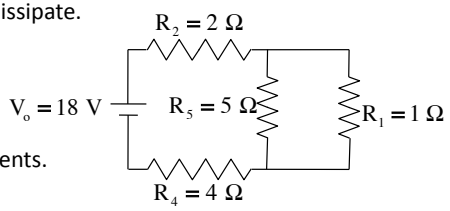
Problem 28.17

How much power does each resistor dissipate.



Almost always, we are looking for currents. With those, we can determine:

$$P = i^2R$$

The equivalent resistance is:

$$R_{eq} = R_2 + R_4 + \left(\frac{1}{R_5} + \frac{1}{R_1}\right)^{-1}$$
$$= (2\ \Omega) + (4\ \Omega) + \left(\frac{1}{5\ \Omega} + \frac{1}{1\ \Omega}\right)^{-1}$$
$$= 6.83\ \Omega$$

The current drawn from the battery is:

$$i_o = \frac{V_o}{R_{equ}}$$
$$= \frac{18\ V}{6.83\ \Omega}$$
$$= 2.64\ A$$

The power dissipated by the 2 ohm and 4 ohm resistors are:

$$P_2 = i^2R_2 \qquad P_4 = i^2R_4$$
$$= (2.64\ A)^2(2\ \Omega) \qquad = (2.64\ A)^2(4\ \Omega)$$
$$= 13.94\ W \qquad = 27.88\ W$$

So how much power is left over?

The power provided by the battery is:

$$P_{battery} = i_oV_o$$
$$= (2.64\ A)(18\ V)$$
$$= 47.52\ W$$

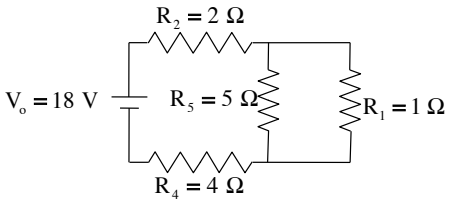
The total power dissipated by the 2 ohm and 4 ohm resistors is:

$$P_2 + P_4 = (13.94\ W) + (27.88\ W)$$
$$= (41.82\ W)$$

The two resistors we've already taken care of will dissipate 41.82 watts. The power supply has provided 47.52 watts. That means there is 5.7 watts left to accommodate the other two resistors.

Look at the parallel part of the circuit, the current flowing into the parallel combination will be 2.64 amps.

If the current is broken into six parts, 5 will pass through the 1 ohm resistor and 1 will move through the 5 ohm resistor. That means:



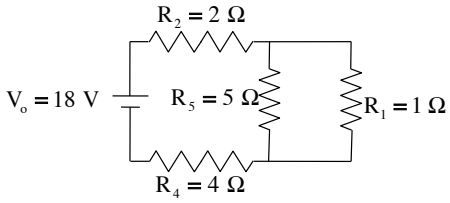
$$i_5 = \frac{1}{6}i_o = \frac{1}{6}(2.64\ A)$$
$$= .44\ A$$

That means the power the 5 ohm resistor dissipates is:

$$P_5 = i_5^2R_5$$
$$= (.44\ A)^2(5\ \Omega)$$
$$= .968\ W$$

The current through the 1 ohm resistor will be:

$$i_1 = \frac{5}{6} i_o = \frac{5}{6}(2.64\ \text{A}) = 2.2\ \text{A}$$



That means the power the 1 ohm resistor dissipates is:

$$P_1 = i_1^2 R_1 = (2.2\ \text{A})^2 (1\ \Omega) = 4.84\ \text{W}$$

As expected, the sum of those power quantities is 4.84 watts +.968 watts = 5.8 watts. Give or take round-off error, this is the amount of power we expected would be available to these two resistors.