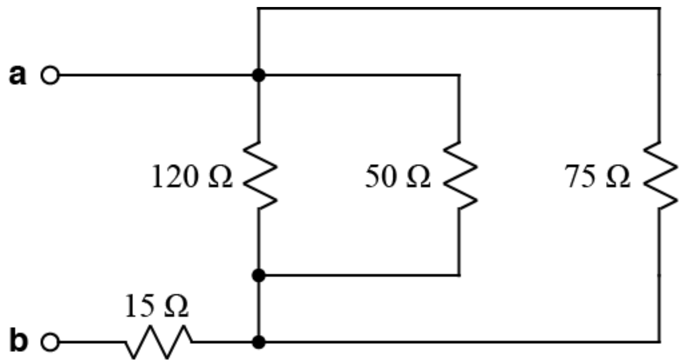
EX:



Find the value of total resistance between terminals **a** and **b**.

SOL'N: The 120 Ω and 50 Ω resistors are in parallel because their opposite ends are connected directly to each other by wires. That is, they are connected by wires on the top side, and they are connected by wires on the bottom side. By the same argument, however, the 75 Ω resistor is also in parallel with the 120 Ω and 50 Ω resistors. We may compute the parallel resistance in various ways, such as combining any two and using the product over sum formula—and then combining that answer with the third resistor using the product over sum formula (which is only correct for two resistors at a time). Alternatively, we may compute the parallel resistance for all three resistors at once using the sum-of-conductance formula, which works for any number of resistors. Both approaches are shown here. The product over sum approach is shown first. The 50 Ω and 75 Ω values are combined first because they have a large common factor:

$$50\,\Omega \,\|\, 75\,\Omega = 25\,\Omega \cdot 2 \,\|\, 3 = 25\,\Omega \cdot \frac{2 \cdot 3}{2+3} = 25\,\Omega \cdot \frac{6}{5} = 30\,\Omega$$

We replace the 50 Ω and 75 Ω resistors with a single 30 Ω resistor, leaving 30 Ω in parallel with 120 Ω.

$$30\,\Omega \,\|\, 120\,\Omega = 30\,\Omega \cdot 1 \,\|\, 4 = 30\,\Omega \cdot \frac{1 \cdot 4}{1+4} = 30\,\Omega \cdot \frac{4}{5} = 24\,\Omega$$

We replace the 50 Ω, 75, and 120 Ω resistors resistors with a single 24 Ω resistor, leaving two resistors in series, (24 Ω and 15 Ω), whose values sum:

$$R_{ab} = 24\,\Omega + 15\,\Omega = 39\,\Omega$$

By coincidence, 39 Ω is a standard 10% tolerance resistor value sold in the EE Stockroom.

The alternative approach using the sum of conductances proceeds as follows:

$$120\,\Omega \parallel 50\,\Omega \parallel 75\,\Omega = \frac{1}{\frac{1}{120} + \frac{1}{50} + \frac{1}{75}}$$

Multiplying top and bottom by the least common multiple of the resistances yields the parallel resistance value:

$$120\,\Omega \parallel 50\,\Omega \parallel 75\,\Omega = \frac{1\,\Omega}{\frac{1}{120} + \frac{1}{50} + \frac{1}{75}} \cdot \frac{600}{600} = \frac{600\,\Omega}{5 + 12 + 8} = \frac{600\,\Omega}{25} = 24\,\Omega$$

The calculation of the total resistance then proceeds as before by summing the series resistances to obtain R_{ab} = 29 Ω.