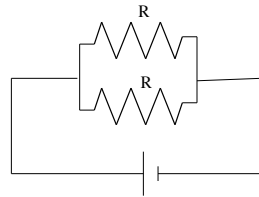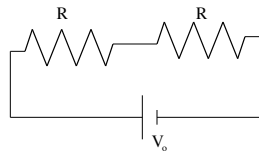## Series/Parallel Power Problem

Two resistors each of magnitude R are wired in series across a battery of voltage V_o. In this configuration, it is observed that the power dissipated by the resistor combination is 5 watts. If the same resistors are then place in a parallel combination and put across the same power supply, how much power will then dissipate?


With the equivalent resistance for the series combination, we can assume it draws i_o worth of current so that it's power rating will be:

$$P_{series} = i_o^2(2R)$$
$$\Rightarrow \quad 5 = i_o^2(2R)$$
$$\Rightarrow \quad i_o^2 R = 2.5$$

The equivalent resistance of the parallel combination is a quarter as large as the equivalent resistance of the series circuit, so that circuit will draw 4 times as much current as the series combination. Doing the power relationship for that, then, we get:

$$P_{parallel} = (4i_o)^2 \left(\frac{R}{2}\right)$$
$$= 8\, i_o^2 R$$

But $i_o^2 R = 2.5$, so evidently $P_{parallel} = 8\, i_o^2 R = 8(2.5 \text{ watts}) = 20 \text{watts}$. In other words, the power dissipated is 4 times greater for the one circuit than the other.
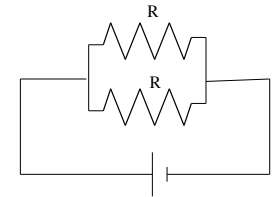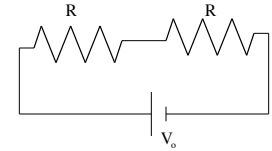
Two resistors each of magnitude R are wired in series across a battery of voltage V_0. In this configuration, it is observed that the power dissipated by the resistor combination is 5 watts. If the same resistors are then place in a parallel combination and put across the same power supply, how much power will then dissipate?
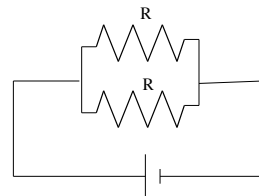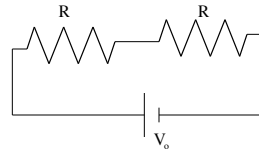
The key is in noticing two things. First, by changing the arrangement of resistors we've changed the equivalent resistance of the circuit. Second, with the equivalent resistance having changed, the current through the combination will change. They two changes are important because the power is related to both the net size of the resistance dissipating the power AND the current through that resistance (both of which have changed).

Start by determining the equivalent resistance of each combination:

$$R_{series} = 2R$$
$$R_{parallel} = \frac{R}{2}$$