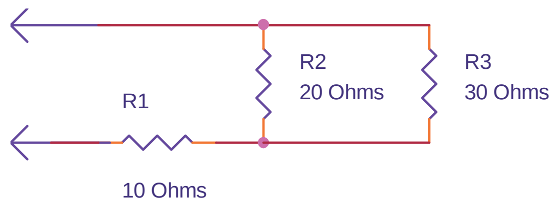
ECT150
Homework #5 Solution Set
Sr. Professor Wheeler

Handout Problems on Parallel Circuits
Total Points: 27 (3 per problem)

All work must be shown, and final answers boxed or underlined. No credit if work is not shown.

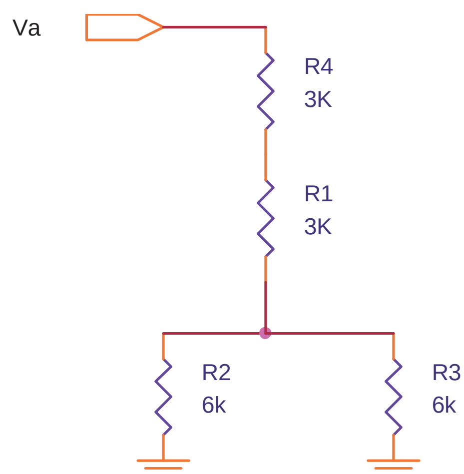
1. What is the total resistance of the circuit below?



The total resistance can be found by:

$$R_T = 20\Omega \,||\, 30\Omega + 10\Omega = \frac{20\Omega \times 30\Omega}{(20\Omega + 30\Omega)} + 10\Omega = \underline{\underline{22\Omega}}$$

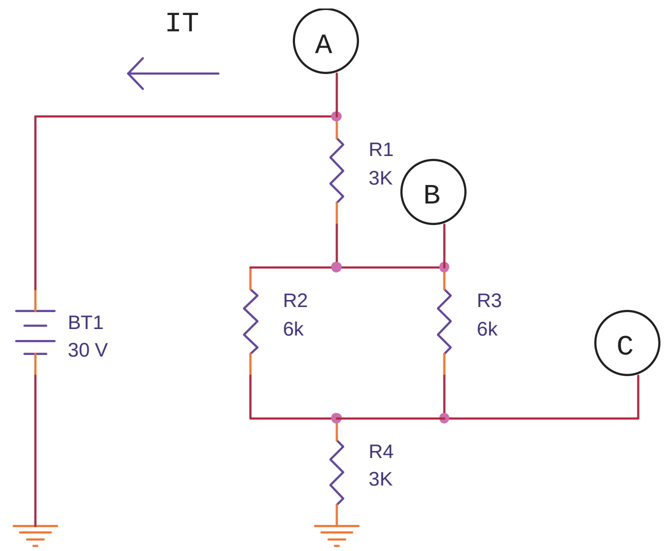
2. What is the total resistance of the network below as measured between point Va and ground?



$$R_T = R4 + R1 + (R2 \,||\, R3) = 3k + 3k + (6k \,||\, 6k) = \underline{\underline{9k\Omega}}$$

3. Calculate the following for the figure below:

a) I_T b) R_T c) V_A



a) $I_T = \dfrac{V_T}{R_T} = \dfrac{30V}{R1 + R4 + (R2 \,||\, R3)} = \dfrac{30V}{9k\Omega} = \underline{\underline{3.33mA}}$

b) $R_T = R1 + R4 + (R2 \,||\, R3) = 3k + 3k + (6k \,||\, 6k) = \underline{\underline{9k\Omega}}$

c) By inspection, $V_A = V_{BT1} = \underline{\underline{30\ V}}$ since it is connected directly to the battery positive.

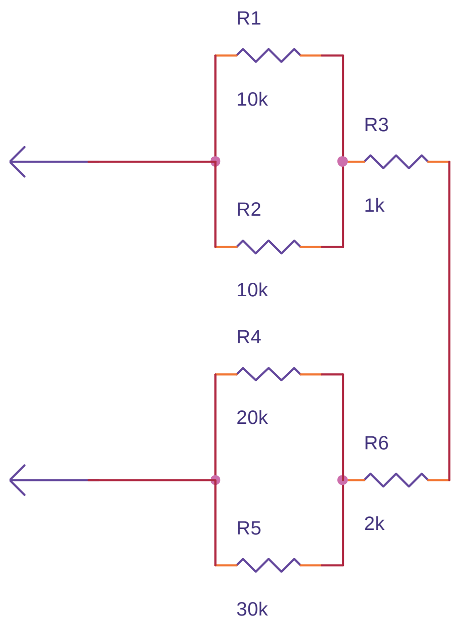
4. Use the current divider rule to find the current I_{R2} in the figure above. Calculate the voltages at points B and C using any available method.

a) $I_{R2} = I_T\left(\dfrac{R3}{R2 + R3}\right) = (3.33mA)\left(\dfrac{6k}{6k + 6k}\right) = \underline{\underline{1.67mA}}$ (Half, since R2==R3)

b) $V_B = V_T\left(\dfrac{(R2 \,||\, R3) + R4}{(R2 \,||\, R3) + R1 + R4}\right) = 30V\left(\dfrac{6k}{9k}\right) = \underline{\underline{20V}}$ (By the voltage divider rule)

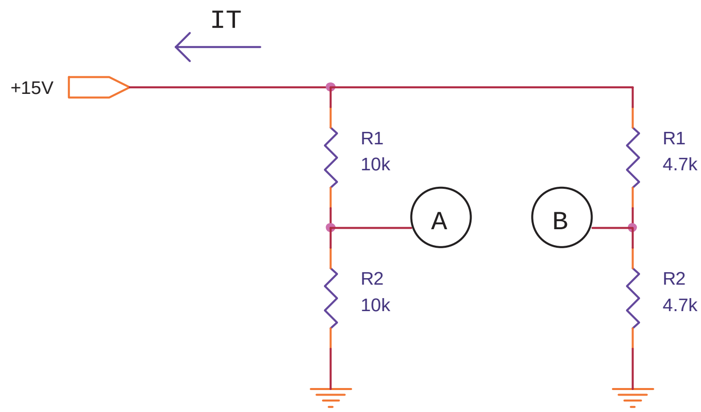
c) $V_C = V_{R4} = I_{R4}R4 = (3.33mA)(3k) = \underline{\underline{10V}}$ (By Ohm's law, $I_{R4} = I_T$)

5. Find the total resistance of the circuit below.



$$R_T = (R1 \| R2) + R3 + R6 + (R4 \| R5) = 10k \| 10k + 1k + 2k + 20k \| 30k = \underline{\underline{20k\Omega}}$$

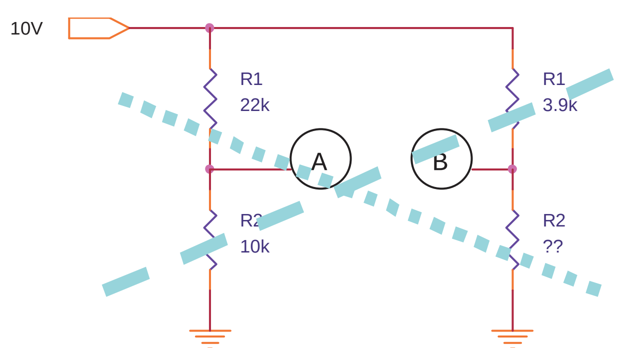
6. The circuit below is a Wheatstone bridge. What will the current I_T be when the circuit is connected to a +15V source?



(Note: The four resistors above should be labeled R1, R2, R3, R4!)

$$I_T = I_1 + I_2 = \frac{15V}{(10k + 10k)} + \frac{15V}{(4.7k + 4.7k)} = \underline{\underline{2.35mA}}$$

7. A Wheatstone bridge is balanced when the voltage V_{AB} is zero. What value of R2 will balance the Wheatstone bridge below? (Use the bridge balance equation, OR Ohm's law to solve for the value of R2 that will make V_B the same as V_A).

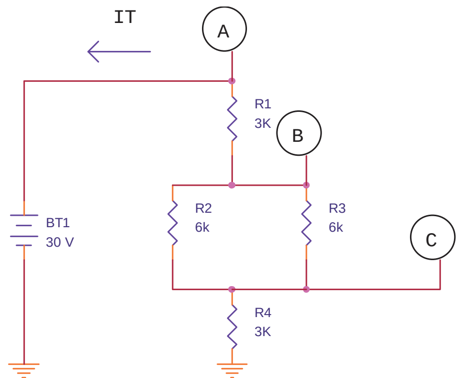


(Again, the four resistors should be labeled R1-R4). For any bridge, the product of the "cross arms" is set equal:

$$R2R1' = R1R2'$$

$$R2' = \frac{R2R1'}{R1} = \frac{(10k)(3.9k)}{22k} = \underline{\underline{1.77k\Omega}}$$ (Where R1' and R2' refer to the right-hand resistors)

8. Calculate the power of each resistor in the figure for problem #3, and the total power. (There will be five resulting answers).



a) $P_{R1} = I_T^2 R1 = (3.33mA)^2 (3k) = \underline{\underline{33.3mW}}$

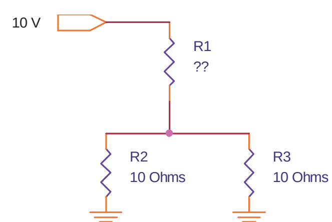
b) $P_{R2} = I_{R2}^2 R2 = \left((3.33mA) \dfrac{R3}{R2+R3} \right)^2 (6k) = \underline{\underline{16.67mW}}$ (Using the current divider rule)

c) $P_{R3} = P_{R2} = \underline{\underline{16.67mW}}$ By inspection since R2=R3 and $I_{R2} = I_{R3}$

d) $P_{R4} = I_T^2 R4 = (3.33mA)^2 (3k) = \underline{\underline{33.3mW}}$ (Could also be same as P_{R1} by inspection)

e) $P_T = V_T I_T = (30V)(3.33mA) = \underline{\underline{100mW}}$ (Could also add up P_{R1} - P_{R4})

9. In the figure below, calculate the value of R_1 that will cause the total circuit power to be 10 watts.



Explanation of method: Find the current that would be drawn from the 10V source to dissipate 10 watts, then calculate the total resistance that gives that current; then work backwards from the total resistance to get R1.

$$I = \frac{P}{V} = \frac{10W}{10V} = 1A$$

$$R_T = \frac{V}{I} = \frac{10V}{1A} = 10\Omega$$

$$R_T = 10\Omega = R2 \,||\, R3 + R1$$

$$\therefore R1 = 10\Omega - R2 \,||\, R3 = 10\Omega - 5\Omega = \underline{\underline{5\Omega}}$$