OCR GCSE GATEWAY PHYSICS A · J249

PHYSICS



MARK SCHEME

P3.2 SIMPLE CIRCUITS

SCORE	PERCENTAGE
/264	%

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Question			Answer/Indicative content	Marks	Guidance
1		i	Simple use of P = V × I / idea of ratios using transformer equations (1) Current reduced by 16 times (1)	2	**ALLOW** current reduced (1)
		ii	Very large decrease in power loss (1) Power loss is related to the square of the current / **AW** (1)	2	
			Total	**4**	
2	a		(Highest current is the) oven [1] 7.83 (A) [2] 1800 / 230 [1]	3	More or less than 2 decimal places or incorrect 2 decimal places scores maximum of [1] for calculation **eg.** 7.826087 / 7.826 / 7.82 / 7.8 [1] **allow** if incorrect appliance selected allow correct calculation of current e.g. **grill 6.52** (A) / **laptop charger 5.00** (A) / **slow cooker 2.00** (A) [2] correct substitution for incorrect appliances can score [1] **Examiner's Comments** This was a 7-mark question on using and providing electricity in the home. It was common to see 3 to 5 marks scored overall. This was well answered with 3 marks being frequently seen for the oven identified and the calculation correct. Often though [2] would be scored for failing to round the answer correctly to 2 decimal places (a common answer that falls into this category was 7.82 rather than 7.83).

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Question			Answer/Indicative content	Marks	Guidance
	b		540 (pence) or £5.40 [2] but if answer is incorrect either 20 x 18 x 1.5 [1] or 20 x 18 x 1500 [1] or 540000 (pence) or £5400 [1] or 1.5 x 20 or 30 [1]	2	5.4 scores [1] Examiner's Comments This was poorly answered with only about a quarter calculating 540 pence or £5.40 [2]. A common answer was 1080. Many scored zero as candidates struggled to convert units and many doubled the power or time etc. Presumably they thought this was necessary as the time given for the grill was 0.5 hours.
			Total	5	

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Question			Answer/Indicative content	Marks	Guidance
3	a		any two for one mark from low maintenance / no cable required / no need for fuel or mains / long life / renewable energy source / idea of no polluting **waste** [1]	1	Eg. 'Don't need to burn fossil fuels to produce electricity' [1] **Ignore** sustainable **Eg.** no CO_2 / acid rain / SO_2 / NOx [1] **Allow** no carbon emissions (when in use) [1] **Ignore** merely 'environmentally friendly / less or no pollution' **Examiner's Comments** This 5-mark question was about using photocells to power a road sign. Most scored 3 or 4 marks overall. In parts a. and c. many candidates lost marks because their answers were not written with technically correct language. 'Generating electricity' or 'catching the light' were common phrases that did not gain any credit. Candidates needed to give two advantages for the mark. Some answers were too vague with 'less / no pollution'. Better answers referred to no CO_2 produced / renewable / low maintenance / robust / long-lasting, etc. Often candidates failed to score a mark as they only had one correct answer – e.g. Renewable and less pollution [0].
	b		light / photons absorbed by silicon (atoms) [1]	2	**allow** light absorbed by photocell [1]

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Question			Answer/Indicative content	Marks	Guidance
			electrons knocked out (of silicon atoms in crystal) [1] (causing) current or electrons to move / flow [1]		**allow** 'free electrons' [1] (for electron flow mark) Examiner's Comments This was quite well answered most scored at least one mark for the idea of light being absorbed by the photocell or silicon. Some explained about the electrons being knocked from the silicon atoms [1] and some referred to the electrons moving around the circuit [1]. Some vague answers had 'sunlight hits or touches the photocell' [0] and light is generated [0]. Some answered in terms of p-n but often gained the marks of electrons knocked [1] and electrons flowing [1] around the circuit.
	c		larger area produces more current / energy / power **OR** larger area absorbs more light / energy / power (from the sun) / AW [1]	2	**allow** on a cloudy / dull day a large area is needed for **enough or more** energy / current / power [1]

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Question			Answer/Indicative content	Marks	Guidance
			when **angle** of (sun)light is low larger area allows **enough or more** light / energy / current / power [2]		**allow** when sun(light) is low (in sky) larger area allows **enough or more** light / energy / current / power [2] **Examiner's Comments** This was a difficult question about collecting enough sunlight to power the road sign. It was about applying the Physics they knew rather than simply stating it. Many could relate the larger area to collecting more light or producing more energy or electricity [1]. Explaining how enough light could be absorbed from low angles was less well demonstrated. Few could explain the angle of the Sun or explain that more energy could be absorbed by the large area of photocells so there was enough energy to power the sign in low (angled) light. Only a few realised that the Sun moves across the sky. Generally, it was common for only [1] mark to be scored here.
			Total	**5**	

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Question			Answer/Indicative content	Marks	Guidance
4			**Level 3: (5 – 6 marks)** Answer correctly describes that less light increases the resistance of the LDR and **explains** how the potential divider works to increase the voltage output. Quality of written communication does not impede communication of the science at this level. **Level 2: (3 – 4 marks)** Answer correctly describes that less light increases the resistance of the LDR and states that the output voltage increases. Quality of written communication partly impedes communication of the science at this level. **Level 1: (1 – 2 marks)** Answer describes that light (level) changes the resistance of the LDR and states that this turns on the light / changes voltage. Quality of written communication impedes communication of the science at this level. **Level 0: (0 marks)** Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted up to grade A Indicative scientific points may include (but are not limited to) the following: **Level 3** • In low light, resistance of LDR is greater than that of the fixed resistor which gives a higher share of the voltage / ora • In low light, the ratio of the LDR resistance to the fixed resistor increases which gives a higher share of the voltage / ora **Level 2** • LDR resistance is low in light / (very) high in dark • The voltage (output) across LDR increases in dark / ora **Level 1** • LDR resistance changes in light or dark • Voltage (output) depends on (ambient) light / resistance **Use the L1, L2, L3 annotations if needed; do not use ticks.** **Examiner's Comments** This was an intentionally challenging 6-mark level of response question on the operation of a LDR. It discriminated very well at the higher grades of A and A*. Many weaker answers showed a misunderstanding of the operation of a LDR. Some referred to the effect of heat whilst others treated it as a photocell which charged-up during the day so it could release its light in the dark. Candidates were confused with the operation of the potential divider. Weaker answers did not mention the LDR and referred only to the potential divider. Very few correctly related the higher resistance of the LDR with a

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Question			Answer/Indicative content	Marks	Guidance
					high output voltage across the potential divider and a low voltage across R. Candidates often made vague comments about currents through the divider. Many weaker answers said that resistance reduced in the dark. However, these answers generally gained level 1 marks if they related this (incorrect change in resistance) to turning on the light. Many got the dark and resistance change correct but did not relate it to voltages so gained [3] marks.
			Total	**6**	
5	a		20 (?) [2] **but if answer incorrect** evidence of calculating a gradient or correctly substituting the values of one data point into R=V/I [1]	2	 Eg. 3 / 0.15 or 6 / 0.3 scores [1] inspect graph for possible answers **Examiner's Comments** Most calculated the resistance correctly with 20.
	b		Maximum of two from: Steeper / greater gradient scores [1] But gradient is 3 × greater scores [2] need three times the voltage (to get the same current) / current will be 3 times less (for the same voltage) [1]	2	 **allow** correct gradient drawn on graph / line through (0,0) and (0.1,6) [2] eg. 6 / 0.1 or 60 (rather than 20) [1] **Examiner's Comments** This part of the question involved the slope of a graph. Surprisingly large numbers of candidates said less steep. Most candidates said steeper [1] without further qualification. Better answers however stated it would be 3 × steeper [2]. Some answered fully and correctly by drawing on the graph.
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
6			2 (MW) [2] **but if answer is incorrect** 10 000 × 200 **or** 100^2 × 200 [1] **or** 2 000 000 [1]	2	**Examiner's Comments** Most candidates substituted into the correct formula and gained a mark. Surprisingly few converted correctly to MW though. Mega was imperfectly known. Some realised that there should be a power of 10-conversion but went for kilo by mistake. Many failed to attempt a conversion at all.
			Total	2	
7			94 (W) [2] **but if answer incorrect** 20 × 4.7 [1]	2	**Allow** 230 × 4.7 or 1081 scores [1] **Examiner's Comments** This part of the question was common with the foundation paper (B752-01). A mark was often given for 1081. Most however scored [2] with 94 (W).
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
8		i	12 (V) [1]	1	**ignore** any sign e.g. + or – **Examiner's Comments** This question on ac and half wave rectification produced the best and worst responses to questions in the whole paper. Almost all could interpret a graph of ac voltage to correctly state the maximum voltage.
		ii	during **A** and **C** current gets though [1] during **B** and **D** current does not get through [1] **or** during **A** and **C** current does not get though [1] during **B** and **D** current gets through [1]	2	**if no other marks are scored allow** diode allows current to flow in one direction only [1] **Examiner's Comments** This question on ac and half wave rectification produced the best and worst responses to questions in the whole paper. Explaining how a diode can be used to produce half wave rectification proved to be too challenging for almost all candidates. The fact that the graph was of alternating voltage meant that barely any candidates could talk about the action of a diode in only allowing current to flow in one direction and hence leading to a half wave rectified output.
			Total	**3**	

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Question			Answer/Indicative content	Marks	Guidance
9		i	Kenya **and** **high**(est) voltage / **high**(est) number (of volts in table) / 240(V) [1]	1	**Both required for the mark** **Eg.** Kenya has a high number [1] **Allow** since the current is constant it needs a high(er) voltage to get a high(er) power / wtte [1] **Examiner's Comments** This part of the question was common with the foundation paper (B752-01). Mostly it was correct with 'Kenya because it has the highest voltage'. UK was a common wrong answer.
		ii	reducing resistance increases current / ora [1] Higher current gives higher power [1] **more power / current** makes iron hotter or work better or remove creases more easily [1] Japan has lowest voltage so power / current needs to be increased [1]	2	**Allow** variable resistor can give a higher current [1] **BUT ignore** increased resistance increases current **Ignore simply** removes creases / iron hotter / works better **Allow** Lower resistance gives higher power [2] **Allow** higher level answers in terms of I^2R or IxV **Examiner's Comments** Weaker answers failed to link the change in resistance to a higher current. Fewer candidates attempted to gain the last mark. Those that did however often answered correctly. Many gave good answers such as low resistance increases the current to give more power for better ironing [2].
			Total	3	

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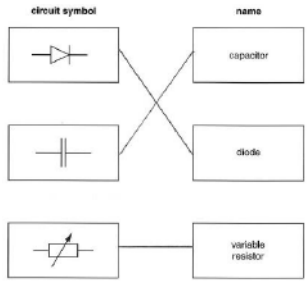
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Question			Answer/Indicative content	Marks	Guidance
10			**Level 3: (5 – 6 marks)** **Answer shows a detailed explanation of how temperature affects the resistance of a filament bulb.** Quality of written communication does not impede communication of the science at this level. **Level 2: (3 – 4 marks)** **Answer gives a simple explanation of how temperature affects the resistance of a filament bulb** **AND** **resistance is caused by collisions.** Quality of written communication partly impedes communication of the science at this level. **Level 1: (1 – 2 marks)** **Simple description of resistance changes OR simple description of a change in the bulb** Quality of written communication impedes communication of the science at this level. **Level 0: (0 marks)** Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted up to grade C Indicative scientific points may include (but are not limited to) the following: **Detailed explanation** • as current increases, temperature increases • as current increases, resistance increases • electrons collide with atoms/ions in the conductor • more collisions equals more resistance • as temperature increases the atoms vibrate more • more collisions causes temperature increase • more vibrations cause more collisions, so resistance increases **Simple explanation** • as temperature increases, resistance increases • current is a flow of charge/electrons in a filament • simple idea of resistance caused by electrons hitting atoms/ions **Simple descriptions** • bulb heats up / temperature increases • resistance increases **allow** wire in place of filament **allow** nuclei, positive nuclei, in place of atoms **Use the L1, L2, L3 annotations in Scoris; do not use ticks** **Examiner's Comments** This 6 mark level of response question on explaining resistance in a filament bulb gates was targeted at grade C. Most candidates seemed unfamiliar in explaining resistance in terms of collisions between

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Question			Answer/Indicative content	Marks	Guidance
					moving electrons and atoms or ions. Because this basic model was lacking very few could reach Level 3. Candidates usually scored Level 1 for describing that the bulb heated up or that the resistance went up when current flows.
			Total	6	
11			 [2]	2	3 lines correct = 2 marks 1 or 2 lines correct = 1 mark Examiner's Comments This question on circuit symbols was answered very well across the whole ability range.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
12	a		150 (ohms) [1]	1	**Examiner's Comments** This question on resistance in circuits was answered very well across the full ability range. Almost all could work out total resistance of two resistors in series
	b		**B** [1] **idea** that the ratio of these resistors is the same as required for the voltage split [1]	2	**if another choice made then [0] marks awarded** if answer line blank **allow** correct row identified in the table **allow** ratio is 1:2 or a calculation with 4V as the answer **Examiner's Comments** This question on resistance in circuits was answered very well across the full ability range. It was particularly pleasing that most candidates could interpret a potential divider to decide on the appropriate pair of resistors in series.
	c		4 (ohms) **and** no [2] **but if answer incorrect** 4 (ohms) **and** yes [1] **or** 4 (ohms) and question unanswered [1] **or** $\frac{12}{3}$ [1]	2	**Examiner's Comments** This question on resistance in circuits was answered very well across the full ability range. Most could calculate the resistance using current and voltage and use this to consider whether it is suitable for an application.
			Total	**5**	

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Question			Answer/Indicative content	Marks	Guidance
13	a		94 (W) [2] **but if answer incorrect** 20 × 4.7 [1]	2	**allow** 230 × 4.7 or 1081 scores [1] **Examiner's Comments** This question on voltage and its importance in power output was well answered by most candidates The calculation of output power was well done by most candidates. Some able candidates (incorrectly) calculated the input power to score 1 mark
	b	i	Kenya **and** **high**(est) voltage / **high**(est) number (of volts in table) / 240(V) [1]	1	**Both required for the mark** **Eg.** Kenya has a high number [1] **allow** since the current is constant it needs a high(er) voltage to get a high(er) power / wtte [1] **Examiner's Comments** Almost all understood the link between voltage and power.
		ii	Japan has low(est) input voltage [1] **and one from** (so) less power output [1] (so) less heat produced by the iron or iron does not get hot (enough) (so) takes too long to heat up [1]	2	**allow** not powerful enough [1] **allow** less energy supplied [1] **Examiner's Comments** Most scored at least 1 in applying the ideas of too little power for the use in an iron but fewer recognised that it was the low voltage in Japan that led to this.
			Total	**5**	

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Question			Answer/Indicative content	Marks	Guidance
14			460 (W) [2] **but if answer incorrect** 230 x 2 [1]	2	**allow** answer in the table if answer line blank [1] Examiner's Comments Most candidates were able to calculate the power of the slow cooker as 460W.
			Total	2	
15			oven (no mark) greatest power / most watts [1] longest time / used for longer / greatest hours [1]	2	**If** appliance line blank allow greatest power / 2000W or longest time / 5hours to identify oven. **If** appliance line incorrect zero marks **allow** power is 2000 and time is 5 [1] **allow** higher level answers e.g. longest power x time [2] not just used most must mention time Examiner's Comments The majority of candidates correctly identified the oven as the appliance which costs the most to use and gave a correct explanation.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
16	a		…. are all straight lines / AW [1]	1	**allow** are not curved or increase at steady rate **[1]** **Examiner's Comments** Very few described that a straight line relationship between current and voltag on a graph passing through the origin indicated ohmic behaviour.
	b	i	(The voltage at **X**) is 2.4 (volts) **and** (The current at **X** is) 0.32 (amps) [1]	1	both required for 1 mark **Examiner's Comments** Most read data from the graph accurately.
		ii	7.5 ohms [1]	1	more than one scores 0 marks if answer line blank allow correct answer indicated in list **Examiner's Comments** Most selected the correct calculated resistance
	c		**E** [1]	1	more than one scores 0 marks if answer line blank allow correct answer indicated in list **Examiner's Comments** About half knew that the lowest gradient had the highest resistance
	d		(charge carriers are) not neutrons they are electrons [1] (resistance does not stay the same) it changes / increases [1]	2	**allow mistakes indicated on the text** **not** resistance decreases **Examiner's Comments** It was encouraging to see that most could recognise the faults in the description of current as flow of neutrons, and that resistance was not independent of temperature. The most common incorrect correction was stating that resistance decreases with increasing temperature.

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Question			Answer/Indicative content	Marks	Guidance
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
17	a		A LDR / light dependent resistor [1] B thermistor [1] A responds to light OR B responds to heat or temperature [1]	3	 allow ecf on the naming of the components e.g. A is a thermistor that responds to temperature and B is an LDR that responds to light [1] allow resistance of thermistor increases with temperature OR resistance of LDR increases with light intensity [1] Examiner's Comments Surprisingly few candidates recognised the symbols for LDR and thermistor. Most of those who did could then describe how resistance varied with light intensity or temperature
	b		 [1] BUT  [2]	2	one mark for symbol correct symbol [1] allow circle around diode symbol, triangle shaded in, or horizontal line through the triangle for symbol mark [1] one mark for direction correct direction [1] allow if symbol incomplete but includes triangle pointing in forward bias direction [1] Examiner's Comments Few candidates knew the symbol for diode [1] but when it was correct a second mark was usually gained for being in forward bias
			Total	5	

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Question			Answer/Indicative content	Marks	Guidance
18			[Level 3] Calculate two resistances correctly AND identifies how resistance changes with length of resistance wire AND gives a basic quantitative relationship Quality of written communication does not impede communication of the science at this level (5 – 6 marks) [Level 2] Calculate two resistances correctly AND identifies how current changes with length of resistance wire OR how resistance changes with length of resistance wire Quality of written communication partly impedes communication of the science at this level (3 – 4 marks) [Level 1] Calculate at least one resistance correctly OR identifies how current or resistance changes with length of resistance wire Quality of written communication impedes communication of the science at this level (1 – 2 marks) [Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to C. To reach L3 both resistances must be calculated correctly. Indicative scientific points at level 3 may include: both calculations and descriptions from level 1 and 2 and • example of a quantitative relationship e.g. doubling the length of the resistance wire approximately doubles the resistance Indicative scientific points at level 1 and 2 may include: • resistance for length 20 cm = 3(.00)(ohms) • resistance for length 10 cm = 1.5(0) (ohms) • idea that as length of resistance wire increases the current decreases / ora • idea that as length of resistance wire increases the resistance increases / ora Use the L1, L2, L3 annotations in scoris. Do not use ticks. Examiner's Comments This 6 mark level of response question was targeted at grades up to C. It was accessible to the full range of candidates. Most were able to calculate resistance accurately and more able candidates went on to describe the relationship between length and resistance. Level 1 responses often described the relationship between length and current or simply completed one correct calculation of resistance.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
19	a		circuit contains diode (1) **then** only allows current in one direction / AW (1) **but** diode connected wrong way in circuit (2)	2	**allow** diode labelled on diagram **allow** the  is the wrong way round (1) **allow** cells / battery wrong way round (1) **Examiner's Comments** Very few candidates identified the diode or knew its purpose. Many thought that the diode was a NOT gate. Some misunderstood the symbol for a battery as providing a gap in the complete circuit.
	b		idea of half wave rectification / current only flows half of the time / current only flows part of the time (1)	1	**allow** the current is changing direction / the current is going back and forth **ignore** just the current is alternating / it is an alternating current **ignore** the current changes **Examiner's Comments** Almost no candidates had any understanding of the role of the diode in half wave rectification.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
20	a	i	0.72 (volts) (2) **but if answer incorrect** 0.7185 or 0.718 or 0.719 or 0.7 (volts) (1)	2	**Allow** 0.15 × 4.79 (1) Examiner's Comments This voltage calculation using Ohm's law was answered correctly by most candidates who gave 0.72V [2]. Some answers did not attempt to give the answer to two significant figures. So it was common to see for one mark 0.7185 or 0.718 or 0.719 as the final answer.
		ii	**D** (1)	1	if answer line blank allow correct answer circled or underlined more than one answer = 0 marks Examiner's Comments The voltage calculation variable resistor 'D' was usually chosen.

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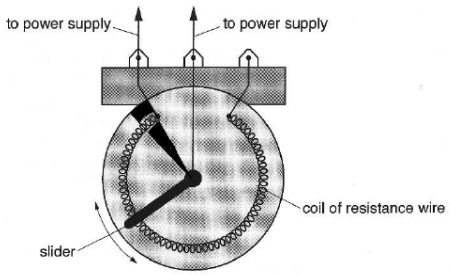
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Question			Answer/Indicative content	Marks	Guidance
	b		**Any two from:** increase the current by one from ? moving the slider clockwise or upwards or to the left ? having less wire / fewer coils in circuit [1] decrease the current by one from ? moving the slider anticlockwise or downwards or to the right ? having more wire / coils in circuit [1] increasing length increases resistance / increasing resistance decreases current / ORA [1]	2	**allow** labelled arrows or indications on diagram to indicate correct directions for upwards **allow** towards the power supply for downwards **allow** away from the power supply **Allow** changing length changes resistance [1] **But** increasing length decreases resistance / ORA [0] **Allow** changing resistance changes current [1] **But** increasing resistance increases current / ORA [0] <u>Examiner's Comments</u> Most knew that the length was related to the resistance and therefore the current. Rather fewer could apply this in the context of the diagram and describe it clearly. Some also got the relationship the wrong way round. For example, more resistance wire gives a larger current.
			Total	**5**	

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Question			Answer/Indicative content	Marks	Guidance
21	a	i	**D** (1)	1	if answer line blank allow correct answer circled or underlined more than one answer = 0 marks Examiner's Comments Most scored at least one mark recognising that the lowest current will arise when the resistance of a wire is highest or the length of the resistance wire is longest. Very few correctly linked the lower current, higher resistance and longer length to score two marks.
		ii	**D** (1)	1	if answer line blank allow correct answer circled or underlined more than one answer = 0 marks Examiner's Comments Most scored at least one mark recognising that the lowest current will arise when the resistance of a wire is highest or the length of the resistance wire is longest. Very few correctly linked the lower current, higher resistance and longer length to score two marks.
	b		 (1)	1	**allow** drawn slider or clear mark anywhere within the black segment (1) Examiner's Comments This was a new diagrammatic representation of how a variable resistor works. Around a quarter of candidates did not attempt this question and only better candidates could apply knowledge to locate the contact to create the shortest length.

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Question			Answer/Indicative content	Marks	Guidance
	c		ohms (1) 4.7 (2) but if calculation incorrect 0.7 (1) 0.15 or 4.67 (1) or 4.66 (1)	3	allow ? (1) allow any number of figures after the decimal point e.g. 4.6666 (1) <u>Examiner's Comments</u> In this three-mark question calculating resistance nearly all could score at least one mark by using he appropriate equation. However many candidates could not express in two significant figures with a large number choosing to round down from 4.67 to 4.7. In recent years the unit of resistance has been provided to students and it was surprising that few knew the unit of resistance as the ohm.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
22			(at a voltage of 4.00×10^5) 5(.00) × 10^3 **or** 5000 (A) [1] (at a voltage of 2.75×10^5) 7.273×10^3 **or** 7.273×10^3 **or** 7273 **or** 7272 (A) [1] (higher voltages best because) lower current / keeps wires cooler / reduces heat loss or energy waste [1]	3	for higher voltage **allow** 7270 **allow** 7.3×10^3 or 7300 **allow** 7200 or 7.2×10^3 [1] **allow** (higher voltages) - greater efficiency / less power loss [1] **ignore** cost Examiner's Comments This question on paying for electricity was answered well. This calculation involving indices was done well (better than previous papers) and it was common to see also the explanation correct with references to lower current. Almost a third gained full marks.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
23		i	24 +/- 4 scores (2) But if answer is incorrect or incomplete: correct plotting of both points (1)	2	tolerance for points is +/- ½ a square **Examiner's Comments** The first part was about using a graph plot to estimate the current at 30cm. Most candidates gained [2] here for 24cm (20-28cm). Those failing to fall into this range of +/-4 gained [1] for the correct plotting of the points.
		ii	as distance increases current falls scores / AW / ORA (1) **BUT** current falls quickly at start but less quickly for greater distances / AW (2) **OR** as distance doubles current is quartered (2)	2	**ignore** stronger or weaker current **allow** inverse square law (2) **Examiner's Comments** Most candidates could describe the basic trend [1], e.g. current reduces as distance increases [1]. Some were vague in describing current as weak or strong, slow or fast [0]. Better answers (less than 10%) went on to explain that as distance doubled the output quartered [2].
		iii	light diverges / spreads / becomes less intense / AW / ORA(1) **or** light intensity follows an inverse square law / AW (1)	1	(when closer) more energy / photons / light hits solar cell / AW / ORA (1) **Examiner's Comments** Most candidates could explain the trend here.
			Total	**5**	

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Question			Answer/Indicative content	Marks	Guidance
24		i	2 (2) if answer incorrect or incomplete then: $\frac{3}{1.5}$ (1)	2	Ignore any units
		ii	any two from decrease the resistance of the variable resistor (1) remove the lamp / change lamp for one of lower resistance (1) make the wires shorter (1) use thicker wires (1) add a bulb in parallel (1)	2	 allow remove variable resistor (1) allow remove ammeter (1) ignore less wires allow any component in parallel (1)
			Total	4	
25			 LDR (1) thermistor (1)	2	if answer line blank allow answers indicated in list each correct answer = 1 mark answers can be in either order
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
26		i	2 (2) if answer incorrect or incomplete then: $\frac{3}{1.5}$ (1)	2	Ignore any units
		ii	any two from: reduce the setting on variable resistor (1) remove the lamp / resistor / ammeter (1) make the wires shorter (1) use thicker wires (1) place resistor and lamp in parallel (1)	2	Allow 'turn the variable resistor down' (1) NOT merely 'adjust the variable resistor' Allow change resistor to one with a lower value (1) Allow replace with a different resistor if qualified Eg. replace bulb with a lower resistance / resistor ignore 'bigger' or 'heavier wire'. Allow lower swg wire / fatter wire (1) Allow short circuit idea: Eg. 'put wire in parallel with resistor' (1)
			Total	4	

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Question			Answer/Indicative content	Marks	Guidance
27	a	i	diode only allows current to flow in one direction (1) on graph, there is only current when there is a + voltage / on graph there is no current when there is a - voltage (1)	2	In **addition** to the marking points to the left, **allow** higher level answers: e.g. diode has high resistance in one direction / ORA (1) e.g. a minimum voltage / threshold voltage needed to produce a current (1)
		ii	Any three from: 1 layer / side has extra electrons (1) 1 layer / side has extra (positive) holes / an absence of electrons (1) electrons drop into the holes so charge cancels / current flows / there is a low resistance (1) current only flows when positive terminal is connected to the side containing holes / ORA (1) **(current across the junction):** holes and electrons move towards each other / opposite directions / across the junction (1) **(when there is no current across the junction)** holes and electrons move away from each other / holes and electrons move away from the junction (1)	3	**Ignore** n-type and p-type **Ignore** references to repel and attract Accept answers that refer to being in depletion or insulating region instead of junction
	b		as temperature increases the resistance decreases / AW (1) change in resistance decreases as the temperature(s) increase / ORA / AW (1)	2	**allow** examples e.g. a 5 (°C) between 15 to 20 (°C) gives a resistance change of 3.4 (ohms) but a 5 (°C) between 35 to 40 (°C) gives a resistance change of 1.2 (ohms) (1)
			Total	7	

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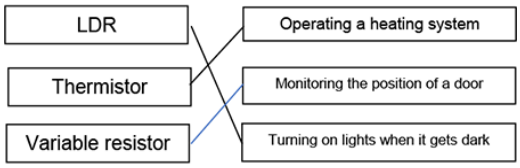
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Question			Answer/Indicative content	Marks	Guidance
28			D ✓	1 (AO2.2)	
			Total	1	
29			B ✓	1 (AO2.2)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
30	a	i	TV ✓	1 (AO3.2b)	<u>Examiner's Comments</u> Most candidates multiplied the relevant variables (power and time used) in the data table, and used the units Wh or kWh. This was a good approach for questions of this type.
		ii	Light bulb ✓	1 (AO3.2b)	<u>Examiner's Comments</u> Here the appliance with the lowest power rating (light bulb) was the right answer **Misconception** The most common misconception was just to compare the power ratings of the appliances and chose the toaster as the answer. Doing some quick calculations of work done and jotting vales next to the table helps answering these types of question. If the power and time for the TV and light bulb had been slightly different it would have given a different answer.
	b			2 (AO 2 × 2.1)	1 mark for each correct link <u>Examiner's Comments</u> Most candidates were credited full marks on this question. Virtually no candidates got one mark, perhaps because this required two components to be used for the same purpose. It was encouraging to see how candidates across the ability range were aware of the use of specific electrical components around their homes.

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Question			Answer/Indicative content	Marks	Guidance
	c		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 10 000 000 (J) award 4 marks Rearrange to energy = charge × potential difference ✓ 44 000 × 230 ✓ 10 120 000 ✓ 10 000 000 (2 sf) (J) ✓ OR Substitute correctly 44 000 (C) = energy ÷ 230 (V)✓ Rearrange to energy = 44 000 (C) × 230 (V) ✓ = 10 120 000 (J) ✓ = 10 000 000 (2 sf) (J) ✓	4 (AO2.1) (AO2.1) (AO2.1) (AO1.2)	Fourth mark is for correct rounding If answer line has 10 120 000 (J) award 3 marks m.p.2 can include m.p.1 if equation not written m.p.2 can include m.p.1 as above Examiner's Comments There was an erratum with this question to correct the units to joules. The figures in this question were difficult, and many candidates coped well with the large numbers and also the rearrangement of the equation. Some candidates rearranged the equation before substitution and others after. Fewer candidates were able to round 10 120 000 J to two significant figures (e.g. 10 000 000 J). OCR support Mathematical Skills Handbook http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf
			Total	8	

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Question			Answer/Indicative content	Marks	Guidance
31	a	i	variable resistor ✓	1 (AO1.2)	ALLOW rheostat IGNORE potentiometer Examiner's Comments Q22 is an overlap question with J249/03. Very few candidates recognised that this was a variable resistor. Many thought it was a thermistor.
		ii	Control / change / vary / increase / decrease / AW the resistance / current in the circuit ✓	1 (AO1.2)	DO NOT ALLOW merely 'changes the voltage or changes p.d.' BUT ALLOW: changes the potential difference or voltage across (component) X ✓ Examiner's Comments Candidates who misidentified the variable resistor in Q22(a)(i) were not able to answer this question.
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4 (V) award 2 marks 0.25 × 16 ✓ 4 (V) ✓	2 (AO2.1) (AO2.1)	Examiner's Comments Most candidates were successfully completed the calculation.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1 (W) award 3 marks P = IV ✓ P = 0.25 × 4 ✓ P = 1 (W) ✓ OR P = I^2R ✓ P = 0.25^2 × 16 ✓ P = 1 (W) ✓	3 (AO1.2) (AO2.1) (AO2.1) (AO1.2) (AO2.1) (AO2.1)	ALLOW e.c.f. from part ci Examiner's Comments A quarter of all candidates calculated the correct answer here. Very few of the other candidates recognised that (c)(i) and (c)(ii) were a developing story and so did not multiply the answer to the first part of the question (4 V) by 0.25 A to calculate the answer to the second part.

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Question			Answer/Indicative content	Marks	Guidance
	c	i	(filament) bulb / lamp ✓	1 (AO3.2a)	Examiner's Comments More able candidates were able to recognise the response of a filament lamp.
		ii	gradient / slope (of graph) changes (as potential difference / voltage changes) ✓ idea of increasing resistance (with more p.d.) / ORA ✓ idea of increasing temperature / AW ✓	3 (AO3.1a) (AO1.2) (AO2.2)	ALLOW 'graph / line / slope levels off' ✓ } Resistance increases with greater temperature ✓✓ Examiner's Comments This overlap question was challenging for most candidates. Most stated 'as p.d. increases, current increases' which does not address the fact that the *V/I* ratio is increasing, due to the graph curving downwards, so *R* must be increasing also.
			Total	11	

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Question			Answer/Indicative content	Marks	Guidance
32	a	i	variable resistor ✓	1 (AO1.2)	**ALLOW** rheostat **IGNORE** potentiometer Examiner's Comments Most named this correctly as a variable resistor for 1 mark. 'LDR' or 'resistor' and 'thermistor' were common incorrect answers.
		ii	Control / change / vary / increase / decrease / AW the resistance / current in the circuit ✓	1 (AO1.2)	**DO NOT ALLOW** merely 'changes the voltage or changes p.d.' **BUT ALLOW**: changes the potential difference or voltage **across (component) X** Examiner's Comments About half of candidates referred correctly to changing, varying or controlling the current or resistance for 1 mark. Incorrect answers varied but frequently seen were a device to measure current or resistance.
	b	i	(filament) bulb / lamp ✓	1 (AO3.2a)	Examiner's Comments Most gave the correct answer as a filament lamp. Lamp or bulb was acceptable also.
		ii	gradient / slope (of graph) changes (as potential difference / voltage changes) ✓ idea of increasing resistance (with more p.d.) / ORA ✓ idea of increasing temperature / AW ✓	3 (AO3.1a) (AO1.2) (AO2.2)	**ALLOW** 'graph / line / slope levels off' / non-linear } Resistance increases with greater temperature ✓✓ Examiner's Comments Many of the answers here did not refer to the graph so these did not secure the first marking point about the slope or the gradient changing. Other marks were available for increasing resistance (often given) and increasing temperature (less often seen). The answered covered the whole range here with only about 10% gaining all three. About a third of candidates gained 1 mark only, usually for the idea of increasing resistance.

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Question			Answer/Indicative content	Marks	Guidance
	c	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4 (V) award 2 marks 0.25 × 16 ✓ 4 (V) ✓	2 (AO2.1) (AO2.1)	Examiner's Comments This standard demand Ohm's law calculation was very well answered by almost all candidates. As, on this occasion, the formula was given in the question then the mark total was limited to 2 marks.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1 (W) award 3 marks P = IV ✓ P = 0.25 × 4 ✓ P = 1 (W) ✓ OR P = I^2R ✓ P = 0.25^2 × 16 ✓ P = 1 (W) ✓	3 (AO1.2) (AO2.1) (AO2.1) (AO1.2) (AO2.1) (AO2.1)	ALLOW e.c.f. from part ci Examiner's Comments About two thirds of candidates gained all 3 marks here for the calculation on power.
			Total	11	

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Question			Answer/Indicative content	Marks	Guidance
33	a	i	as the length of the wire increases the resistance increases / proportional relationship / ORA ✓ **BUT** idea of **directly** proportional ✓ ✓	2 (AO2 × 3.2b)	**IGNORE** positive correlation Numerical answers must **USE** values rather than merely quoting values Eg. (approximately) doubling the length, doubles the resistance / ORA ✓ ✓ Eg. Increases by 7 to 8Ω per 25cm / 0.3Ω (allow 0.28 to 0.32) per cm ✓✓ <u>Examiner's Comments</u> Most answers indicated the correct relationship between the length of the wire and its resistance for 1 mark. It was common in answers for values to be merely quoted rather than used. For example, better answers (from about a fifth of candidates) that stated 'doubling the length doubles the resistance' were credited both marks.
		ii	mean for 25cm (is recorded to 3 decimal places) **and** it should be recorded to one decimal place ✓ mean for 50cm is incorrect **and** it should be 16.2Ω ✓	2 (AO2 × 3.3a)	Error **and** a solution required for each marking point. **ALLOW** answer in terms of sig. figs: Eg. mean for 25cm is recorded to 4 sig. figs. – it should be recorded to 2 sig. figs. <u>Examiner's Comments</u> About third of answers identified clearly the mean for 25cm was recorded to three decimal places and it should only be one. Also shown in about a fifth of answers was the mean at 50cm should be 16.2.
		iii	75cm attempt 3 or 18.7 (is an anomaly) ✓ it has not been included in the **mean** ✓	2 (AO2 × 3.2a)	<u>Examiner's Comments</u> There was an erratum included for this question. Virtually all candidates edited their question to include this. There was no evidence at all that any candidates were disadvantaged by this and 80% gained full marks.

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Question			Answer/Indicative content	Marks	Guidance
		iv	**straight** line **through the origin** scores ✓✓ **straight** line / linear relationship / proportional and not through origin scores ✓	2 (AO2 × 3.1a)	**ALLOW** answers shown on a diagram **ALLOW** directly proportional ✓ ✓ **DO NOT ALLOW** a curved line through origin **IGNORE** positive correlation (in written comments) Examiner's Comments Some sketched a straight line graph through the origin for 2 marks here. Some described it as a straight line through the origin [2] or it was directly proportional [2]. Others described the shape as a straight line or proportional [1] but did not mention the origin.
	b	i	**Any two from:** (extra resistance due to) connecting leads too long / too thin ✓ (extra) resistance of the croc clips / connections ✓ croc clip is not at 0cm / the end of the ruler / length of resistance wire **longer** than intended / AW ✓ Heating effect of wires ✓	2 (AO2 × 3.1b)	**DO NOT ALLOW** idea of less resistance Eg. Crocodile clips rusted / poor conductor / bad or loose connections **IGNORE** crocodile clips in wrong place unless qualified correctly. Eg. croc clips too far apart **ALLOW** Parallax error on meter (if it is analogue) / meter not calibrated (so resistance higher) Examiner's Comments Answers her were often vague here and examiners were seeking to award marks for clearly described errors. About a third gained one mark for either the idea of the crocodile clip not being at zero or the meter not being zeroed or calibrated.

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Question			Answer/Indicative content	Marks	Guidance
		ii	**Any one from:** make the connecting wires as short as possible ✓ keep croc clips clean / solder connections ✓ place croc clip exactly at the end of the ruler / at 0cm / AW✓	1 (AO3.3b)	Solution needs to be consistent with an error identified in part i. OR a new specified error **ALLOW**: use **thicker** connecting wires **ALLOW** let wire(s) cool between readings / Securely fix croc clip / calibrate meter / avoid parallax error Examiner's Comments About a quarter gained one mark here for taking an error from part (i) and providing a solution.
			Total	11	

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Question			Answer/Indicative content	Marks	Guidance
34		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.8 (kW) award 4 marks	4	ALLOW 2.78 kW or 2.783 kW ✓✓✓✓
			(P =) $I^2 \times R$ ✓	(AO1.2)	ALLOW equation in any form
			11 x 11 x 23 or 11^2 x 23 or 121 x 23 ✓	(AO2.1)	
			= 2783 ✓	(AO2.1)	
			Conversion to kW = 2.8 ✓	(AO2.1)	ALLOW ECF candidates answer to 3rd marking point converted to kW Examiner's Comments This question required candidates to recall the equation: *power = current² x resistance* before converting their answers into kW. Out of the candidates who gained credit, most were credited with all four marks. A few candidates were only credited with one mark for converting the power output in W into kW. A significant number of candidates used an incorrect equation for power, most commonly using *current* rather than *current²* AfL When a physics question requires candidates to apply their mathematical skills they should always write down how they are answering the question. Using brief notes is and writing down intermediate calculations helps the examiner to see what the candidate is doing. A single finger error will result in many candidates receiving no credit because they only write down their final answer. Marks may be available for each stage of the process, using the correct equation, rearranging the equation, substituting in correct values. Choosing to access

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Question			Answer/Indicative content	Marks	Guidance
					these compensatory marks by showing workings is good examination technique.
		ii	Wind speed varies / AW ✓	1 (AO2.1)	ALLOW it depends on the strength of the wind / how windy it is / AW IGNORE there might not be any wind / wind changes direction / AW
		iii	(Idea of) not always enough wind / demand may exceed supply / AW ✓	1 (AO2.1)	ALLOW (it) may not generate enough power / energy / AW Examiner's Comments Most candidates gained full credit for Q16(d)(ii) and (d)(iii). Those who did not gain credit often provided non-specific generalised reasons about the weather or the wind turbine 'breaking'.
			Total	6	

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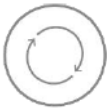
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Question			Answer/Indicative content	Marks	Guidance
35		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.8 (kW) award 4 marks	4	ALLOW 2.78 kW or 2.783 kW ✓✓✓✓
			(P =) $I^2 \times R$ ✓	(AO 1.2)	ALLOW equation in any form
			11 × 11 × 23 or 112 × 23 or 121 × 23 ✓	(AO 2.1)	
			= 2783 ✓	(AO 2.1)	
			Conversion to kW = 2.8 (kW) ✓	(AO 2.1)	ALLOW ecf candidates answer to 3rd marking point converted to kW Examiner's Comments Q23 is an overlap question with J249/04 and candidates found it very challenging with only a small number of the most able candidates being credited with any marks. From the stem of the question candidates knew that their answer needed to be between 1.0 kW and 3.0 kW. There were compensatory marks available where candidates wrote down the equation they were using and the different stages of their calculations. The most common workings shown were 11 × 23 or 23 ÷ 11, rather than 112 × 23 = 2.78kW. .
		ii	Wind speed varies / AW ✓	1 (AO 2.1)	ALLOW it depends on the strength of the wind / how windy it is / AW IGNORE there might not be any wind / wind changes direction / AW Examiner's Comments Many candidates realised that the wind speed would vary, but most responses were vague statements about the 'weather'.

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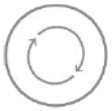
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Question			Answer/Indicative content	Marks	Guidance
		iii	(Idea of) not always enough wind / demand may exceed supply / AW ✓	1 (AO 2.1)	ALLOW (it) may not generate enough power / energy / AW Examiner's Comments Two thirds of the candidates reasoned that there may not be enough wind of the required speed or that a 3.0 kW wind turbine would not be sufficient to power a household.  AfL It is very important to show candidates how to focus their answers on the question that they are being asked. For example, this question was about whether 'just one wind turbine' could be a reliable source of power a house. However, many candidates answered a question about the impact of a domestic electrical supply failure, which would apply to any source of power to a house.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
36			FIRST CHECK THE ANSWER ON ANSWER LINE **If answer = 38.28 (W) award 3 marks** Recall (Power =) potential difference x current ✓ 12 × 3.19 ✓ (P =) 38.28 (W) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**ALLOW** correct equation in any form **ALLOW** 38.3 (W) or 38 (W) Examiner's Comments Candidates had to recall the equation: power = potential difference x current and substitute the values provided in the question. Most candidates achieved full marks although some of the less able candidates could not recall the equation and therefore gained no credit.  **AfL** Candidates would benefit from writing down the equation and their calculations rather than just their final answer so that compensatory marks may possibly be awarded.
			Total	3	

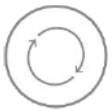
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Question			Answer/Indicative content	Marks	Guidance
37	a		A.C. (transmitted in power lines) / (electrical/electron/particle) oscillations / AW ✓ **BUT** Alternating currents/(electrical/electron/particle) oscillations produce (radio) waves/electromagnetic radiation ✓✓	2 (AO2×1.1)	<u>Examiner's Comments</u> This Assessment Objective 1 question assessed candidates' knowledge and understanding of how radio waves are produced. This proved to be one of the most difficult questions on the paper but also discriminated well. Only the most able candidates gained marks for relating the production of radio waves to the oscillations of electrons in the transmission lines. **Misconception** Common misconceptions included radio waves being produced by something in the house or because the transmission lines produced heat.

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Question			Answer/Indicative content	Marks	Guidance
	b		(High voltage means) lower current ✓ Less heating/heat loss/power loss/energy wasted or more useful energy transmitted / ORA ✓	2 (AO2×1.1)	IGNORE no energy losses / prevent energy loss / AW ALLOW more efficient / (wires at) lower temperature <u>Examiner's Comments</u> Although this question has been asked often in past GCSE Physics papers, over one quarter of candidates did not gain credit. Many gained 1 mark for the idea of less energy lost (as heat) but only the more able candidates were able to link this to higher voltages resulting in a lower current.  AfL Candidates had many misconceptions about why energy should be transferred at high voltages. The responses often referred to incorrect ideas e.g. 'to make the energy move faster/further' or 'to transfer enough power to the home' or 'to reduce the resistance'. Candidates should also be aware that the idea of NO energy losses will not gain credit.

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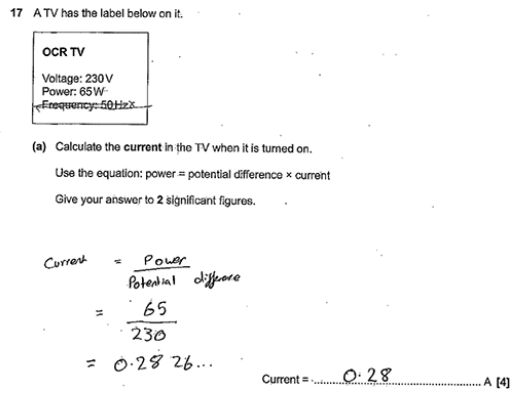
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Question			Answer/Indicative content	Marks	Guidance
	c		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 20 (A) award 5 marks Recall $I^2 = P / R$ ✓ 6.156 kW = 6156 W ✓ (I^2 =) 6156 / 15.39 **OR** (I^2=) 400 ✓ (I =) √400 ✓ (I =) 20 (A) ✓	2 (AO 1.2) (AO 2.1) (AO 2.1) (AO 2.1)	**ALLOW** correct equation in any form **DO NOT ALLOW** marks to be awarded from incorrect equation e.g. I = P / R Award marks if 6.156kW has not been correctly converted to W E.g. (I^2 =) 0.4 or 6.156/15.39 ✓✓ (I=) √0.4 ✓✓✓ I = 0.63 ✓✓✓✓ <u>Examiner's Comments</u> The majority of candidates scored either zero marks or 5 marks for this question. Over a quarter of candidates did not know the correct equation: power = (current)^2 x resistance. It was common to see an incorrect version of the equation (power = current x resistance) used instead. Some candidates did show their calculations and could therefore score 1 mark for converting kW into W.
			Total	9	
38			B ✓	1 (AO1.2)	<u>Examiner's Comments</u> Overall this question was very well answered. Some lower ability candidates incorrectly selected response C.
			Total	1	

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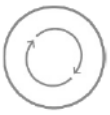
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Question			Answer/Indicative content	Marks	Guidance
39	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.28 (A) award 4 marks Rearrange equation current = power ÷ potential difference/ I = P ÷ V ✓ I = 65 ÷ 230 ✓ I = 0.2826086 ✓ I = 0.28 (A) ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO1.2)	NOTE If answer not to 2 sig figs max 3 marks ALLOW one mark for any calculated answer to 2sf Examiner's Comments Higher ability candidates rearranged the equation, substituted the numbers and wrote the answer as 0.2826 before rounding the answer as 0.28 (two significant figures). A number of candidates wrote their answer exactly from the calculator as 0.28 which was not acceptable for two significant figures. Exemplar 1  17 A TV has the label below on it. OCR TV Voltage: 230 V Power: 65 W Frequency: 50 Hz (a) Calculate the current in the TV when it is turned on. Use the equation: power = potential difference × current Give your answer to 2 significant figures. Current = Power / Potential difference = 65 / 230 = 0.28 26... Current = 0.28 A [4] This candidate has clearly rearranged the equation and then substituted the correct numbers from the data box. It is then clear that the candidate has then calculated the correct answer before rounding it correctly to two significant figures.

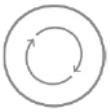
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Question			Answer/Indicative content	Marks	Guidance
					The candidate has perhaps helpfully crossed out the frequency as this is not needed for this part. Candidates need to be careful about crossing out quantities as the crossed out quantities might be needed in later parts. Underlining the quantities needed is probably a better method.  AfL For calculations, candidates should show their working. The following steps are useful: 1 Recall equation or select the appropriate equation from the data sheet (if not given in the question) 2 rearrange equation, if necessary 3 substitute the numbers into the equation 4 calculate the answer 5 consider significant figures or decimal places.
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 117000 (or 116000) (J) award 4 marks E = P x t ✓ Unit conversion 30 minutes = 1800 seconds ✓ E = 65 x 1800 ✓ E = 117000 (J) ✓	4 (AO1.2) (AO1.2) (AO2.1) (AO2.1)	ALLOW ECF from (a) E = Q x V or I x t x V E = 0.28 ×1800 × 230 ALLOW ECF for incorrect time conversion ALLOW three marks for 1950 (J) E = 116000 (J) ✓ <u>Examiner's Comments</u> Candidates did not always know which equation to use. Many recalled correctly the equation relating energy, power and

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Question			Answer/Indicative content	Marks	Guidance
					time but did not always remember that the energy needed to be measured in seconds. Higher ability candidates clearly showed their working including the conversion of 30 minutes to 1800 seconds. Some candidates recalled that E = Q × V and Q = I × t or E = I × t × V and used the answer from 17(a). This was correct physics and thus gained full credit.  AfL When carrying out calculations, candidates should consider units. Normally time is measured in second. Candidates should be aware of exceptions to the normal units, e.g. when energy transferred is measured in kW h, then the power is measured in kilowatt, kW and time in hour h. Similarly, if a speed is measured in measured in km / h, then the distance should be measured in kilometre, km and the time in hour, h.
			Total	8	

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Question			Answer/Indicative content	Marks	Guidance
40	a	i	LED / cells connected the wrong way around OR ✓ Voltmeter is across the battery/cells OR voltmeter should be across the LED ✓	2 (AO2x3 .2a)	ALLOW diode IGNORE voltmeter in wrong place Examiner's Comments The majority of the candidates gained at least one mark. Vague answers such as "voltmeter is in the wrong place" did not gain credit. Higher ability candidates stated for one of the errors that the LED (or cells) were connected the wrong way around or the LED (or cells) needed to be reversed. For the other error, it was expected that the candidates would indicate that the voltmeter was not measuring the potential difference across just the LED, but across the battery. Candidates gained a mark for this error by suggesting connecting the voltmeter across the LED. Incorrect answers given by many candidates included the ammeter being in the wrong place or the variable resistor being in the wrong place. Often candidates incorrectly suggested that the order of the components mattered.
		ii	Any one from: Control/change/alter the current (in the circuit) ✓ Control/change/alter the potential difference/voltage (across the LED) ✓	1 (AO1.2)	DO NOT ALLOW to vary the resistan Examiner's Comments A large number of candidates answered this question by stating that the component was a variable resistor or to vary the resistance of the circuit. Few candidates answered the question in term of the purpose of the variable resistor was to vary the potential difference across the LED or vary the current through the LED (by varying the resistance in the circuit).

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Question			Answer/Indicative content	Marks	Guidance
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE **If answer = 100 (Ω) award 3 marks** Resistance = potential difference ÷ current / R = V ÷ I ✓ R = 3.0 ÷ 0.03 ✓ R = 100 (Ω) ✓	3 (AO1.2) (AO2.1) (AO2.1)	<u>Examiner's Comments</u> The majority of the candidates were able to rearrange the given equation and substitute into the rearranged equation the correct values to give an answer of 100 Ω. A very small minority of candidates used 0.3 A rather than 0.03 A. Candidates often underline the quantities in the question, which was good practice.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE **If answer = 4.5 (C) award 4 marks** Charge flow = current × time / Q = I × t ✓ t = 2.5 minutes = 150 seconds ✓ Q = 0.03 x 150 ✓ Q = 4.5 (C) ✓	4 (AO1.2) (AO1.2) (AO2.1) (AO2.1)	**ALLOW** 3 marks for an answer of 0.075 (C) (time not converted to seconds) ✓✓✓ <u>Examiner's Comments</u> In this question, higher ability candidates who did not obtain the correct answer, but showed their working, could still gain marks from their working. In this case, the equation for charge flow needed to be recalled and the time of 2.5 minutes needs to be changed to 150 seconds, before the answer could be calculated.
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE **If answer = 13.5 (J) award 2 marks** E = 4.5 x 3.0 ✓ E = 13.5 (J) ✓	2 (AO2.1) (AO2.1)	**ECF** from **(ii)** **ALLOW** 14(J) <u>Examiner's Comments</u> Most candidates were able to multiply their answer to (ii) by 3.0 to gain the correct answer.
			Total	**12**	

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Question			Answer/Indicative content	Marks	Guidance
41			B ✓	1 (AO2.2)	Examiner's Comments Candidates clearly recalled that the current-voltage graph for a filament lamp was non-linear and they then had to choose between options B and D. Option D, the graph for a thermistor, was chosen by many. Option C is the correct answer as the increased current heats the lamp filament, a hotter filament has an increased resistance and therefore a smaller current is observed than might be expected.
			Total	1	
42			A ✓	1 (AO2.2)	
			Total	1	

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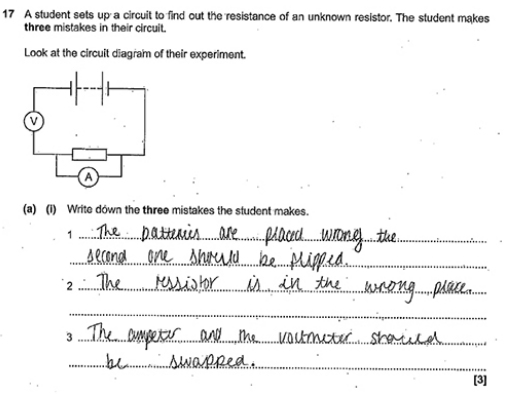
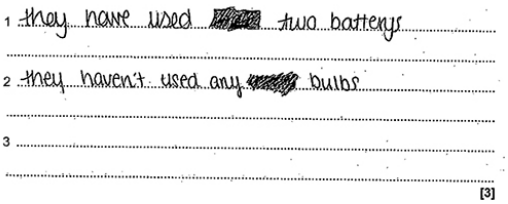
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Question			Answer/Indicative content	Marks	Guidance
43	a	i	The voltmeter is in series ✓ The ammeter is in parallel ✓ One of the cells is connected the wrong way round / AW ✓	3 (AO3.2b) (AO3.2b) (AO3.2b)	**ALLOW** reverse arguments: E.g. voltmeter should be in parallel ✓ E.g. ammeter should be in series ✓ **ALLOW** The cells/batteries are incorrectly connected / facing each other <u>Examiner's Comments</u> Many candidates had problems with this circuit that were not relevant to the question. Some expected to see components (such as a filament bulb) which did not feature and others were unfamiliar with the symbol for a battery (two or more cells in series/two cells joined by a dotted line). Exemplar 1 shows a candidate who identified the problems with the battery and the voltmeter and ammeter. Although the candidate has stated two separate points were on the same line for the third mistake, as what the candidate wrote made it clear exactly what they intended the second identified mistake was allowed by the examiner to gain full marks. Exemplar 2 is typical of many candidate responses seen by examiners and gained no marks.  Misconception Remember it is the apparatus and techniques in Topic P9 (Practical skills) that candidates are examined on not the specific practical activity that they experienced in their science classroom.

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Question			Answer/Indicative content	Marks	Guidance
					Exemplar 1  17 A student sets up a circuit to find out the resistance of an unknown resistor. The student makes **three** mistakes in their circuit. Look at the circuit diagram of their experiment. (a) (i) Write down the **three** mistakes the student makes. 1 The batteries are placed wrong the second one should be flipped. 2 The resistor is in the wrong place. 3 The ampeter and the voltmeter should be swapped. [3] Exemplar 2  1 they have used two batterys 2 they haven't used any bulbs 3 [3]
		ii	**Any one from:** Put the voltmeter in parallel with the resistor ✓ Put the ammeter in series ✓ Turn around one of the cells/AW ✓	1 (AO3.3b)	**ALLOW** swap the meters over or AW <u>Examiner's Comments</u> Many candidates who had gained some marks in 17(a)(i) also answered this question successfully. Typical responses that were given the mark included 'turn one of the two batteries round' or 'swap the voltmeter and ammeter over'.

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Question			Answer/Indicative content	Marks	Guidance
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 200 Ω award 4 marks Unit conversion 20(mA) = 0.02(A)/20x10^{-3} (A) ✓	4 (AO1.2)	If final unit is kΩ or V/mA, this unit conversion is not needed so mp1 is subsumed into mp2
			R = 4.0 ÷ 0.02 ✓	(AO2.1)	**ECF** incorrect or absent conversion of mA to A e.g. a bald answer of 0.2 gains mp2 & mp3 unless the unit is kΩ or V/mA, when all 4 marks are awarded.
			R = 200 ✓	(AO2.1)	
			Ω ✓	(AO1.2)	Mark unit independently **ALLOW** ohm(s) or V/A or V/mA if consistent with working <u>Examiner's Comments</u> In this question the unit mark was free-standing and so any valid unit combination was allowed. Both 0.20 kΩ and 0.2 mA/V are examples of responses which gained 4/4. Because of the application of error-carried-forward, candidates losing the first mark by not converting mA to A did not lose subsequent marks, so for example 0.2 Ω with suitable workings could gain three of the four marks.
			Total	8	

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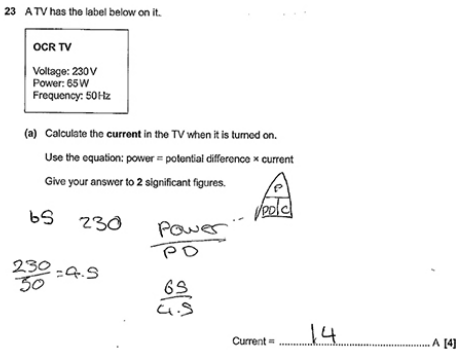
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Question			Answer/Indicative content	Marks	Guidance
44	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.28 (A) award 4 marks	4	
			Rearrange equation current = power ÷ potential difference/ I = P ÷ V ✓	(A1.2)	
			I = 65 ÷ 230 ✓	(A2.1)	
			I = 0.2826086 ✓	(A2.1)	NOTE If answer not to 2 sig figs max 3 marks
			I = 0.28 (A) ✓	(A1.2)	ALLOW one mark for any calculated answer to 2sf Examiner's Comments In their response to this question candidates earned a marks for the correct rearrangement of the given equation, a mark for substitution of the appropriate values, a mark for evaluation, and a mark for expressing the evaluated result to 2 significant figures. Error-carried-forward applied here, as shown in Exemplar 9. The first mark was earned by the power/p.d. quotient; it would have been cleared if they had included a subject to make it into a clear equation). There was no obvious logic to their other workings, but the final expression written is 65/4.5 = 14.4444 which (expressed to 2 s.f.) is 14, so earned second mark was given. Examiners are expected to mark positively and although the candidate has not set their workings out sensibly the examiner has assumed 65/4.5 and 14 to be the candidate's final decision.

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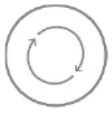
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Question			Answer/Indicative content	Marks	Guidance
					Exemplar 9  23 A TV has the label below on it. OCR TV Voltage: 230 V Power: 65 W Frequency: 50 Hz (a) Calculate the **current** in the TV when it is turned on. Use the equation: power = potential difference × current Give your answer to **2** significant figures. 65 230 Power / PD 230/50 = 4.5 65/4.5 Current = 14 A [4]
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 117000 (or 116000) (J) award 4 marks E = P x t ✓ Unit conversion 30 minutes = 1800 seconds ✓ E = 65 x 1800 ✓ E = 117000 (J) ✓	4 (A1.2) (A1.2) (A2.1) (A2.1)	ALLOW ECF from (a) E = Q x V or I x t x V E = 0.28 x 1800 x 230 ALLOW ECF for incorrect time conversion ALLOW three marks for 1950 (J) E = 116000 (J) ✓ <u>Examiner's Comments</u> This calculation, the last on the paper, required recall of the energy/power/time relationship and conversion of minutes to seconds, resulting in a large value answer. One candidate did calculate 117000 J correctly and then wrote 'Wrong!' next to it: However, the examiner ignored this comment and the candidate was credited with full marks for the question.
			Total	8	

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Question			Answer/Indicative content	Marks	Guidance
45			As speed increases, (thinking) distance increases / ORA ✓ BUT (thinking) distance is (directly) proportional to speed / as speed doubles, (thinking) distance doubles / linear relationship through the origin ✓	2 (AO 3.1a) (AO 3.2b)	ALLOW numerical values from graph, e.g. at 15 (m/s), td = 10m but at 30 (m/s) td = 20(m). ALLOW numerical values from graph, e.g. at 15 (m/s), td = 10 (m) but at 30 (m/s) td = 2×10 = 20 (m) for 2 marks <u>Examiner's Comments</u> Most candidates stated that the thinking distance increased with increasing speed. Few candidates stated that the thinking distance was directly proportional to the speed. The question does indicate that candidates should use data from the graph. In this case, candidates could easily see that the thinking distance line is a straight line through the origin. Alternatively, they could have read the thinking distance at a speed of 15 m / s and 30 m / s to see that the thinking distances are 10 m and 20 m. This means that as the speed doubles the thinking distance doubles.  AfL Understand how to test from a graph whether two quantities are directly proportional. 1. Take a quantity on the x-axis and double it and read off the y-axis values and see whether they double as well 2. See whether there is a straight line through the origin.
			Total	2	
46			B ✓	1 (AO2.1)	
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
47			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5(.00) (C) award 3 marks	3	
			(Rearrange equation) (charge =) energy transferred / potential difference ✓	(AO1.2)	
			(charge =) 200 / 40 ✓	(AO2.1)	
			(charge =) 5 (C) ✓	(AO2.1)	
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
48	a		(Circuit) A - the total resistance is half the value of one of the resistors / less than the smallest resistor value ✓ (Circuit) B - the total resistance is double the value of one of the resistors / adding the two resistances together ✓	2 (AO2x2.1)	Assume answer refers to circuit A unless indicated otherwise **ALLOW** (Circuit A) is parallel **and** has 2 loops/paths (for the current to flow through) / AW **ALLOW** higher level response i.e. correct equation for resistors in parallel **ALLOW** (Circuit) B is series **and** has only 1 loop/path (for the current to flow through) / AW **ALLOW** maximum of 1 mark for (circuit) A is parallel/has two loops/paths **and** (circuit) B is series/has one loop/path
	b	i	**Any two from:** (more current means) ions vibrate **more** / AW✓ (more current means) **more** electrons collide with ions (in the lattice) / AW ✓ (more collisions mean) hard**er** for electrons to pass (through wire/lamp) / AW ✓ (which) increases temperature (and therefore resistance) / AW ✓	2 (AO2x1.1)	**ALLOW** atoms/particles/molecules for ions **ALLOW** (lamp) heats up / high(er) temperature
		ii	Lamp, cell, ammeter and variable resistor in series ✓ Voltmeter in parallel with the lamp ✓	2 (AO2x2.2)	**IGNORE** voltmeter in series for this mark **ALLOW** voltmeter in parallel with ammeter and lamp but not variable resistor
		iii	Measure current **and** potential difference/voltage ✓ **Any two from:** Change current/variable resistor/pd (value) ✓ Take at least 3 sets of different V and I readings ✓ Calculate the resistance using V/I or using the current and pd values / plot a graph of V against I ✓	3 (AO3x1.2)	**ALLOW** take readings on ammeter **and** voltmeter **IGNORE** repeating same V and I readings **ALLOW** graph of I against V / graph of I against R

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Question			Answer/Indicative content	Marks	Guidance
			Total	9	
49			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.9 (A) award 2 marks (Rearrangement: I_p =) $I_s \times V_s / V_p$ ✓ OR (I_p =) 12 × 9.0 / 120 ✓ (I_p =) 0.9 (A) ✓	2 (AO1.2) (AO2.1)	
			Total	2	
50			D	1 (AO2.2)	
			Total	1	
51			C	1 (AO2.2)	
			Total	1	
52			D	1 (AO1.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
53	a	i	Correct symbol for a voltmeter ✓ Voltmeter is in parallel with the lamp ✓	2 (AO1.1) (AO2.2)	 **ALLOW** voltmeter in parallel with lamp and ammeter
		ii	Mistake: Units for current are missing ✓ Correction: Add A/amps/amperes/mA (for the unit) ✓ Mistake: Current is not recorded to correct number of decimal places / 1d.p. Correction: Current should be recorded to 1 d.p./1.0A ✓	4 (AO3.2a) (AO3.2b) (AO3.2a) (AO3.2b)	 **ALLOW** Current at 1.0 V is recorded to 4 significant figures **ALLOW** current should be recorded to 2 sig figs
		iii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.25 (Ω) award 3 marks** Rearrange to give resistance = potential difference ÷ current ✓ 4(.0) ÷ 3.2 ✓ = 1.25 (Ω) ✓	3 (AO1.2) (AO2.1) (AO2.1)	**ALLOW** 1.3 (Ω) ✓✓✓ (**ALLOW** *R*) = *V* ÷ *I* Choice of *V*, I for wrong data point loses this mark but can get mp1 for equation and mp3 for evaluation ecf. Mp3 may depend on units chosen for current in (ii).
	b	i	Point 1,1 correctly plotted within ½ small square ✓ Suitable curved line of best-fit drawn ✓	2 (AO2.2 x 2)	 Should be within 1 small square of each point. May not be extrapolated to (0,0,)
		ii	Current increases as potential difference increases/AW ✓ Rate of increase reduces/current increases more slowly with potential difference/AW ✓	2 (AO3.1a) (AO3.1a)	**IGNORE** it is a straight line **ALLOW** (they are) not proportional / not linear **ALLOW** resistance increases as current goes up/filament gets hotter
		iii	Change lamp for a (fixed) resistor ✓ Measure current for different potential differences/AW ✓	2 (AO1.2 x 2)	 **ALLOW** repeat the experiment
		iv	Straight line (through the origin)/ current is (directly) proportional to voltage ✓ Resistance is constant./not changing/ fixed✓	2 (AO1.2 x 2)	 **ALLOW** obeys Ohm's Law
			Total	**17**	

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Question			Answer/Indicative content	Marks	Guidance
54			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Circuit A identified as a parallel circuit and having the brightest lamps **AND** Detailed explanation of why A has the brightest lamps **AND** Identification of control variables *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Circuit A identified as a parallel circuit and having the brightest lamps **AND** An explanation of why A has the brightest lamps **OR** Identification of control variables *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)** Circuit A identified as having the brightest lamps. **OR** Identification that circuit A is in parallel. **OR** Identification of control variables *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** No response or no response worthy of credit.	6 (AO1.2 x 2) (AO2.2 x 2) (AO3.2b x 1) (AO3.3a x 1)	**AO1.2 Demonstrate knowledge and understanding of series and parallel circuits** For example: • circuit A is parallel • circuit B is series • both circuits have one cell **AO2.2 Apply knowledge and understanding of series and parallel circuits** For example: • resistance is lower in circuit A / ORA • more current flows in circuit A / ORA **AO3.2b Analyse information and ideas to draw conclusions** For example: • lamps in circuit A are brighter / ORA **AO3.3a Analyse information to develop experimental procedure by identifying control variables** • same (number of) lamps • same (number of) cells
			Total	**6**	

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Question			Answer/Indicative content	Marks	Guidance
55			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5(.00) (C) award 3 marks (Rearrange equation) Charge = energy transferred / potential difference ✓ (charge =) 200 / 40 ✓ = 5 (C) ✓	3 (AO1.2) (AO2.1) (AO2.1)	
			Total	3	

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