3.11 Circuits, Resistance and Components: 30-minute Pack

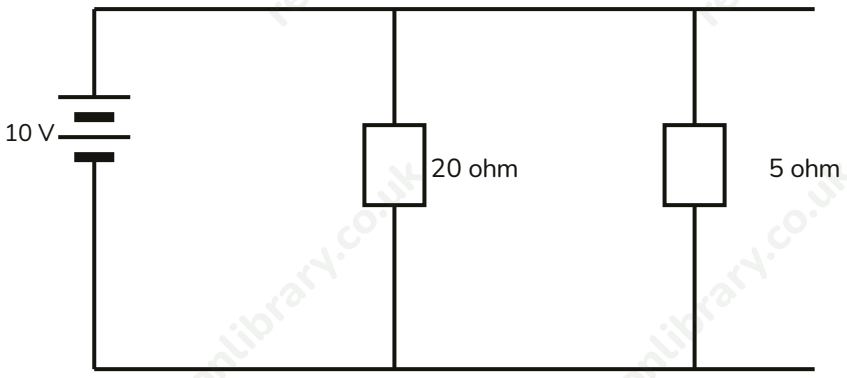
Total Marks

AQA 8464 · Calculator allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Figure 2 shows a 20 ohm resistor and a 5 ohm resistor connected in parallel across a 10 V battery.



(a) State the potential difference across the 5 ohm resistor, giving a reason. **(2)**

(b) Use I = V / R to calculate the current in the 20 ohm resistor. **(2)**

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(c) The current in the 5 ohm resistor is 2.0 A. Calculate the total current supplied by the battery. **(2)**

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(Total for Question 1 is 6 marks)

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2 A resistor is connected in a circuit and its current-potential difference (I-V) graph is plotted at constant temperature.

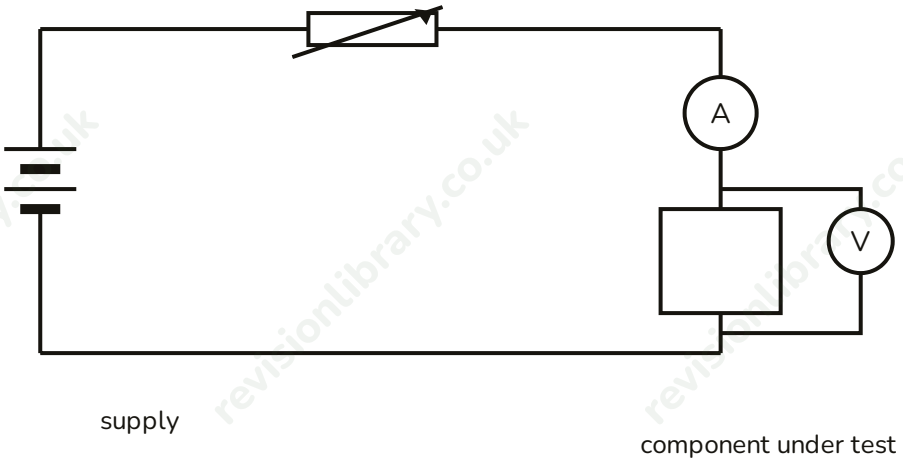
(a) State the shape of the I-V graph for a resistor at constant temperature. **(1)**

(b) Explain what this graph shape shows about the resistance of the resistor as the potential difference increases. **(2)**

(Total for Question 2 is 3 marks)

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3 A student carries out the required practical to investigate the I-V characteristics of a resistor, a filament lamp and a diode, using a circuit containing a power supply, a variable resistor, an ammeter and a voltmeter.



(a) State the equipment needed in addition to the component being tested, and describe the role of the variable resistor in this investigation. **(2)**

(b) For the filament lamp, explain why the circuit is adjusted to also take readings with the current flowing in the opposite direction. **(1)**

(c) Explain one precaution the student should take when investigating the filament lamp, other than reversing the current direction, to obtain a valid I-V graph. **(2)**

(d) State one difference you would expect to see between the I-V graph for the resistor and the I-V graph for the diode. **(1)**

(Total for Question 3 is 6 marks)

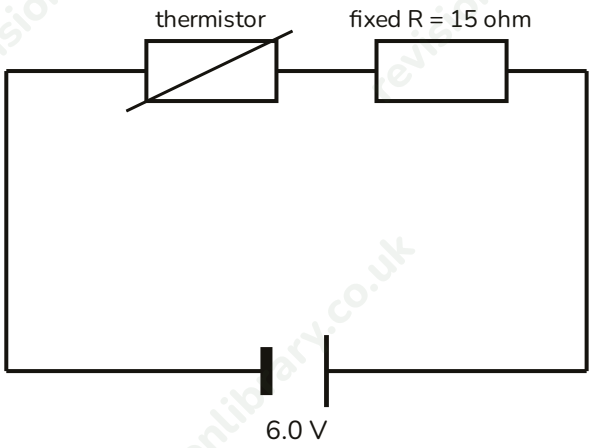
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4 A greenhouse heater is controlled by a circuit containing a thermistor connected in series with a fixed resistor and a relay switch, powered by a constant potential difference supply. When the temperature in the greenhouse falls, the heater should switch on. Explain, using ideas about resistance, current and potential difference, how the thermistor allows this circuit to detect a fall in temperature and trigger the heater switching on.

(Total for Question 4 is 6 marks)

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5 Higher tier only. Figure 4 shows a thermistor connected in series with a fixed 15 ohm resistor, across a 6.0 V supply. At a particular temperature, the thermistor has a resistance of 45 ohm.



(a) Calculate the total resistance of the circuit at this temperature. **(1)**

.....

(b) Calculate the current in the circuit at this temperature. **(2)**

.....

(c) The temperature rises and the resistance of the thermistor falls to 15 ohm. Calculate the new current in the circuit, and use it to describe how the potential difference across the fixed resistor changes as the temperature rises. **(3)**

.....

(Total for Question 5 is 6 marks)

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Mark scheme · 3.11 Circuits, Resistance and Components: 30-minute Pack

Question 1

(a) 10 V **B1**

(a) reason: components connected in parallel share the same potential difference as the supply, oe **B1**

(a) Answer: 10 V, the same as the battery, because parallel branches share the supply potential difference.

(b) substitutes: I = 10 / 20 **M1**

(b) 0.50 A cao **A1**

(b) Answer: 0.50 A

(c) ft adds branch currents: 0.50 + 2.0 **M1**

(c) 2.5 A cao (ft from (b)) **A1**

(c) Answer: 2.5 A

Question 2

(a) a straight line through the origin **B1**

(a) Answer: A straight line through the origin.

(b) the resistance stays constant, oe **B1**

(b) because current is directly proportional to potential difference (a straight line through the origin), oe **B1**

(b) Answer: The resistance stays constant, because current is directly proportional to potential difference.

Question 3

(a) any two of: power supply, ammeter, voltmeter, variable resistor, connecting leads **B1**

(a) the variable resistor changes the current (and potential difference) in the circuit, so several pairs of readings can be taken across a range of values, oe **B1**

(a) Answer: Power supply, ammeter, voltmeter, connecting leads; the variable resistor changes the current so a range of readings can be taken.

(b) to check whether the lamp behaves in the same way when the potential difference is reversed (to see if the graph is symmetrical about the origin), oe **B1**

(b) Answer: To check whether the lamp behaves the same way with the current reversed, so the graph can be checked for symmetry.

(c) EITHER waits for the current and potential difference readings to settle at each voltage before recording them as a pair; OR stays within the lamp's rated voltage (one precaution, 1 mark) **B1**

(c) For the chosen precaution: so the filament reaches a steady temperature and resistance before the readings are recorded; OR to avoid damaging the lamp, respectively (1 mark; maximum 2 marks for one route) **B1**

(c) Answer: At each voltage, wait for the current and potential difference readings to settle before recording them as a pair. This lets the filament reach a steady temperature and resistance before the readings are recorded. Alternatively, stay within the lamp's rated voltage to avoid damaging it.

(d) the resistor's graph is a straight line through the origin, symmetrical in both directions; the diode only conducts appreciably in one direction (forward bias), oe **B1**

(d) Answer: The resistor gives a straight line through the origin in both directions; the diode only conducts in one direction.

Question 4

Level 1 One or two isolated, correct statements are made, for example that thermistor resistance changes with temperature, with little or no reference to current, potential difference or the switching action. **1-2**

Level 2 Describes that the thermistor's resistance increases as temperature falls, and links this to a change in current or potential difference somewhere in the circuit, but the explanation of how this triggers the relay/heater is only partial or lacks clear logical sequencing. **3-4**

Level 3 A clear, logically sequenced explanation that links the fall in temperature to an increase in the thermistor's resistance, to an increase in the total resistance of the series circuit, to a decrease in the current in the circuit, to a resulting change in potential difference across the fixed resistor, and finally to this change being what triggers the relay to switch the heater on. Correct scientific terminology is used throughout. **5-6**

Indicative content:

- as the greenhouse temperature falls, the resistance of the thermistor increases
- the thermistor and fixed resistor are in series, so the total resistance of the circuit increases
- since the supply potential difference is constant, and current = potential difference / total resistance, the current in the circuit decreases as total resistance increases
- components in series share the supply potential difference between them, so as the current changes, the potential difference across the fixed resistor also changes
- this change in current or potential difference is what is detected by the relay/switching part of the circuit
- when the change reaches a threshold, the relay switches the heater circuit on
- the direction of the resistance change (increases as temperature falls) must be linked correctly for full credit

Question 5

(a) 60 ohm (45 + 15) **B1**

(a) Answer: 60 ohm

(b) ft substitutes: I = 6.0 / 60 **M1**

(b) 0.10 A cao (ft) **A1**

(b) Answer: 0.10 A

(c) new total resistance = 15 + 15 = 30 ohm **M1**

(c) new current I = 6.0 / 30 = 0.20 A **dM1**

(c) correct comparison: potential difference across the fixed resistor increases, from 1.5 V (0.10 x 15) to 3.0 V (0.20 x 15), as temperature rises, oe **A1**

(c) Answer: New current = 0.20 A; the potential difference across the fixed resistor increases from 1.5 V to 3.0 V as temperature rises.

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