

Resistors

Mark Scheme



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1. Resistors are electrical components that oppose the flow of charge, allowing us to safely control the current and potential difference within a circuit.

For each of the following questions **circle** the letter of the correct answer.

- a) Look at the four circuit symbols shown below. Which symbol represents a **variable** resistor?

C – is the only correct answer.	1 mark
	Total: 1 mark

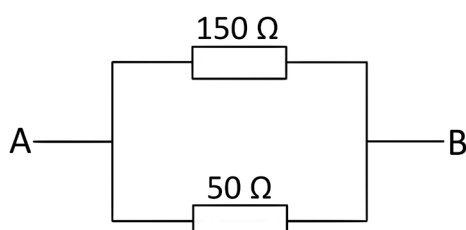
- b) What is the standard unit of measurement for electrical resistance?

C – is the only correct answer.	1 mark
	Total: 1 mark

- c) A potential difference of 12 V is applied across a fixed resistor. A current of 3.0 A flows through it. What is the resistance of the resistor?

B – is the only correct answer.	1 mark
	Total: 1 mark

- d) The diagram shows a 150 Ω resistor and a 50 Ω resistor connected in parallel.



What is the total resistance between points A and B.

A – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 4 marks)

2. The figure below shows a circuit containing a 24 V power supply, some resistors and an ammeter.

a) Determine the potential difference across the 8 Ω resistor.

19.2 Ω	1 mark
	Total: 1 mark

b) State the potential difference across the 12 Ω resistor.

24 V	1 mark
	Total: 1 mark

c) Calculate the effective resistance of:

i. The 8 Ω and the 2 Ω resistors connected in series.

$8 + 2 = 10 \Omega$	1 mark
	Total: 1 mark

ii. The 12 Ω and the 4 Ω resistors connected in parallel.

$\frac{1}{R_t} = \frac{1}{12} + \frac{1}{4}$	1 mark
$\frac{1}{R_t} = \frac{4}{12} \quad R_t = 1 \div \frac{4}{12}$	
$R_t = 3 \Omega$	1 mark
	Total: 2 marks

d) Calculate the reading on the ammeter.

Current in the 4 Ω branch = $24 \div 4 = 6 \text{ A}$	
Current in the 12 Ω branch = $24 \div 12 = 2 \text{ A}$	1 mark
$I = 24 \div 3 \quad I = 8 \text{ A}$	1 mark
	Total: 2 marks

e) Without further calculation, state what happens, if anything, to the ammeter reading if:

i. the 8 Ω resistor is shorted out with a thick piece of wire.

It stays the same / no change.	1 mark
	Total: 1 mark

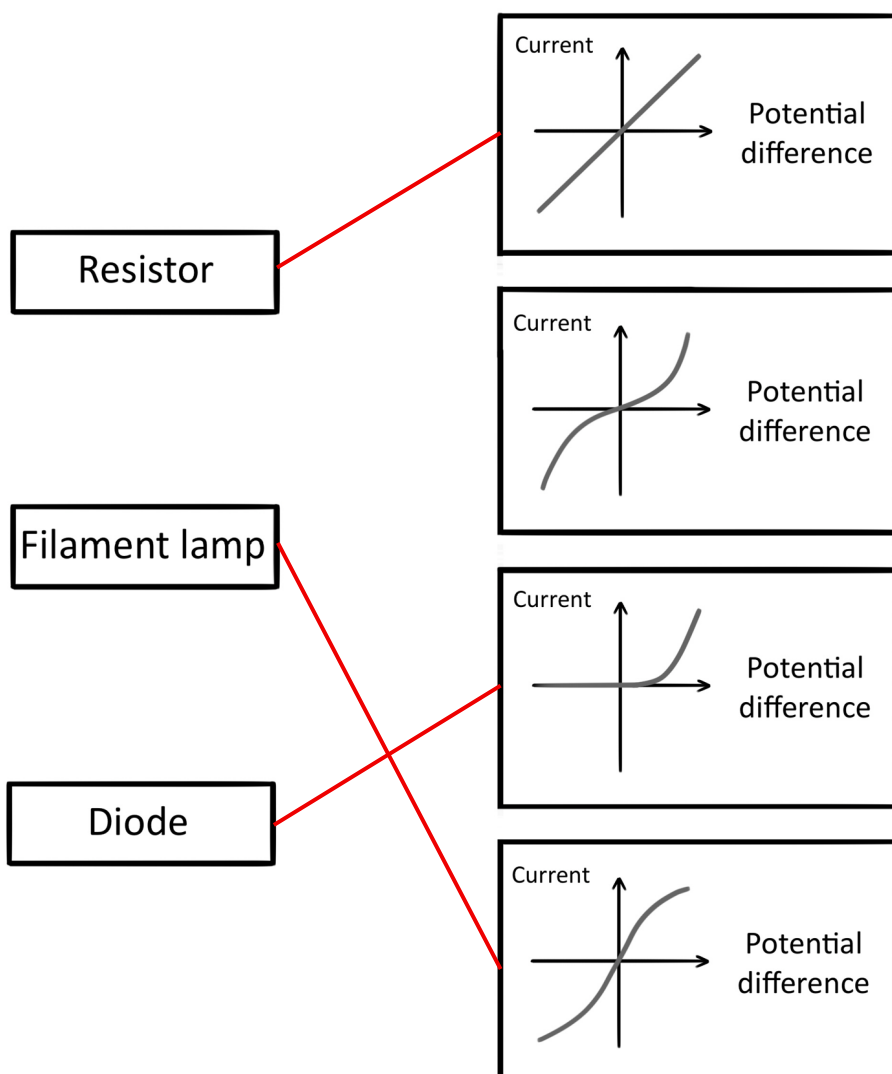
ii. the thick piece of wire from (e)(i) and the 12 Ω resistor are both removed.

It decreases (to 6A).	1 mark
	Total: 1 mark

(Total for Question 2 is 9 marks)

3. A student carries out an experiment to investigate the current-potential difference (I-V) characteristics of three different electrical components. They plot a graph of their results for each component.

a) Draw **one** line from each component to its correct graph.



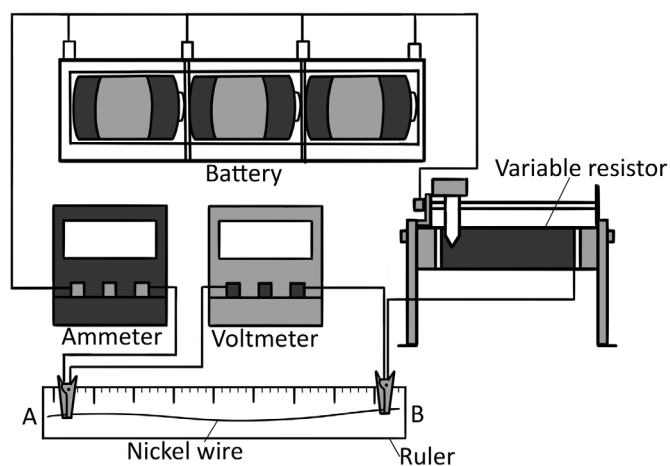
Allow 1 mark for each correct match up.	
	Total: 3 marks

b) What is the function of a diode?

It only allows current to flow in one direction.	1 mark
Allow: it has very high resistance in the reverse direction.	
Reject: Just saying "It stops current" without specifying direction.	
	Total: 1 mark

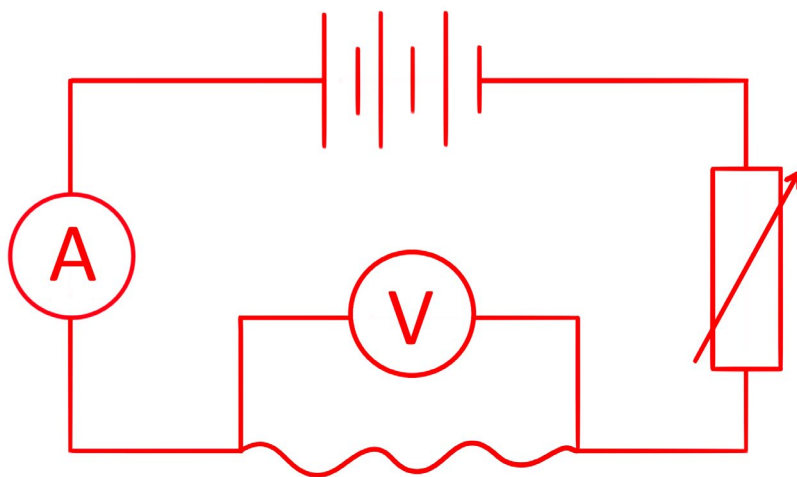
(Total for Question 3 is 4 marks)

4. A student investigates how the current through a fixed resistor changes when the potential difference across it is varied.



- a) Draw a circuit diagram that the student could use for this investigation.
Your circuit must include:

- a battery.
- the nickel wire.
- a variable resistor.
- an ammeter.
- a voltmeter.



Award 1 mark for the correct electrical symbols.

1 mark

Award 1 mark for a three cell battery.

1 mark

Award 1 mark for the ammeter and the voltmeter being used correctly.

1 mark

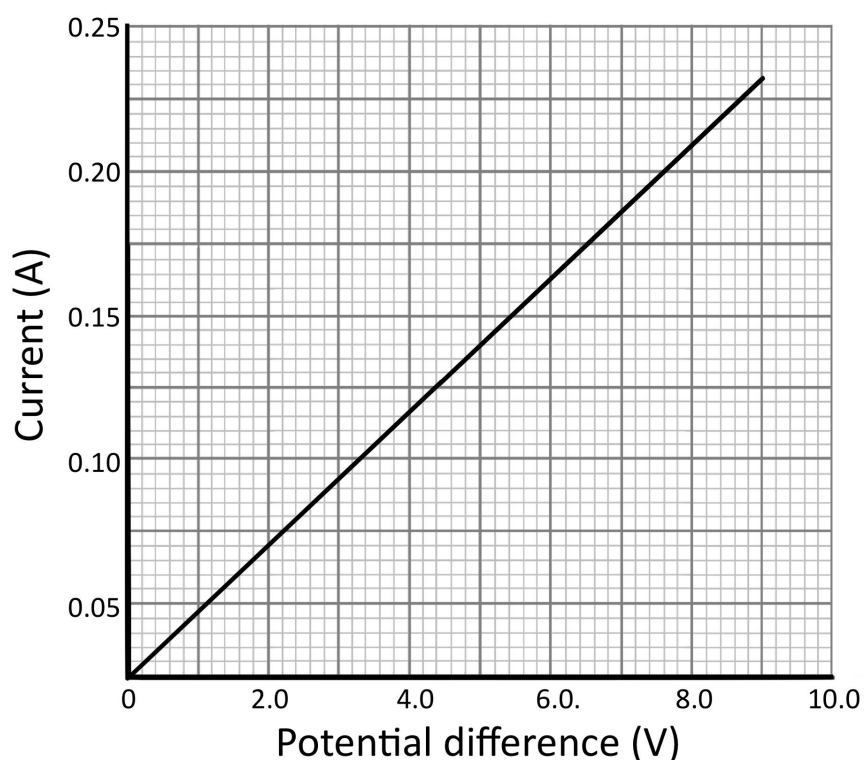
The ammeter being used in series and the voltmeter used in parallel.

Total: 3 marks

b) State the purpose of the variable resistor in this circuit.

Accept either of the following correct responses:	
- To change / vary the current (in the circuit). - To change / vary the potential difference (across the fixed resistor).	1 mark
	Total: 1 mark

The student plots their results on the graph shown in the figure below.



c) State **two** conclusions that can be made from the graph about the relationship between current and potential difference for this resistor.

Award 1 mark for each of the following conclusions:	
The current is directly proportional to the potential difference.	1 mark
(Because) the graph is a straight line that passes through the origin / (0,0).	1 mark
	Total: 2 marks

d) Use the graph in Figure X to determine the resistance of the fixed resistor.

Use the physics equation: $R = V \div I$

Step 1: Read values from the graph.	
Reads any correct pair of coordinates from the line. For example:	
$V = 4.0V$ and $I = 0.10$	1 mark
$R = V \div I$	1 mark
$R = 4.0 \div 0.10$	1 mark
	Total: 3 marks

(Total for Question 4 is 9 marks)

5. A student builds the temperature-sensing circuit shown in the figure below to control a cooling fan in a greenhouse.

- a) Describe the relationship between the temperature of a thermistor and its resistance.

As temperature increases, resistance decreases (and vice versa).	1 mark
Allow: They are inversely proportional or negative correlation.	
	Total: 1 mark

The cooling fan is connected in parallel with the fixed resistor. The fan only turns on when the potential difference across the fixed resistor becomes high enough.

- b) Explain how the circuit causes the potential difference across the fixed resistor to increase when the greenhouse gets hot.

Any four of the following logically sequenced points:	
Examiner note: Award max 4 marks for a complete logical explanation.	
- As the temperature increases, the resistance of the thermistor decreases. - This means the total resistance of the circuit decreases. - Therefore the current flowing through the circuit increases. - Because the fixed resistor has a constant resistance, a higher current means a higher potential difference across it ($V = I \times R$). - The thermistor now takes a smaller share of the total potential difference, leaving a larger share for the fixed resistor.	
	Total: 4 marks

- c) At 20 °C, the thermistor has a resistance of 250 Ω . The fixed resistor has a resistance of 150 Ω .

Calculate the potential difference across the fixed resistor at this temperature.

Step 1: calculate total resistance	
$R_{\text{total}} = 250 + 150 = 400 \text{ } (\Omega)$	1 mark
Step 2: calculate current	
$I = V \div R$ $I = 400 \div 12$ $I = 0.03 \text{ (A)}$	1 mark
Step 3: calculate potential across fixed resistor	
$V = I \times R$ $V = 0.03 \times 150$ $V = 4.5$	1 mark
	Total: 3 marks

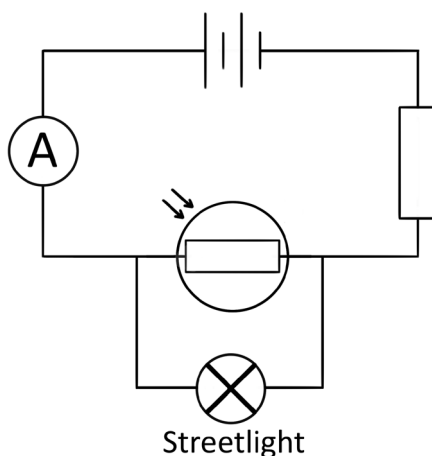
(Total for Question 5 is 8 marks)

6. A student is investigating Light Dependent Resistors (LDRs).

a) State the rule that describes how the resistance of an LDR changes when light intensity changes.

As light intensity increases, the resistance of the LDR decreases (and vice versa).	1 mark
Allow: They are inversely proportional or negative correlation.	
	Total: 1 mark

The student builds the circuit shown in the figure below to model an automatic streetlight.

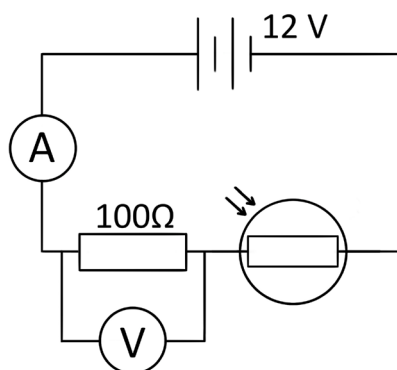


b) Explain how this circuit ensures that the streetlight turns on when it gets dark.

Any four of the following logically sequenced points:	
Examiner note: Award max 4 marks for a complete logical explanation covering both the dark and light states.	
• When it is dark, the resistance of the LDR is very high. • Because they are in parallel, the current takes the path of least resistance. • Therefore most/all of the current flows through the streetlight branch (turning it on). • When it is light, the resistance of the LDR is very low. • The LDR now provides a path of much lower resistance than the lamp, so the current flows through the LDR / bypasses the lamp (turning it off).	
	Total: 4 marks

(Total for Question 6 is 5 marks)

7. A student builds the light-sensing circuit shown in the figure below.



In bright light, the LDR has a resistance of $20\ \Omega$.

When the room goes completely dark, the resistance of the LDR increases by a factor of 10.
Calculate the change in the voltmeter reading when the room goes from bright light to dark.

You must show all your working.

Scenario 1: Bright Light	
Step 1: Calculate total resistance	
$R_{\text{total}} = 100 + 20 = 120\ (\Omega)$	1 mark
Step 2: Calculate current	
$I = 12 \div 120 = 0.10\ \text{A}$	1 mark
Step 3: Calculate potential difference across voltmeter ($100\ \Omega$)	
$V(\text{bright}) = 0.10 \times 100 = 10\ (\text{V})$	1 mark
Scenario 2: Dark room	
Step 4: Calculate new LDR resistance	
$R_{\text{LDR}} = 20 \times 10 = 200\ \Omega$	1 mark
Therefore new $R_{\text{total}} = 300\ \Omega$	
Step 5: Calculate new current and potential difference	
$I = 12 \div 300 = 0.04\ \text{A}$	
$V_{\text{dark}} = 0.04 \times 100 = 4\ \text{V}$	1 mark
Step 6: Calculate the change	
$10\ \text{V} - 4\ \text{V}$	
$V = 6$	1 mark
	Total: 6 marks

(Total for Question 7 is 6 marks)