

Series and parallel circuits

6.2.2 · Physics · revision notes

The rules for current, potential difference and resistance in series and parallel circuits, and how to use them in multi-step calculations. You need to explain why adding resistors in series increases the total resistance but adding them in parallel decreases it. You do not need to calculate the total resistance of resistors in parallel.

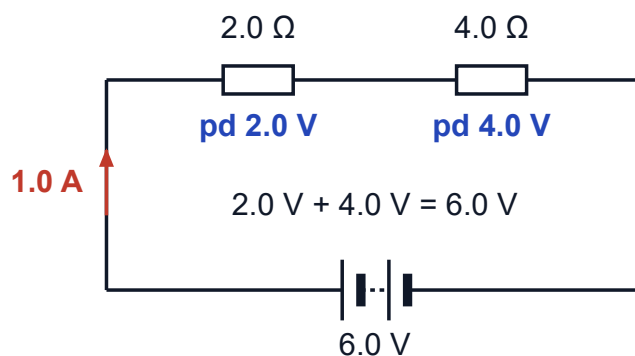
Key facts

- Series: same current through each component
- Series: $R_{\text{total}} = R_1 + R_2$
- Parallel: $I_{\text{total}} = I_1 + I_2$
- Add a resistor in series → total resistance up; in parallel → total resistance down
- Series: $V_{\text{total}} = V_1 + V_2$ (pd is shared)
- Parallel: same pd across each branch
- Parallel: total resistance is less than the smallest resistor

Notes

Series circuits

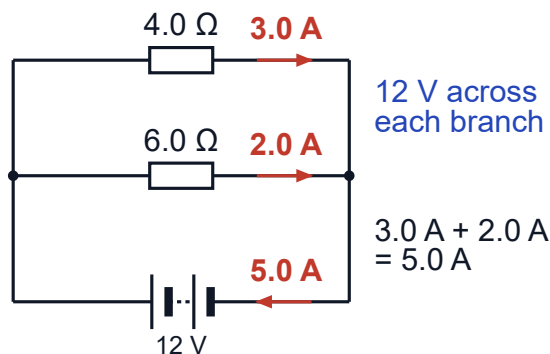
- Components in **series** are connected one after another in a single loop.
- The **current** is the same through each component.
- The total pd of the supply is **shared** between the components: $V_{\text{total}} = V_1 + V_2$.
- The total resistance is the sum of the resistances: $R_{\text{total}} = R_1 + R_2$.
- The component with the bigger resistance gets the bigger share of the pd, because $V = I R$ and the current is the same.



Series: same current; the pds add up to the supply pd ($R_{\text{total}} = 6.0 \Omega$).

Parallel circuits

- Components in **parallel** are each on their own branch, connected across the same two points.
- The **pd across each branch is the same**. If each branch is connected straight across the supply, each branch has the full supply pd.
- The total current is the sum of the currents through the branches: $I_{\text{total}} = I_1 + I_2$.



Parallel: same pd across each branch; the branch currents add up.

- The total resistance of two resistors in parallel is **less than the smallest** of the two resistances.
- Each branch can have its own switch, so each component can be turned on and off separately.

Don't lose marks

- ✗ Adding the resistances of resistors in parallel as if they were in series.
- ✗ Saying the current is shared in a series circuit. It is the pd that is shared; the current is the same.
- ✗ Using the whole supply pd with just one resistor in a series circuit.
- ✗ Thinking the total resistance in parallel is between the two values. It is less than the smallest.
- ✗ Explaining total resistance with just 'there are more resistors' without mentioning pd and current.

More tips

Memory tricks

- Series: Same current, Shared pd. Parallel: same Pd, current sPlits.
- Check a series answer: the pds must add up to the supply pd.
- Check a parallel answer: the total current must be bigger than any one branch current.
- Parallel sense check: the total resistance is always smaller than the smallest resistor.

Exam technique

- Label the circuit diagram with every value you know or work out (V, I and R).
- Write the rule you are using, e.g. 'series, so same current', so the examiner can follow your method.
- In 'explain' questions about total resistance, always mention both the pd and the current.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3**Tell series and parallel circuits apart**

Series: one loop, one path. Parallel: two or more branches connected across the same two points.

Grade 4**State the series and parallel rules**

Series: same current, pd shared. Parallel: same pd across each branch, branch currents add up.

Grade 4**Add resistances in series**

Use $R_{\text{total}} = R_1 + R_2$.

Grade 5**Find a missing current or pd**

e.g. the supply pd equals the sum of the pds in series; the total current equals the sum of the branch currents.

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