

Series and parallel circuits

AQA GCSE Physics 8463 and Combined Science Trilogy 8464 | Foundation and Higher | Paper 1

Worked solutions and teaching prompts | 51 practice marks

Specification points covered

8463 4.2.1.1 / 8464 6.2.1.1: interpret standard circuit diagrams
 8463 4.2.1.3 / 8464 6.2.1.3: use $V = IR$; resistor combinations (RP3 / RP15)
 8463 4.2.2 / 8464 6.2.2: series and parallel current, potential difference and resistance

A community centre is choosing emergency-lighting circuits. A class tests the layouts using fixed resistors to model light units. Assume ideal dc supplies, negligible wire resistance and constant resistor temperature. Each test uses the stated supply.

Award equivalent correct methods and sensible rounding. Practice marks are deliberately tight. Allow consistent follow-through in linked parts; do not award a conversion twice. This is an original PhysicsUK resource, not an official AQA mark scheme.

1 Checking the circuit ideas

1(a) Describe how the current paths differ in a series circuit and a parallel circuit. **[2 marks]**

Answer / mark points: A series circuit has one complete path through all its components. [1] A parallel circuit has separate branches, giving more than one complete path. [1]

1(b) A trainee says the second resistor in a series circuit carries less current because the first resistor uses up charge. Explain why this is wrong. **[2 marks]**

Answer / mark points: The current is the same through both resistors. [1] Charge is conserved and is not used up; the resistors transfer energy as charge passes through them. [1]

Teacher prompt: Do not accept current is used up, electricity is used up, or charge changes into energy.

2 Series test loads

Table 1 gives two separate tests. In each test the resistors are connected in series.

Table 1

Test	Supply / V	R_1 / Ω	R_2 / Ω
1	6.0	10	20
2	12	15	25

2(a) For test 1, calculate the total resistance and then the current supplied. **[2 marks]**

Answer / mark points: Total resistance = $10 + 20 = 30 \Omega$. [1]
 $I = V / R = 6.0 / 30 = 0.20 \text{ A}$. [1]



2 Series test loads continued

2(b) Repeat the calculation of total resistance and supply current for test 2. [2 marks]

Answer / mark points: Total resistance = $15 + 25 = 40 \Omega$. [1]
 $I = 12 / 40 = 0.30 \text{ A}$. [1]

2(c) In test 2, calculate the potential difference across R_1 and across R_2 . [2 marks]

Answer / mark points: Across R_1 : $V = IR = 0.30 \times 15 = 4.5 \text{ V}$. [1]
 Across R_2 : $V = 0.30 \times 25 = 7.5 \text{ V}$. [1] The two values add to the 12 V supply.

Teacher prompt: Series components share potential difference, not necessarily equally.

2(d) In test 2, change R_2 to 45Ω . The supply stays at 12 V. Calculate the new current. [2 marks]

Answer / mark points: New total resistance = $15 + 45 = 60 \Omega$. [1]
 $I = 12 / 60 = 0.20 \text{ A}$. [1]

3 Reading the two lighting layouts

In both circuits in Figure 1, $R_1 = 10 \Omega$ and $R_2 = 20 \Omega$. Both switches are closed.

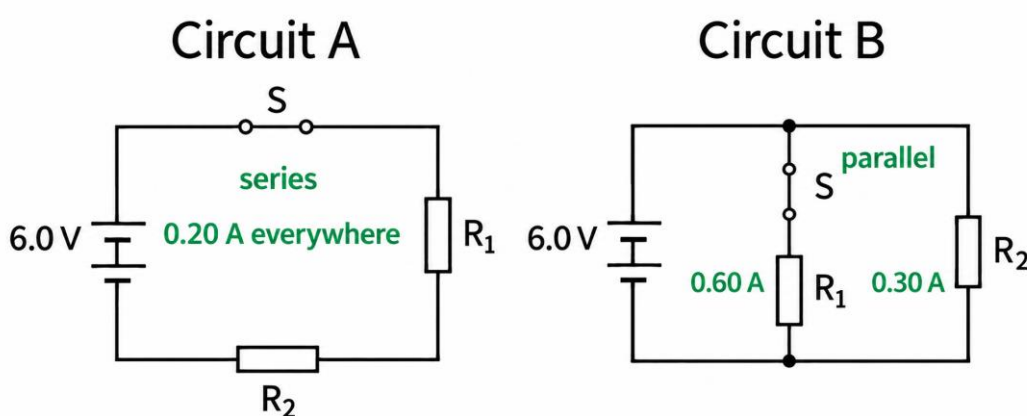


Figure 1

3(a) Circuit A carries 0.20 A through R_1 . State the current through R_2 . [1 mark]

Answer / mark points: 0.20 A. [1] Both resistors lie in the same unbranched loop.

3(b) For Circuit A, calculate the potential difference across each resistor. [2 marks]

Answer / mark points: Across R_1 : $0.20 \times 10 = 2.0 \text{ V}$. [1]
 Across R_2 : $0.20 \times 20 = 4.0 \text{ V}$. [1]

3(c) State the potential difference across each resistor in Circuit B. [1 mark]

Answer / mark points: 6.0 V across R_1 and 6.0 V across R_2 . [1 for both] Each branch is across the supply.



3 Reading the two lighting layouts continued

3(d) For Circuit B, calculate the current through R_1 and the current through R_2 . [2 marks]

Answer / mark points: Through R_1 : $I = 6.0 / 10 = 0.60$ A. [1]
Through R_2 : $I = 6.0 / 20 = 0.30$ A. [1]

3(e) Calculate the total current supplied in Circuit B. [1 mark]

Answer / mark points: Total current = $0.60 + 0.30 = 0.90$ A. [1]

3(f) Measurements give 6.0 V across Circuit B and 0.90 A total current. Use $V = IR$ to determine its total resistance. [1 mark]

Answer / mark points: Total resistance = $V / I = 6.0 / 0.90 = 6.67 \Omega$, approximately 6.7 Ω . [1]

Teacher prompt: This uses measured supply values, not the reciprocal-resistance formula. Do not use just one branch current.

4 Changes and faults

Use Figure 1 with its original resistor values unless a question states a change.

4(a) Add a 24 Ω parallel branch to Circuit B. Calculate its current and the new supply current. [2 marks]

Answer / mark points: Third-branch current = $6.0 / 24 = 0.25$ A. [1]
New total current = $0.60 + 0.30 + 0.25 = 1.15$ A. [1]

4(b) In the original Circuit B, open S. State the new supply current and explain why it is not zero. [2 marks]

Answer / mark points: The total supply current is 0.30 A. [1] R_1 has no complete path, but the separate R_2 branch still has a complete path across 6.0 V. [1]

4(c) Open S in Circuit A. State the current through each resistor and explain your answer. [2 marks]

Answer / mark points: The current through each resistor is 0 A. [1] Opening S breaks the only complete path, so no charge flows around the loop. [1]

4(d) A trainee adds 10 Ω and 20 Ω and claims Circuit B has a total resistance of 30 Ω . Explain why this cannot be correct. [2 marks]

Answer / mark points: The total parallel resistance must be less than the smaller individual resistance, 10 Ω . [1] Adding a parallel branch provides another current path, increasing the total current at the same potential difference and therefore decreasing total resistance. [1]

Teacher prompt: Do not require equal branch resistances. Do not add parallel resistances.

4(e) The real light units each need 6.0 V and must operate independently. Choose layout A or B. Explain how it meets both requirements and why A is unsuitable. [3 marks]

Answer / mark points: Choose B: each light receives the full 6.0 V supply. [1] Opening one branch leaves the other complete, so the other light can still operate. [1] A shares the supply potential difference between the lights and opening its switch breaks the only path for both. [1]

Teacher prompt: Do not calculate real light-unit currents using the test-resistor model unless resistance data are supplied.



5 A control-panel circuit

Figure 2 models a control panel. Z is in series with the parallel X and Y branches. The measured current through X is 0.20 A.

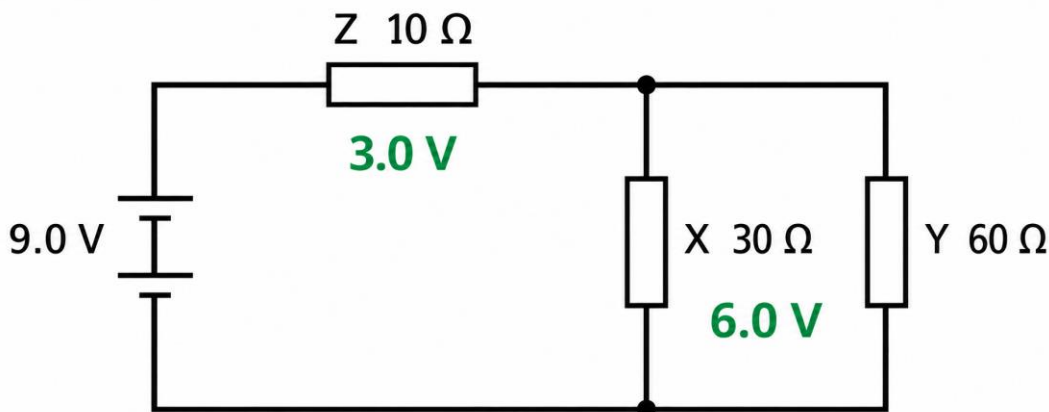


Figure 2

5(a) Calculate the potential difference across X. [1 mark]

Answer / mark points: $V = IR = 0.20 \times 30 = 6.0 \text{ V}$. [1]

5(b) Calculate the current through Y. [1 mark]

Answer / mark points: Y is in parallel with X, so its potential difference is 6.0 V. $I = V / R = 6.0 / 60 = 0.10 \text{ A}$. [1]

5(c) State the current through Z and show how you obtain it. [1 mark]

Answer / mark points: Current through Z = $0.20 + 0.10 = 0.30 \text{ A}$. [1] It is the total current before the split.

5(d) Calculate the potential difference across Z. [1 mark]

Answer / mark points: $V = IR = 0.30 \times 10 = 3.0 \text{ V}$. [1]

5(e) A pupil says all three resistors have 3.0 V across them because 9.0 V is divided equally by three. Explain the error and show the correct supply-voltage check. [2 marks]

Answer / mark points: X and Y are parallel branches and each has 6.0 V, whereas Z has 3.0 V. [1] A complete loop contains Z and either X or Y: $3.0 + 6.0 = 9.0 \text{ V}$. [1] Do not add the potential differences across two alternative branches.

Teacher prompt: Potential difference is shared along a complete path, not divided by the number of components in the whole diagram.

5(f) Replace Z with a connecting wire, keeping the 9.0 V supply. Calculate the new current through X, through Y and from the supply. [3 marks]

Answer / mark points: X and Y are now directly across 9.0 V. Through X: $9.0 / 30 = 0.30 \text{ A}$. [1]
Through Y: $9.0 / 60 = 0.15 \text{ A}$. [1]
Supply current = $0.30 + 0.15 = 0.45 \text{ A}$. [1]



6 Comparing resistor combinations

A class uses the same two $20\ \Omega$, $1\ \text{W}$ fixed resistors and a $3.0\ \text{V}$ dc supply. Table 2 gives measurements at constant temperature. This supports RP3 / RP15; it is not the full practical.

Table 2

Arrangement	Potential difference / V	Total current / mA
Single resistor	3.0	150
Two in series	3.0	75
Two in parallel	3.0	300

6(a) To determine the resistance of a complete resistor combination, describe where to connect the ammeter and the voltmeter. **[2 marks]**

Answer / mark points: Connect the ammeter in series in the main supply path to measure the total current. [1] Connect the voltmeter in parallel across the whole resistor combination. [1]

Teacher prompt: For a series pair, the voltmeter must span both resistors, not just one.

6(b) Use Table 2 to calculate the resistance of each arrangement. Show the current conversions. **[3 marks]**

Answer / mark points: Single: $150\ \text{mA} = 0.150\ \text{A}$; $R = 3.0 / 0.150 = 20\ \Omega$. [1]

Series: $75\ \text{mA} = 0.075\ \text{A}$; $R = 3.0 / 0.075 = 40\ \Omega$. [1]

Parallel: $300\ \text{mA} = 0.300\ \text{A}$; $R = 3.0 / 0.300 = 10\ \Omega$. [1]

Teacher prompt: One mark for each correct converted calculation. A repeat of the equation alone is not an extra mark.

6(c) Explain why adding a second resistor increases total resistance in series but decreases it in parallel. Use the fixed supply potential difference in your explanation. **[2 marks]**

Answer / mark points: In series the additional resistor increases opposition along the same path, so the current decreases at fixed potential difference and V / I increases. [1] In parallel there is another path, so total current increases at fixed potential difference and V / I decreases. [1]

Teacher prompt: A complete explanation links the path arrangement to current and resistance, not simply bigger or smaller.

6(d) Describe a reliable procedure for comparing the three arrangements using the same resistors. Include reconnection, temperature control, repeat measurements and how to use the readings. **[4 marks]**

Answer / mark points: Switch off before reconnecting the same resistors as single, series and parallel arrangements; check connections and use the same $3.0\ \text{V}$ supply setting. [1]
Keep resistor temperature constant: use short measurement periods, switch off between readings and allow cooling to the same temperature if needed. [1]
Record paired potential-difference and total-current readings for each arrangement, repeat under the same conditions and calculate means. [1]
Convert current to A, calculate total resistance using V / I for each arrangement and compare the results. [1] Accept a coherent equivalent procedure.

Teacher prompt: Repeated readings do not remove systematic error. Accept averaging repeated resistance values calculated from each paired reading.

Review and improve

Check complete paths, shared potential difference, total versus branch current, and charge not being used up.

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