resistance of the diode. Either method required candidates to accurately interpret the graph. When reading values from the graph, it is good practice to read off values at gridlines rather than estimating values between gridlines.
			Total	**9**	
4			**A**	1 (AO 2.2)	**<u>Examiner's Comments</u>** Many candidates correctly answered this question. A common error was D where candidates had selected a circuit where the high output voltage would occur when it was light.
			Total	**1**	
5			**C**	1 (AO 2.1)	**<u>Examiner's Comments</u>** This question assessed candidates' recall of the voltage of the mains supply in the UK and rearrangement of the relevant equation from the Equation Sheet. The vast majority of candidates did this successfully. There was evidence that some candidates who chose the incorrect option had tried to use an incorrect equation such as $P = I^2R$. Exemplar 1

					 7 A teacher plugs an electric kettle into the domestic electricity supply. The kettle has a power rating of 2300W. What is the current in the kettle? Use the Equation Sheet. A 0.10A B 3A C 10A D 13A Your answer C [1] This response shows how the candidate identifies the correct equation from the equation sheet, recalls the voltage of the mains supply in the UK and rearranges the equation to calculate the current in the kettle.
			Total	**1**	
6			Power supply attached to electric heater **AND** correct symbol for ammeter in series with heater ✓ Correct symbol for voltmeter in parallel with heater or power supply ✓	2 (2 × AO1.2)	Maximum of 1 mark if a line drawn through the ammeter and/or voltmeter **IGNORE** extra ammeters/other components in series **ALLOW** 1 mark for incorrect symbols for ammeter and voltmeter in the correct places
			Total	**2**	
7		i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 70 (A) award 2 marks** Rearrangement: Current in secondary coil = current in primary coil × potential difference across primary coil ÷ potential difference across secondary coil **OR** 2800 × 900 ÷ 36000 ✓ (Current in secondary coil =) 70 (A) ✓	2 (2 × AO2.1)	**ALLOW** rearranged equation in symbols or numbers **<u>Examiner's Comments</u>** This question required candidates to identify the correct equation from the Data Sheet, which made the question more accessible.
		ii	**Any three from:** It is a <u>step-up</u> transformer / to	3 (3 × AO1.1)	**ALLOW** voltage

			increase p.d. ✓ Decrease current (in power lines) ✓ less energy wasted/lost / less heat in power lines / less thermal transfer ✓ (idea that) power loss depends on current^2 ✓		**ALLOW ORA** for high current **IGNORE** just ideas about efficiency **DO NOT ALLOW** so no power wasted / no energy wasted (as heat in power lines) / no thermal transfer **IGNORE** less power loss **<u>Examiner's Comments</u>** Many candidates gained 1 mark for the idea of less energy lost (as heat) but only the more successful responses were able to link this to higher voltages resulting in a lower current.
		iii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.25 (Ω) award 3 marks** Rearrangement: resistance = power ÷ (current)^2 ✓ (Resistance =) 864 900 ÷ 1860^2 or 864 900 ÷ 3 459 600 ✓ (Resistance =) 0.25 (Ω) ✓	3 (1 × AO1.2) (2 × AO2.1)	**Allow** ¼ (Ω)
			Total	**8**	
8			**Level 3 (5–6 marks)** Comparisons between the two sets of data and with the manufacturer's data in terms of accuracy **AND** comparison in precision of the two sets of data. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.*	6 (1 × AO3.1a) (1× AO3.1b) (2× AO3.2a) (2 × AO3.2b)	**AO3.1a/3.1b Analyse information to interpret and evaluate the accuracy and precision of the data.** For example • P has taken 3 readings, but Q has taken 5 readings • Different lengths of wire have been used • P lengths recorded to nearest cm; Q lengths recorded to nearest mm or different sig figs /decimal places

			Level 2 (3–4 marks) Comparisons between the accuracy of the two sets of data or with the manufacturer's data **AND** a simple comparison in precision of the two sets of data **OR** A comparison between the accuracy of the two sets of data or with the manufacturer's data **AND** comparison in precision of the two sets of data *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** There is a simple comparison between the two sets of data or with the manufacturer's data **OR** a simple explanation is given about accuracy or precision *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 mark** *No response or no response worthy of credit.*		• Resistance data has been recorded to differen numbers of sig figs/decimal places • Both sets of data have repeat readings and calculated the mean **AO3.2a Analyse information to make judgements about the accuracy and precision of the data.** For example • P has unequal intervals / Q has equal intervals (10cm) between the readings • P has small range (9cm), Q has large range (50cm) • P has recorded their resistance data to zero decimal places • Q has repeat resistance readings closer together • For Q, resistance per length are similar • Reading for P 15 cm mean resistance is more than for 19 cm **AO3.2b Analyse information to draw conclusions about the accuracy and precision of the data.** For example: • Q is more accurate since resistance per unit length is closer to the true value of 1.2 Ω / cm • Q is more accurate as Q used longer lengths of wire (which reduces the heating effect) • Q's readings are more precise as the repeat

					readings are closer together **Examiner's Comments** This question required candidates to compare the data of the two tables and explain which data is more accurate and more precise. This question tested the language of measurement in scientific investigations. This type of question is deliberately open ended to give candidates the opportunity of structuring their answers. A useful way for candidates to answer this type of question is to start by explaining the meaning of the word accurate and the word precise. There were then many comparisons that candidates could make using the data. When answering this type of question candidates should be encouraged to support their answers with evidence. Ideally each comparison should then link with whether this indicated that the data is more / less accurate or more / less precise. High scoring candidates often calculated the mean values of the resistance per unit length – often by the table of results. Some candidates effectively wrote notes on the two tables of results and based their answers on these notes. Exemplar 1

					Students Q's data is both the most accurate and precise. Firstly this is because student Q had two more lengths included in the data than Student P, meaning they can see if there is too much range in the values of resistance per unit length. Additionally, the lengths increase by a set amount of 10cm rather than it being added randomly like it was done in student P's data. Student P also made errors in his mean calculations; the values include too much range, they could be counted as anomalies, which are supposed to be ignored. This shows how student Q's results are more accurate as the values are more close to one another. Finally, the range in the final resistance per unit length is much greater in student P's data showing how it is not as precise as student Q's data, which is also closest to the manufacturer's value of 1.25Ω/cm. In this response the candidate makes a general opening comment about Q's data being more accurate and precise – this on its own is vague since it does not address the meaning of accurate and the meaning of precise. There is then an irrelevant section referring to the lengths increasing by a set amount. The student then compares the data but lacks detail on why the mean calculations are incorrect. The final paragraph makes it clear that the candidate understands preciseness and then discusses closest to the true value. Overall, there is some confusion between accuracy and precision so Level 2. The communication statement is met so 4 marks were given. **Misconception** Candidates are often confused between the terms accurate and precise. To assist candidates there is a useful

					publication – Language of measurement.
			Total	**6**	
9			A ✓	1 (AO2.1)	**Examiner's Comments** For this type of question candidates need to eliminate incorrect responses. High scoring candidates often worked out the values for each combination before making their choice. Most candidates realised that B could not be the correct answer.
			Total	**1**	