

Series Circuits

Mark Scheme



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1. A series circuit is a single, continuous loop where the electrical current must flow through every component one after the other.

- a) A student set up a series circuit to determine the resistance of a resistor R.
The figure below shows the circuit the student set up. The meter readings are 2.5 A and 10 V.

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

- b) A student builds a series circuit using a cell and two identical lamps.
The current flowing through the first lamp is 0.4 A.
What is the current flowing through the second lamp?

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

- c) The circuit diagram shows a 10 Ω resistor and a 20 Ω resistor connected in series to a 12 V battery.
What is the current in the battery?

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

- d) A series circuit contains a 12 V battery and two resistors.
The potential difference across the first resistor is 4 V.
What is the potential difference across the second resistor?

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

- e) Which circuit shows a voltmeter measuring the potential difference across a resistor?

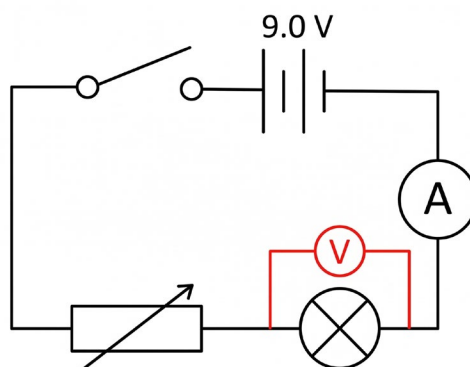
C – is the only correct answer.	1 mark
	Total: 1 mark

- f) A student is investigating the resistance of a fixed resistor.
Which diagram shows the correct way to connect the ammeter and the voltmeter?

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

(Total for Question 1 is 6 marks)

2. A student investigates the electrical properties of a filament lamp.
The student sets up the circuit shown in the figure below.



- a) State the purpose of the variable resistor in this circuit.

Accept any one of the following:	
To change / vary the current (in the circuit). Allow: So they can take multiple readings.	
To change / vary the potential difference (across the filament lamp).	
	Total: 1 mark

- b) The student uses individual cells that each have a potential difference of 1.5 V.

Calculate the number of cells needed to make the 9.0 V battery shown in the circuit.

$9.0 \div 1.5 = 6$	1 mark
	Total: 1 mark

- c) The student needs to measure the potential difference across the filament lamp.
On the figure above, **draw** the correct electrical symbol and connections for this meter.

See diagram above.	
Award 1 mark for the correct electrical symbol.	1 mark
Award 1 mark for the correct location. Which is across the bulb or light.	1 mark
	Total: 2 marks

- d) The student closes the switch.

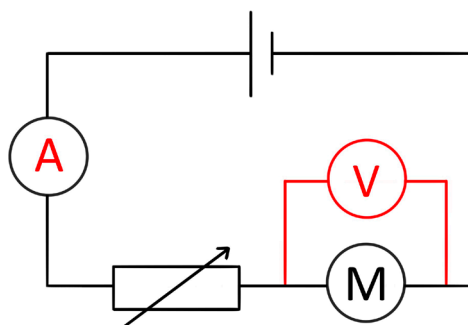
The potential difference across the filament lamp is 5.0 V and the current is 2.4 A.

Calculate the energy transferred by the filament lamp in 1 minute.

$E = V \times I \times t$	1 mark
$E = 5.0 \times 2.4 \times 60$	1 mark
$E = 720 \text{ J}$	1 mark
	Total: 3 marks

(Total for Question 2 is 7 marks)

3. A student uses the circuit in the figure below to investigate a small electric motor.



- a) The student has forgotten to add an ammeter and voltmeter to their circuit.

Draw the symbols for an ammeter and voltmeter on the circuit above and place them correctly to enable the student to use them.

A (for ammeter) drawn inside the empty circle on the left side of the circuit (in series).	2 marks
Voltmeter symbol drawn (V inside a circle). Voltmeter connected in parallel.	1 mark
Voltmeter connected across the motor (M).	1 mark
	Total: 4 marks

- b) The student turns on the circuit. The potential difference across the motor is 12.0 V and the current flowing through it is 2.5 A. Calculate the resistance of the motor.

$R = V \div I$	1 mark
$R = 12.0 \div 2.5$	1 mark
$R = 4.8$	1 mark
	Total: 3 marks

- c) Calculate the power of the electric motor.

$P = V \times I$	1 mark
$P = 12 \times 2.5 = 30$	1 mark
	Total: 2 marks

- d) The student leaves the motor running for **2 minutes**.

Use your answer from part (c) to calculate the electrical energy transferred by the motor in this time.

$E = P \times t$	1 mark
$E = 30 \times 120$	1 mark
$E = 3600$	1 mark
	Total: 3 marks

- e) The student increases the resistance of the variable resistor.

Explain what happens to the reading on the voltmeter.

An explanation to include:	
The reading on the voltmeter decreases.	1 mark
Because the total resistance of the circuit increases, so the current decreases / a larger share of the total potential difference is now taken by the variable resistor.	1 mark
	Total: 2 marks

(Total for Question 3 is 14 marks)

4. A student wanted to determine the resistance of a length of iron wire.
To do this the student set up a series circuit as shown in the figure below.

Using the correct electrical symbols, draw a circuit diagram of the student's circuit.

Use the following symbol to represent the iron wire in your circuit.

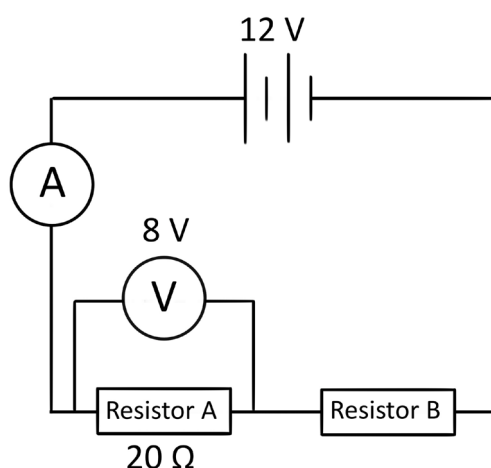


• Circuit diagram to include the following: • Correct symbol for a cell or battery / d.c. power supply. • Correct symbol for an ammeter (A inside a circle). • Correct symbol for a voltmeter (V inside a circle). • Correct symbol for a variable resistor. • The power supply, ammeter, variable resistor, and the wavy line (test wire) are all connected in a single continuous series loop. • The voltmeter is connected in parallel across the wavy line (test wire).	
	Total: 6 marks

(Total for Question 4 is 6 marks)

5. The circuit diagram shows two resistors, A and B, connected in series to a 12 V battery. The voltmeter across resistor A reads 8.0 V. The resistance of resistor A is 20 Ω .

The figure below shows the circuit.

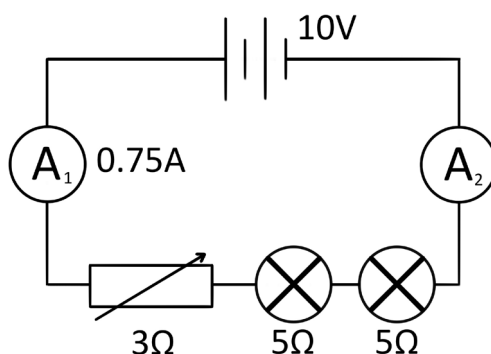


Calculate the total energy transferred by Resistor B when the circuit is switched on for **5 minutes**.

Step 1: Calculate the Current (I) $I = V \div R$ $I = 8 \div 20$ $I = 0.4 \text{ A}$	1 mark
Step 2: Calculate the potential difference across Resistor B (V) $V_{\text{Total}} = \text{voltage of resistor A} + \text{voltage of resistor B}$ $12 \text{ V} = 8 \text{ V} + \text{voltage of resistor B}$ $\text{voltage of resistor B} = 4 \text{ V}$	1 mark
Step 3: Convert Time to seconds $\text{Time to seconds} = 5 \times 60 = 300 \text{ seconds}$	2 marks
Step 4: Calculate Energy for Resistor B $E = V \times I \times t$ $E = 4.0 \times 0.4 \times 300$	1 mark
Final Answer = 480 (J)	1 mark
	Total: 6 marks

(Total for Question 5 is 6 marks)

6. The figure below shows a two lamps and a variable resistor connected in series in a circuit.



- a) Calculate the total resistance of the circuit.

$3 + 5 + 5 = 13$	1 mark
	Total: 1 mark

- b) The ammeter A1 reads 0.75 A.

What will be the reading on ammeter A2?

0.75 A	1 mark
	Total: 1 mark

- c) The resistance of the variable resistor is increased to 7 Ω .

Calculate the current in the circuit at this new resistance.

$R_{\text{total}} = 7 + 5 + 5 = 17 \Omega$	1 mark
$I = V \div R$ $I = 10 \div 17$ $I = 0.59 \text{ A}$	1 mark
	Total: 2 marks

- d) The circuit could be set up with a light dependent resistor (LRD) instead of a variable resistor.
In the box below draw the electrical symbol for a light dependent resistor.

	1 mark
Do not accept any other symbol.	
	Total: 1 mark

e) A manufacturer is designing a new string of 50 decorative fairy lights.

They are deciding whether to connect the 50 lamps in a series circuit or a parallel circuit.

Compare the advantages and disadvantages of connecting the lamps in a series circuit rather than a parallel circuit.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Simple, isolated statements are made about series or parallel circuits. For example, "if one breaks they all break" or "it uses less wire."
Level 2	3 - 4	A relevant comparison that addresses both series and parallel circuits but may lack detail. The student might focus heavily on just the disadvantages of a series circuit, or make points without explaining the underlying circuit rules.
Level 3	5 - 6	A detailed, coherent, and logically structured comparison. The student discusses both advantages and disadvantages of using a series circuit for the fairy lights, clearly contrasting them with a parallel circuit.

Indicative content:	
Disadvantages of a series circuit (advantages of parallel): • If one lamp breaks / blows, the circuit is broken and all the lamps will go out. • It is very difficult to find which specific bulb is broken out of the 50. • In a series circuit, the total potential difference is shared between all 50 lamps. • This means each lamp will receive a very small potential difference and will be very dim (unless a massive power supply is used). • In a parallel circuit, every lamp gets the full potential difference of the power supply (so they are brighter). • You cannot add a switch to control individual lamps in a series circuit (they all turn on/off together). Advantages of a series circuit (disadvantages of parallel): • A series circuit uses much less wire / is easier and cheaper to manufacture. • The total current is lower in a series circuit compared to 50 branches in parallel. • A parallel circuit with 50 branches would draw a very large total current from the power supply. • This large current could cause the wires to overheat, creating a fire hazard. • A series circuit battery will last longer (if battery-operated) because the power/current drawn is lower.	
	Total: 6 marks

(Total for Question 6 is 11 marks)