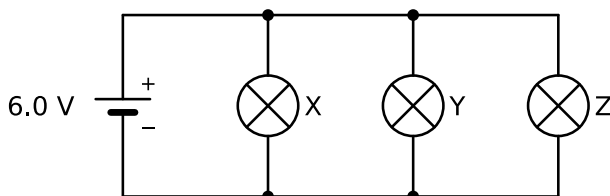


Part A: Concepts

1. Three identical bulbs X, Y, and Z are connected in parallel to a 6.0 V battery.



- a. What is the voltage across each bulb? Explain.
- b. Bulb Y burns out. What happens to bulbs X and Z? Explain.
- c. A fourth identical bulb is added on a new branch. What happens to the total resistance, the total current from the battery, and the brightness of X?
 - a. **6.0 V** each. Every branch connects straight across the battery, so each gets the full battery voltage.
 - b. X and Z **stay lit** at the same brightness. Each has its own path to the battery, so a break in Y's branch does not open their loops.
 - c. The total resistance **decreases** (another path), so the total current **increases**. X keeps the same 6.0 V and the same current, so its brightness **does not change**.

Part B: Solving Parallel Circuits

Show your equations, substitutions, and answers with units.

2. A 10. Ω resistor and a 15 Ω resistor are connected in parallel. Find their total resistance. Explain why your answer must be less than 10. Ω .

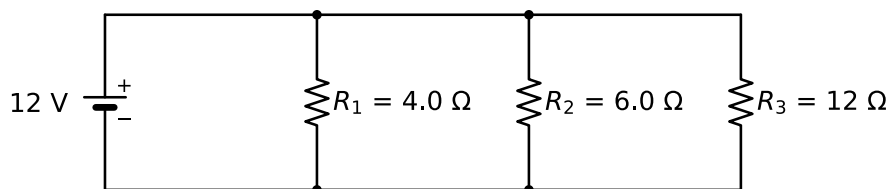
Equation: $1/R_T = 1/R_1 + 1/R_2$

Substitute: $1/R_T = 1/10. + 1/15 = 3/30 + 2/30 = 5/30$ (in $1/\Omega$)

Flip: $R_T = 30/5 \Omega$. **Answer:** $R_T = 6.0 \Omega$

Adding a second branch gives charge another path, so the total resistance is always less than the smallest branch.

3. For the circuit shown, find the current in each branch, the total current, and the total resistance.



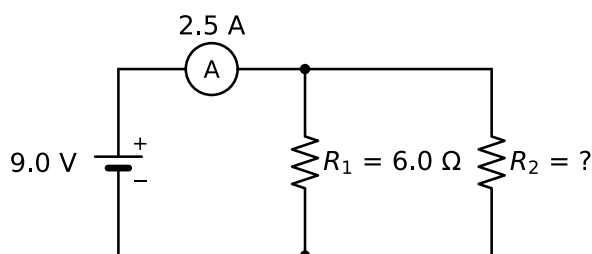
Branch voltage: each branch gets the full 12 V

$$I_1 = 12 \text{ V} / 4.0 \, \Omega = \mathbf{3.0 \text{ A}}, I_2 = 12 \text{ V} / 6.0 \, \Omega = \mathbf{2.0 \text{ A}}, I_3 = 12 \text{ V} / 12 \, \Omega = \mathbf{1.0 \text{ A}}$$

Total current: $I = 3.0 \text{ A} + 2.0 \text{ A} + 1.0 \text{ A} = \mathbf{6.0 \text{ A}}$

Total resistance: $R_T = V/I = 12 \text{ V} / 6.0 \text{ A} = \mathbf{2.0 \, \Omega}$. Check: $1/R_T = 1/4.0 + 1/6.0 + 1/12 = 3/12 + 2/12 + 1/12 = 6/12$, so $R_T = 2.0 \, \Omega$.

4. The ammeter on the main wire reads 2.5 A. Find the current through R_1 , the current through R_2 , and the resistance R_2 .



Through R_1 : $I_1 = V/R_1 = 9.0 \text{ V} / 6.0 \, \Omega = \mathbf{1.5 \text{ A}}$

Through R_2 : junction rule, $I = I_1 + I_2$, so $I_2 = 2.5 \text{ A} - 1.5 \text{ A} = \mathbf{1.0 \text{ A}}$

Resistance: $R_2 = V/I_2 = 9.0 \text{ V} / 1.0 \text{ A} = \mathbf{9.0 \, \Omega}$

5. A 120 V kitchen circuit has a 20. A breaker. A 12 Ω coffee maker, a 20. Ω blender, and a 24 Ω toaster are all plugged in and turned on at the same time.
- Find the current through each appliance.
 - Will the breaker trip? Show how you know.
 - Which one appliance should be unplugged to lower the total current the most? What is the new total current?
 - Why are homes wired in parallel instead of series?
- a.** Each gets 120 V. Coffee maker: $120 \text{ V} / 12 \, \Omega = \mathbf{10. \text{ A}}$. Blender: $120 \text{ V} / 20. \, \Omega = \mathbf{6.0 \text{ A}}$. Toaster: $120 \text{ V} / 24 \, \Omega = \mathbf{5.0 \text{ A}}$.
- b.** $I = 10. \text{ A} + 6.0 \text{ A} + 5.0 \text{ A} = 21 \text{ A}$. That is more than 20. A, so **yes, the breaker trips**.
- c.** The **coffee maker**, because it draws the most current. The new total is $6.0 \text{ A} + 5.0 \text{ A} = \mathbf{11 \text{ A}}$, safely under 20. A.
- d.** In parallel every device gets the full 120 V and can be turned on or off without affecting the others. In series one device turning off would shut off everything, and the voltage would be shared.