PARALLEL CIRCUITS

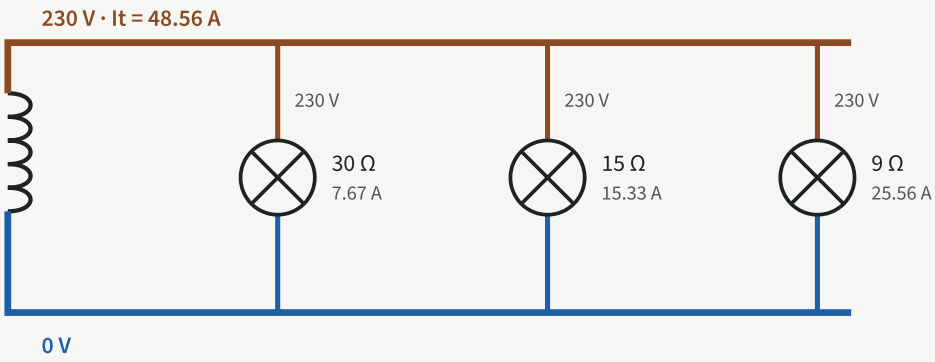
WHY DOES ADDING MORE LOADS MAKE THE TOTAL RESISTANCE GO DOWN?

Each load gets its own connection **directly across line and neutral**, so each one sees the full 230 V. **This is how electricians wire circuits** in buildings.

Open circuit — There's a break in the path, so there's no potential difference and **no current flows**.

Closed circuit — The path is complete, so current can flow.

In parallel, if the cable to one lamp breaks, the other lamps still have their own path to line and neutral, so **they stay on**. A blown bulb in the bedroom doesn't put out every light in the house.



Every branch has the full 230 V across it. The current splits between the branches, and the lowest resistance takes the most current.

Parallel rules Voltage is **constant**: every load gets the full supply voltage. Current **divides** between the branches, and the branch currents add up to the total.

$1/R_t = 1/R_1 + 1/R_2 + 1/R_3 \ldots$

Total resistance is **always lower than the lowest resistor**. Use that to check your answer.

WORKED EXAMPLE: 30 Ω, 15 Ω AND 9 Ω IN PARALLEL ON 230 V

```
1) Total resistance
   1/Rt = 1/30 + 1/15 + 1/9
        = 0.0333 + 0.0667 + 0.1111 = 0.2111
   Rt   = 1 ÷ 0.2111 = 4.74 Ω     (lower than 9 Ω ✓)

2) Total current (Ohm's law)
   It = V ÷ Rt = 230 ÷ 4.7368 = 48.56 A   (full Rt kept)

3) Branch currents (Kirchhoff's current law check)
   I₁ = 230 ÷ 30 =  7.67 A
   I₂ = 230 ÷ 15 = 15.33 A
   I₃ = 230 ÷ 9  = 25.56 A
   Total = 48.56 A ✓
```

MORE PRACTICE

```
20 Ω, 10 Ω, 121 Ω:
   1/Rt = 0.05 + 0.1 + 0.0083 = 0.1583 → Rt = 6.32 Ω

7 Ω, 11 Ω, 36 Ω:
   1/Rt = 0.1429 + 0.0909 + 0.0278 = 0.2615 → Rt = 3.82 Ω

25 Ω, 42 Ω, 21 Ω  (try it yourself first)
   1/Rt = 0.04 + 0.0238 + 0.0476 = 0.1114 → Rt = 8.97 Ω
```

Calculator method (fx-85GT)

The `x⁻¹` key means "1 over". Type `30 x⁻¹ + 15 x⁻¹ + 9 x⁻¹ =`. If it shows a fraction, press `S⇔D` to get 0.2111. **That's 1/Rt, not your answer.** Press `x⁻¹ =` again to flip it: **4.74 Ω**. Forgetting that last flip is the most common mistake. Keep the full numbers in the calculator until the end, because rounding halfway through gives you answers that are slightly off.

Why "1 over"? The bath analogy

There's **one** bath (the whole circuit). A series circuit is like a single plug hole with more plugs stacked under it, so the water drains slowly. A parallel circuit is like a plug with **several holes**, so the water has lots of paths out at once. More paths means more flow, which means less total resistance.

Only two resistors?

You can use product over sum: `Rt = (R₁ × R₂) ÷ (R₁ + R₂)`. With three or more, use the 1/Rt formula. That's the one the awarding body expects.

A **voltmeter** is always connected **across** a load, in parallel with it, because voltage is constant in parallel.

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