Current and Circuit Components, Series and Parallels Circuits, and Resistance

Questions

Q1.

Figure 2 shows the junction of three wires, F, G and H, in a circuit.

The current in wire F is 6.0 A.
The current in wire G is 3.5 A.

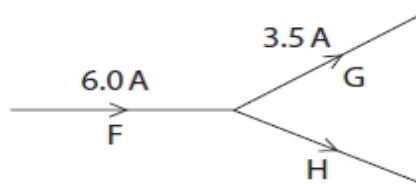Calculate the current in wire H.

(1)

Figure 2

current in wire H = ... A

(Total for question = 1 mark)

Q2.

A wire in a circuit carries a current of 0.9 A.
Calculate the quantity of charge that flows through the wire in 50 s.
State the unit of charge with your answer.

Use the equation

charge = current × time

(3)

quantity of charge = ... unit ....

(Total for question = 3 marks)

Q3.

A student investigates how the current in a lamp changes with the potential difference across the lamp.
The student uses the results to calculate the resistance of the lamp.

The results are shown in the table in Figure 5.

potential difference in V	current in A	resistance in Ω
1.0	0.09	11
2.0	0.14	14
3.0	0.18	17
4.0	0.22	18
5.0	0.26	
6.0	0.30	20

(i) One value of resistance is missing from the table in Figure 5.

Calculate the value of resistance that is missing from the table.

(3)

missing resistance = ... Ω

(ii) The student writes this conclusion:

'The resistance of the lamp is directly proportional to the potential difference.'

Comment on the student's conclusion.

Use information from Figure 5 in your answer.

(3)

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(iii) The student used a power supply that had fixed output voltage settings.

Each of these outputs was a whole number of volts.
Describe how the student could add a component to the circuit that would
provide a continuously variable voltage across the lamp.

(2)

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(Total for question = 8 marks)

Q4.

When the current in a lamp is 0.15 A, the resistance of the lamp is 40 Ω.

Calculate the voltage across the lamp.

Use the equation

$$V = I \times R$$

(2)

voltage = ... V

(Total for question = 2 marks)

Q5.

A student measures the current in the lamp for several values of potential difference across the lamp.

Figure 13 shows the student's results.

potential difference across the lamp in volts (V)	current through the lamp in amps (A)
0.06	0.05
0.12	0.08
0.18	0.10
0.24	0.12
0.30	0.13
0.36	0.13

Figure 13

The student uses the results in Figure 13 to write this conclusion.

'As the potential difference across the lamp increases, the current in the lamp increases and the relationship is directly proportional.'

Comment on the student's conclusion.

(3)

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(Total for question = 3 marks)

Q6.

A student investigates resistors connected in series in an electrical circuit.

The student has

- a 3.0 V battery
- a 22 Ω resistor
- a resistor marked X.The student does not know the value of the resistor marked X.

The student decides to measure the potential difference (voltage) across resistor X.

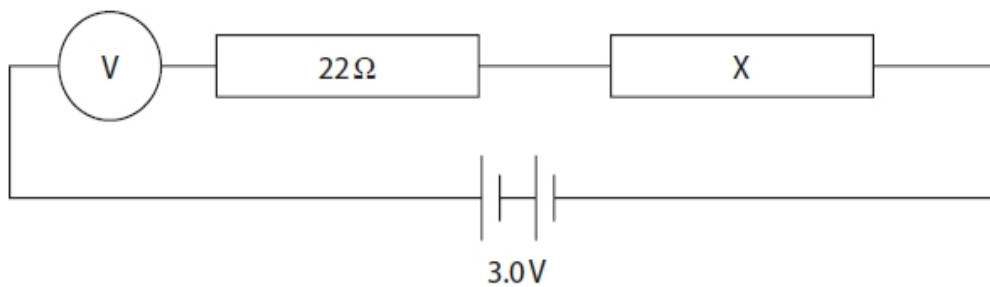Figure 15 shows the circuit that the student connected.

3.0V

Figure 15

The circuit is connected incorrectly.

Describe how the student should correct the mistake.

(2)

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(Total for question = 2 marks)

Q7.

Figure 18 shows the results from an experiment where the potential difference (voltage) across a filament lamp was varied.

The current and voltage were measured.
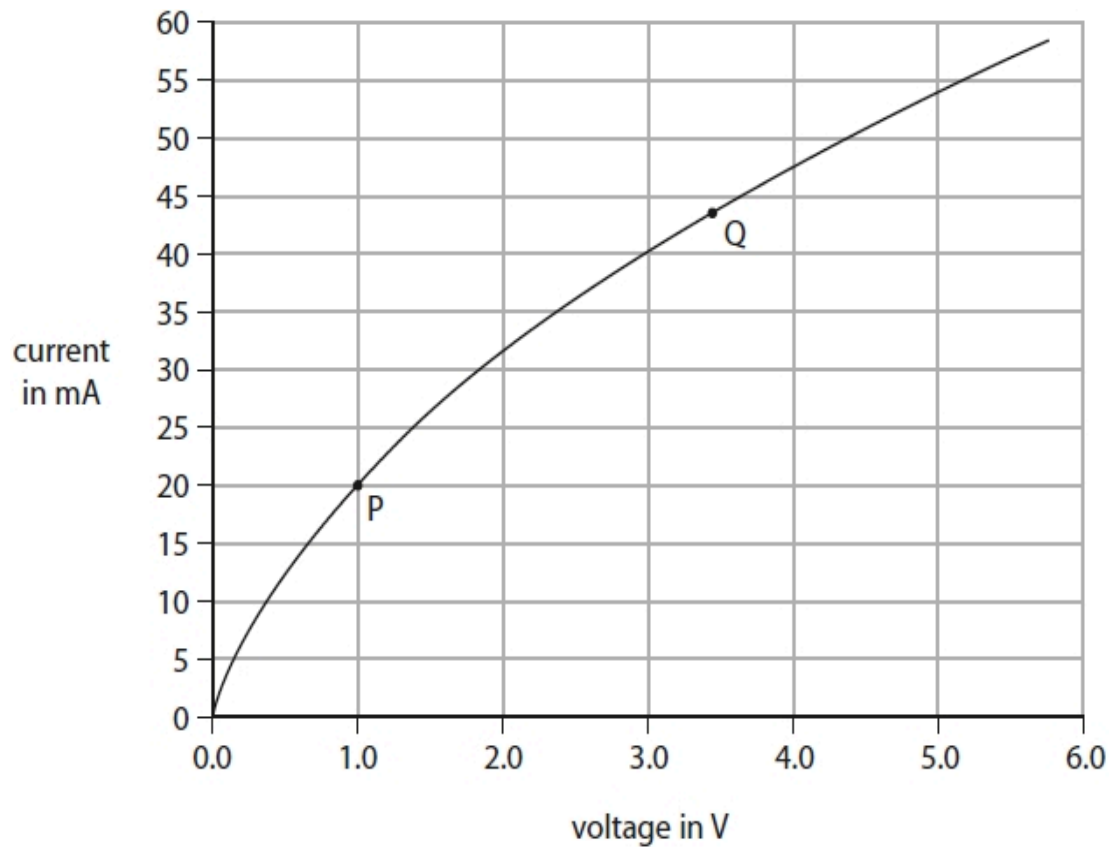
Figure 18

(i) Describe the relationship between the current and the voltage as shown in the graph in Figure 18.

(2)

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(ii) Use the values of the voltage and current at point P and at point Q on the graph in Figure 18 to complete the table in Figure 19.

(2)

	voltage in V	current in mA
point P		
point Q		

Figure 19

(iii) Calculate the resistance of the filament lamp when the voltage is 4.5 V and the current is 51 mA.

Use the equation

$$R = \frac{V}{I}$$

(2)

resistance = ... Ω

(iv) Explain why the resistance of the filament lamp changes as the voltage across it increases.

(3)

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(Total for question = 9 marks)

Q8.

Figure 1 shows an electrical circuit.
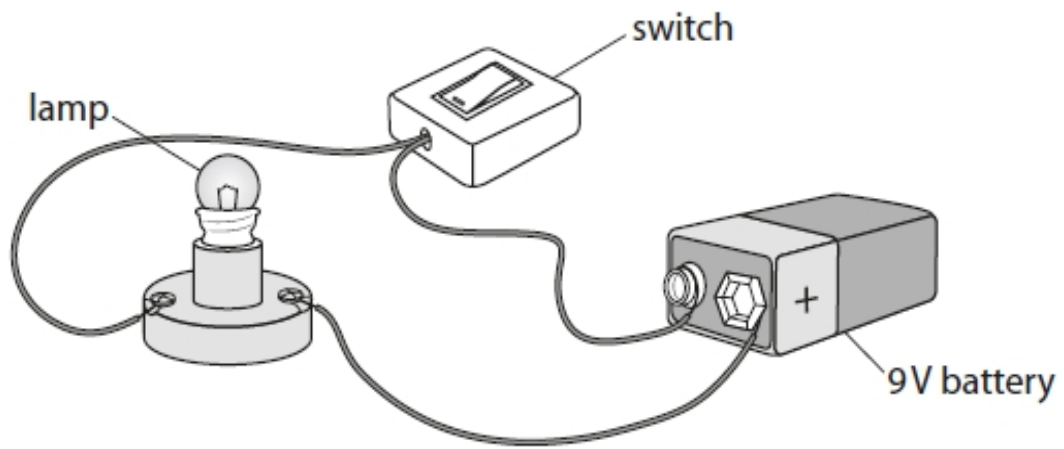
Figure 1

Draw a circuit diagram of the electrical circuit in Figure 1 in the space below.

(4)

(Total for question = 4 marks)

Q9.

A resistor is connected to a power supply.

The resistor becomes warm while there is a current in it.

Explain why the resistor becomes warm.

(2)

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(Total for question = 2 marks)

Q10.

Figure 17 shows two different types of the same circuit component.
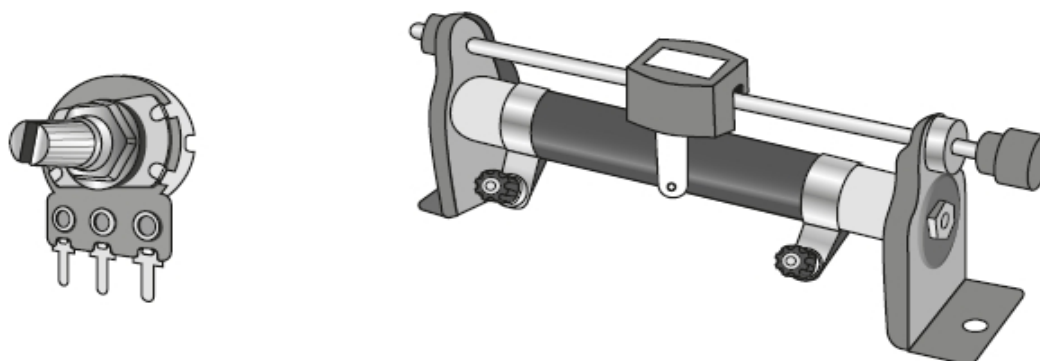
Figure 17

What is the name of this circuit component?

(1)

☒ A   diode

☒ B   light dependent resistor

☒ C   thermistor

☒ D   variable resistor

(Total for question = 1 mark)

Q11.

Which row in the table describes the way that ammeters and voltmeters should be connected with a component in a circuit?

(1)

		ammeter	voltmeter
☒	A	in parallel	in parallel
☒	B	in parallel	in series
☒	C	in series	in parallel
☒	D	in series	in series

(Total for question = 1 mark)

Q12.

Figure 5 shows a charger for a car battery.
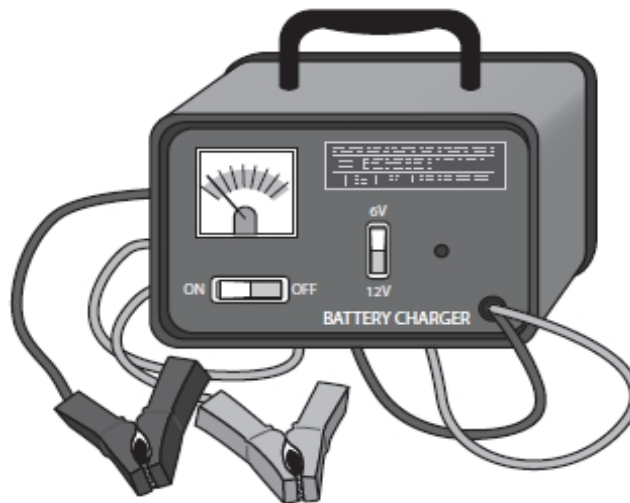
Figure 5

(i) The meter on the battery charger shows the current supplied to a battery.

The meter on the battery charger is

(1)

☒ A   an ammeter
☒ B   an ohmmeter
☒ C   a voltmeter
☒ D   a wattmeter

(ii) The battery charger supplies a steady current of 2.5 A to the battery.

Calculate the charge flowing to the battery in 8 minutes.
Use the equation

$$\text{charge} = \text{current} \times \text{time}$$

(2)

charge = ... C

(Total for question = 3 marks)

Q13.

Which of these symbols is used to represent a thermistor in an electrical circuit?

(1)

☒ A —▷|—

☒ B

☒ C —(M)—

☒ D
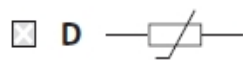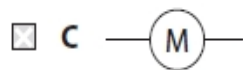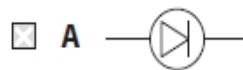
(Total for question = 1 mark)

Q14.

Figure 2 shows an ammeter that can read up to 5 A.
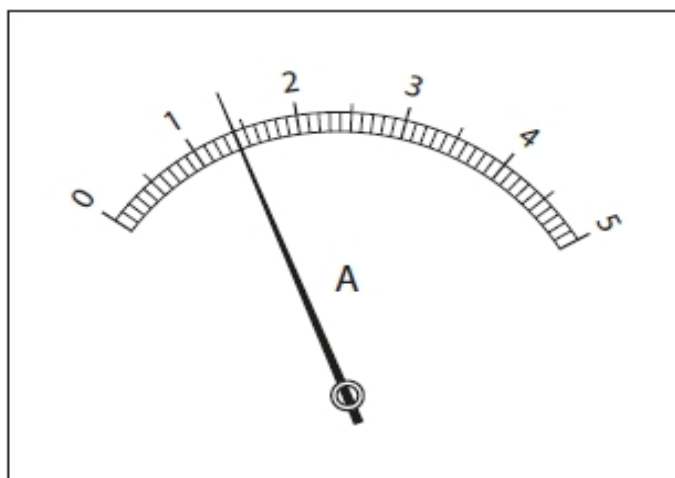
Figure 2

State the value of the current shown on the ammeter in Figure 2.

(1)

current = ... A

(Total for question = 1 mark)

Q15.

* Explain, with the aid of a circuit diagram, the method a student could use to investigate how the resistance of a single lamp changes with the potential difference across the lamp.

(6)

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(Total for question = 6 marks)

Q16.

A student investigates resistors connected in parallel using a number of resistors. Each resistor has the same resistance.

Figure 19 shows a circuit diagram with one resistor, R.
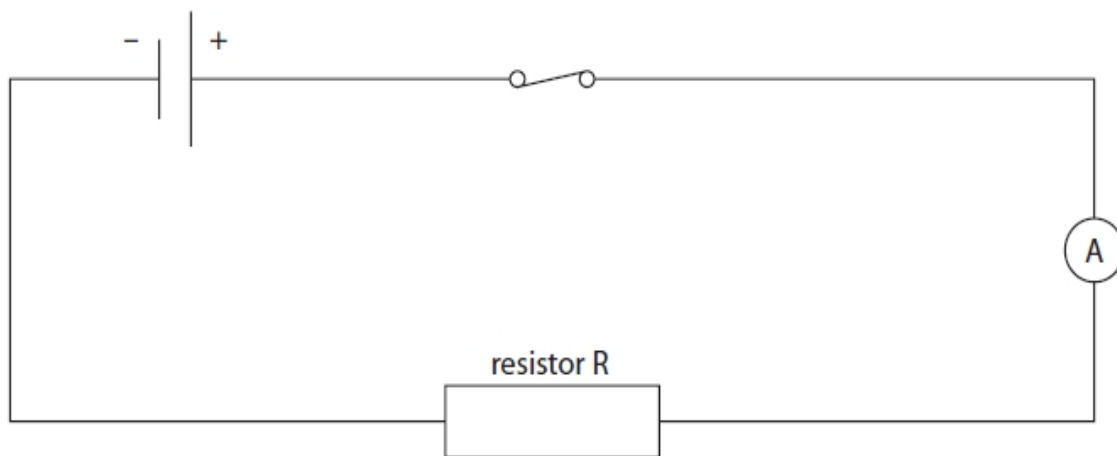
Figure 19

(i) Add to Figure 19:

- a voltmeter to find the potential difference across resistor R
- another resistor in parallel with resistor R.

(2)

(ii) State the measurements that the student must take to find the overall resistance of the resistors in parallel.

(2)

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(iii) The student investigates how the overall resistance of the circuit changes when additional resistors are added
      Tin parallel to R.

Each resistor has the same resistance.

Figure 20 shows the results of the student's investigation.
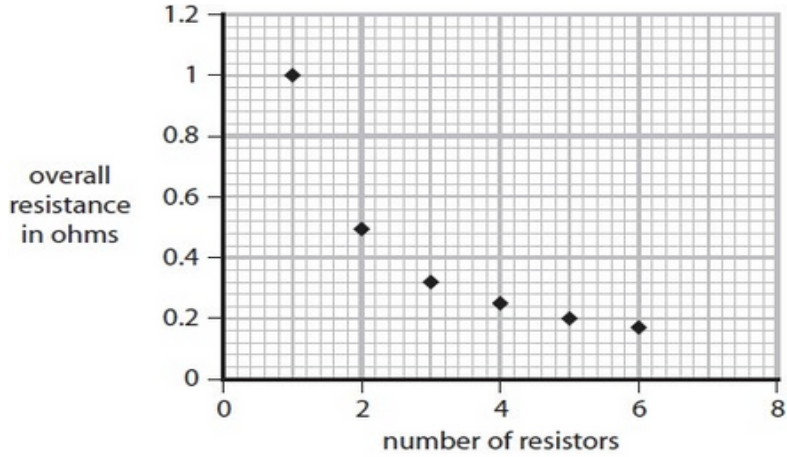
Figure 20

State the resistance of a single resistor.

(1)

resistance = ... Ω

(iv) Comment on the relationship between the overall resistance of the circuit and the number of resistors in parallel.

Use information from Figure 20 to support your answer.

(3)

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(Total for question = 8 marks)

Q17.

A technician investigates different electrical devices that are used in a car.

The technician connects a device to the 12 V car battery.

The technician measures the current in the circuit and the potential difference (voltage) across the device.
Figure 17 shows the car battery and the device that is being tested.

Figure 17

The technician connects four devices to the car battery.

Each device is connected to its own switch and its own fuse.

Figure 18 shows how the four devices, fuses and switches are connected.

The current in each device is shown next to the device.
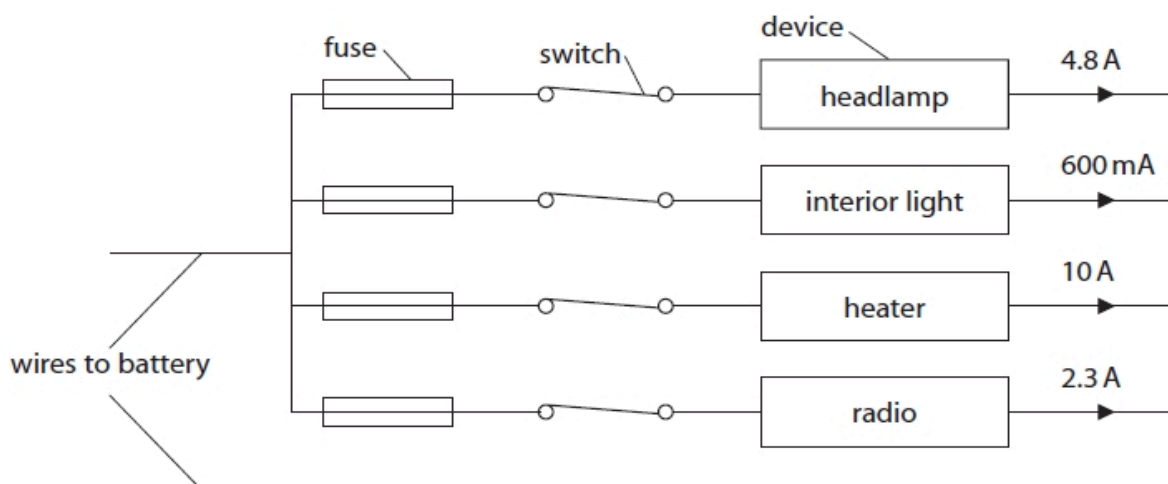
Figure 18

(i) Calculate the current in the wires to the battery when all the devices are switched on.

(1)

current = ... A

(ii) State how the overall resistance of the circuit changes when any one of the devices is switched off.

(1)

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(iii) There is a current of 2.3 A in the radio when the radio is working correctly.

Which of these should the technician choose to protect the radio circuit?

(1)

☒ A   2 A fuse

☒ B   5 A fuse

☒ C   10 A fuse

☒ D   13 A fuse

(iv) Explain why the wires to the battery in a car are thicker than the wires that connect each device to its switch and its fuse.

(2)

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(Total for question = 5 marks)

Mark Scheme - Current and Circuit Components, Series and Parallels Circuits, and Resistance

Q1.

Question Number	Answer	Additional guidance	Mark
	2.5(A)	Accept $2\frac{1}{2}$ (A)	(1)

Q2.

Question Number	Answer	Additional guidance	Mark
	substitution (1) (Q=)0.9 x 50 evaluation (1) 45 unit (1) coulomb	 award 2 marks for the correct answer without working If no substitution seen 4.5 or 450 scores 1 mark only independent mark C, c, As Accept recognisable spellings of coulomb	(3)

Q3.

Question Number	Answer	Additional guidance	Mark
(i)	recall and substitution into V = IR (1) $5.0 = 0.26 \times R$ rearrangement (1) $(R=) \dfrac{5.0}{0.26}$ evaluation (1) 19 (Ω)	accept substitution and rearrangement in either order $(R=) \dfrac{V}{I}$ $\dfrac{5.0}{0.26}$ scores 2 marks accept answers that round to 19 (Ω) (e.g. 19.23) accept answer written table if not written on answer line. award full marks for the correct answer without working	(3)

Question Number	Answer	Additional guidance	Mark
(ii)	a comment that includes the following points idea that resistance increases with potential difference (1) idea that doubling the potential difference does not result in doubling of resistance (1) OR V = constant x R is not supported by this data (1) correct processing of data from the table to support either of the above mark points (1)	 idea that equal increments of potential difference do not cause equal increments of resistance reverse argument e.g. if student was correct then equal increments of p.d. would cause equal increment of resistance if student was correct then current would be constant ignore simple quoting of data for this mark	(3)

Question Number	Answer	Additional guidance	Mark
(iii)	A description that includes	marks may be obtained from a circuit diagram	(2)
	add a variable resistor (1)	rheostat	
	with		
	in series (with the lamp / power supply) (1)	accept between / before / after for in series	
	OR		
	add a potential divider (1)	potentiometer	
	with		
	in parallel with power supply (1)	across the power supply	
		ignore replacing power supply / using fixed resistor(s) / LDR / thermistor	
		in both cases, second mark conditional on first mark	

Q4.

Question number	Answer	Additional guidance	Mark
	substitution (1) 0.15 x 40		(2) AO2
	evaluation (1)		
	6(.0) (V)	award full marks for correct answer without working	

Q5.

Question Number:	Answer	Additional guidance	Mark
	a comment that makes reference to any three of the following points: • idea that the current increases with the p.d. /voltage (1) • until (current) reaches a constant value (1) • the current is not directly proportional to p.d. (1) • uses idea that the values do not go up in equal steps / does not show doubling	(staying) at 0.13(A)	(3) AO 3 2a AO 3 2b

Q6.

Question number	Answer	Additional guidance	Mark
	voltmeter should be moved (1)	voltmeter is in wrong place / (re)connect the voltmeter allow 'voltage' for 'voltmeter' in this context	(2)
	(to be) in parallel with the resistor X (1)	allow across X or equivalent statement answers may be seen on the diagram	

Q7.

Question number	Answer	Additional guidance	Mark
(i)	A description including as the potential difference (voltage) increases so does the current (1) idea of gradient of graph decreasing as V increases (1)	positive correlation at a decreasing rate non-linear not directly proportional	(2) AO3
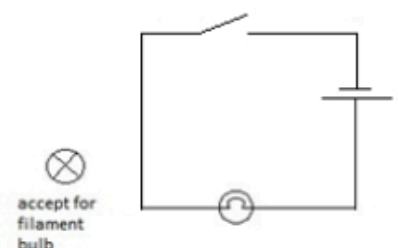
Question number	Answer			Additional guidance	Mark
(ii)	Award one mark for each row of the table				(2) AO2
		voltage V	current in mA	ignore any units added in the boxes	
	point P	1(.00)	20		
	point Q	3.4 ±0.1	43 ±1		

Question number	Answer	Additional guidance	Mark
(iii)	substitution (1) $(R=) \dfrac{4.5}{51(\times 10^{-3})}$ evaluation (1) 88.(2) (Ω)	 0.088(2) or 8.8(2) or 0.88(2) or 0.09 seen scores 1 mark 0.088(2) kΩ or 0.09 kΩ scores 2 marks award full marks for correct answer without working	(2) AO2

Question number	Answer	Additional guidance	Mark
(iv)	an explanation linking any three of: identification of resistance increasing (1) heating (of the filament)　(1) because of more collisions (1) of electrons (with ions / atoms / other electrons) (1)	temperature increases	(3) AO1

Q8.

Question number	Answer	Additional guidance	Mark
	  accept for filament bulb battery/cell symbol (1) lamp symbol (1) switch symbol (1) then complete series circuit shown (1)	ignore polarity of battery	(4) AO3

Q9.

Question Number:	Answer	Additional Guidance	Mark
	an explanation linking:	throughout accept atoms / ions for lattice accept charges / charged particles for electrons	(2) AO 1 1
	collisions between electrons and lattice (1)	allow collision between electrons in this context	
	lattice {vibrates / moves} **more** (1)	KE of lattice increases KE of electrons decreases	

Q10.

Question number	Answer	Mark
	D variable resistor Options A, B and C are all wrong identifications with both the circuit components shown	(1) AO1

Q11.

Question number	Answer	Mark
	C ammeter in series with component, voltmeter in parallel Only option C is correct for both the ammeter and the voltmeter	(1) AO1

Q12.

Question number	Answer	Additional guidance	Mark
i	A an ammeter B, C and D are incorrect because they do not show current		(1)

Question number	Answer	Additional guidance	Mark
ii	substitution (1) (Q) = 2.5 x 8 (x60) evaluation (1) 1200 (C)	allow 20 (C) for 1 mark award full marks for the correct answer without working	(2)

Q13.

Question Number	Answer	Mark
	The only correct answer is D **A is incorrect** because that is the symbol for a diode **B is incorrect** because that is the symbol for a light dependent resistor **C is incorrect** because that is a symbol for a motor	(1)

Q14.
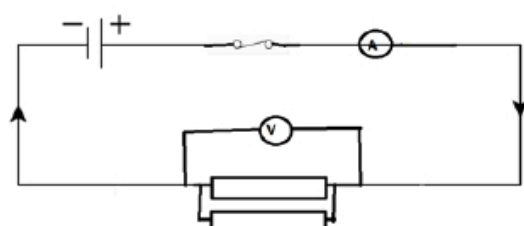
Question number	Answer	Mark
	1.4 (A)	(1) AO2

Q15.

Question Number	Answer	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1(6 marks) Circuit diagram including • power supply • ammeter • voltmeter • filament lamp • means of varying potential difference Description of method • measure current with ammeter • measure potential difference with voltmeter • vary the potential difference • calculate the resistance • repeat and compare	(6) AO 1 2

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• An explanation that demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Presents an explanation that is not logically ordered and with significant gaps. (AO1)
Level 2	3-4	• An explanation that demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents an explanation of the procedure that has a structure, which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5-6	• An explanation that demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure, which is clear, coherent and logical. (AO1)

Q16.

Question number	Answer	Additional guidance	Mark
(i)	 voltmeter in parallel across resistor (1) second resistor in parallel (1)		(2)

Question number	Answer	Additional guidance	Mark
(ii)	potential difference/ voltage (drop across resistors in parallel) (1) current (in the circuit)(1)	voltmeter reading ammeter reading	(2)

Question number	Answer	Additional guidance	Mark
(iii)	1 (Ω)	one (ohm)	(1)

Question number	Answer	Additional guidance	Mark
(iv)	Comments to include: the (overall) resistance decreases as the number of resistors (in parallel) increases (1) the relationship is non-linear (1) any two relevant values from the graph (1)	decreases at a decreasing rate the relationship is inversely proportional scores first 2 marks	(3)

Q17.

Question number	Answer	Additional guidance	Mark
(i)	17.7 (A)		(1) AO1

Question number	Answer	Additional guidance	Mark
(ii)	(The resistance) increases		(1) AO1

Question number	Answer	Additional guidance	Mark
(iii)	B 5 A fuse A is incorrect because it has a smaller value than the expected current C and D are incorrect because they have a much higher value than the expected current		(1) AO1

Question number	Answer	Additional guidance	Mark
(iv)	An explanation linking **two** of thick(er) wires have low(er) resistance (1) less thermal energy transferred (in the wires)(1) less potential difference / voltage (drop) across the wires (1)	allow reverse argument allow so wires do not get hot allow less voltage is lost more current can be carried	(2) AO1