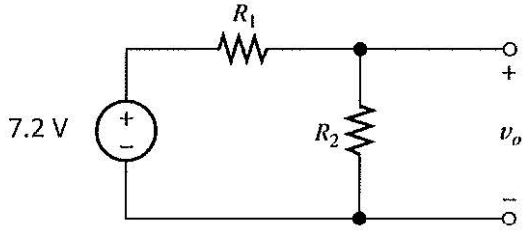
RBE 1001 B19 HW3 CIRC1

1) A robot operated by a 7.2 V battery uses sensors that require a supply voltage (v_o) of 4.3 V. You use the "voltage-divider" circuit as shown.
   a) Find R_1 and R_2 in the circuit below if the current drawn from the 7.2 V battery is to be 30 mA.
   b) Now suppose that a 152 Ω load resistance is connected across the output terminals representing the sensor. Find the new value of v_o.



$V_o = V_{R_2} = I R_2$

$R_2 = \frac{V_{R_2}}{I} = \frac{4.3(V)}{0.030(A)}$

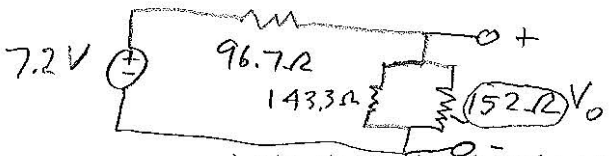
$V_{R_1} = 7.2(V) - 4.3(V) = 2.9(V)$

$R_2 = 143.3\,\Omega$

$R_1 = \frac{V_{R_1}}{I} = \frac{2.9(V)}{0.030(A)} = 96.7\,\Omega$

For parallel Resistors!

$R_{EQ} = \frac{(143.3)(152)}{143.3+152} = 73.8\,\Omega$



2) The electronics aboard a certain robot consume 65 W when operated from a 12.0 V source. If a certain fully-charged battery is rated for 12.0 V and 20 ampere-hours, for how many hours can the electronics be operated from the battery without recharging?

$V_o = V_s\left(\frac{R_{EQ}}{R_1 + R_{EQ}}\right) = 7.2(V)\left(\frac{73.8(\Omega)}{96.7(\Omega)+73.8(\Omega)}\right) = 3.1(V)$

$P = VI$

$I = \frac{P}{V} = \frac{65(W)}{12(V)} = 5.42(A)$

$\text{Time to discharge} = \frac{20(A\text{-hours})}{5.42(A)} = 3.69(hr)$

3) A certain resistor absorbs a power of 0.3 W when the applied voltage is 7.2 V.
   a) Find the resistance.
   b) Suppose that the voltage is reduced by 33% to 4.8 V. By what percentage is the power reduced?

a) $P = IV = I^2R = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P} = \frac{(7.2^2)(V^2)}{0.3(W)} = 173\,\Omega$

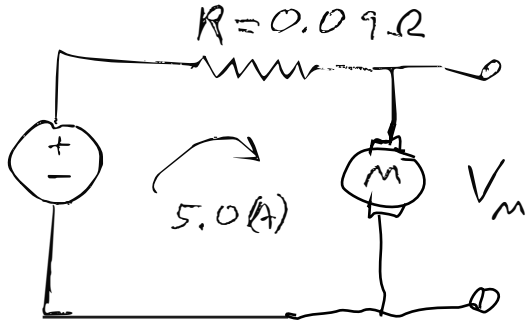
$P = \frac{V^2}{R}$, let $V' = .67V$

$P' = \frac{(.67V)^2}{R} = 0.45\left(\frac{V^2}{R}\right)$

b) $P' = 45\%\,P$ so 55% reduction

4) A DC motor drives the front wheels of a robot. The motor can draw a maximum current of 5.0 A from its 7.2 V source. In order to sense the motor current, you decided to connect a 0.09 Ω resistor in series with the motor. (Note: The motor is being constrained to 5.0A, but this is not the stall current)
   a) Draw a diagram for the circuit showing the voltage source, the sense resistor and the motor.
   b Calculate how much power the resistor should be able to absorb.
   c) Calculate the motor voltage if the current through the resistor is 5.0 A.

a)



b) $P = I^2R = (5.0)^2(A^2)(0.09(\Omega)) = 2.25\,(W)$

c) From KVL $+7.2(V) - 5.0(A)(.09\,\Omega) - V_m = 0$

$V_m = 6.75\,(V)$