FLIPPED around PHYSICS

5.4.1 More about resistance

Adding resistors

videos

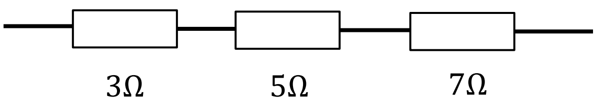
The overall resistance of several resistors depends on whether they are combined in series or parallel. It is worth recalling the following equation:

$$R = \frac{\rho l}{A}$$

where R = resistance of a length of conductor, ρ = resistivity of the material, l = length and A = cross-sectional area

We can see that the resistance increases in proportion to the length, and inversely to the cross-sectional area.

When we add resistors one after the other, the resistance increases. This is analogous to increasing the length of the conductor (in the equation above).



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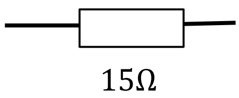
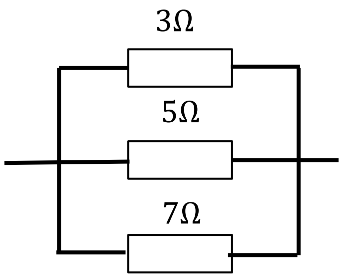


In fact, the rule for adding resistors in series is very simple. The total resistance is the sum of the resistances.

$$R_{total} = R_1 + R_2 + R_3 + \cdots$$

When we add resistors side by side, in parallel, the resistance decreases. This is analogous to increasing the cross-sectional area (in the equation at the top). We find that the total resistance is given by:

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$$



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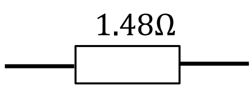
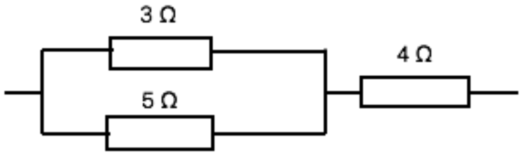
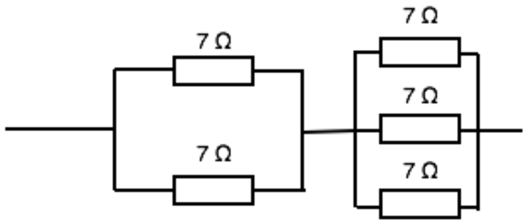


(1)✏What is the equivalent resistance for the following resistor combinations?





Heating caused by resistance

When current passes through a material which has resistance, the material heats up, and the charges lose energy. For electrons flowing through metal wires the electrons collide with the metal ions causing them to vibrate. The electrons lose kinetic energy in this process. Temperature is a measure how strongly the ions vibrate.

The power (*P*) lost through heating as it passes through a piece of material can be calculated. Remember that power is current x voltage (*P=IV*). Also recall ohm's law (*V=IR*).
(2)✏If the voltage dropped across the piece of material is IR (from ohm's law), substitute this for V in the equation for power.

Power is energy per second:

$$P = \frac{E}{t}$$

where E is energy in joules and t is the time in seconds

(3)✏Write down a formula (using I, R and t) to calculate the heat energy E produced in a time t.

(4)✏Looking at this formula, can you explain why overhead power lines in the National Grid carry electricity at very high voltage?