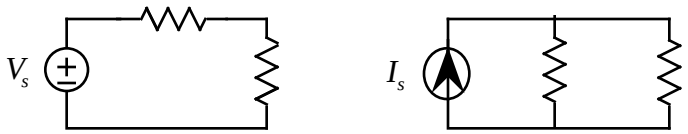
ECE 109 - SERIES AND PARALLEL - INVESTIGATION 12
VOLTAGE AND CURRENT DIVISION

SUMMER 2007 **A.P. FELZER**

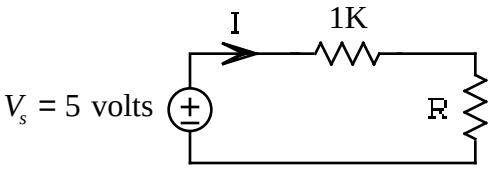
To do "well" on this investigation you must not only get the right answers but must also do neat, complete and concise writeups that make obvious what each problem is, how you're solving the problem and what your answer is. You also need to include drawings of all circuits as well as appropriate graphs and tables.

In the last Investigation we showed how to make use of equivalent resistance to analyze series circuits with voltage sources and parallel circuits with current sources as follows



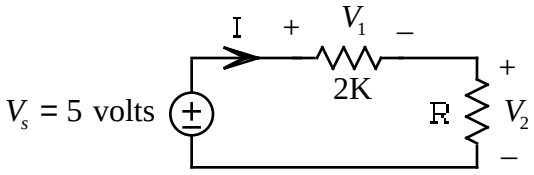
The objective of this Investigation is to see how the voltages and currents in these circuits depend on the values of the resistors. Be sure to take a look at the **Computer Demos** on Series and Parallel Resistor Circuits.

1. The objective of this first Problem is to see how the value of I depends on the value of R



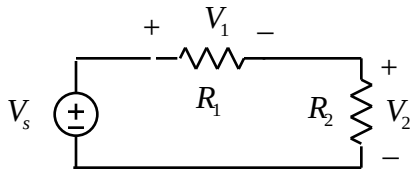
   a. First find I when $R = 0$. Hint: draw the circuit with $R = 0$
   b. Find I when $R = 2\text{K}$
   c. Find I when R is 4K
   d. Find I when $R = \infty$. Hint: draw the circuit with $R = \infty$
   e. What happened to I when the value of the series resistor R was increased from 0 to ∞
   f. Now make use of your results to sketch I as a function of R

2. The objective of this second Problem is to use the results in Problem (1) to see how varying R affects the voltages V_1 and V_2 in our series circuit as follows



   a. How does increasing R affect V_1. Hint - make use of the fact that $V_1 = 2000I$ and increasing R makes I decrease
   b. Make use of your result in part (a) to sketch V_1 as a function of R. Describe what's going on
   c. How does increasing R affect V_2. Hint - make use of the fact that $V_2 = V_s - V_1$
   d. Make use of your result in part (c) to sketch V_2 as a function of R. Describe what's going on

3. The objective of this Problem is to obtain general equations for V_1 and V_2 as functions of the resistors R_1 and R_2

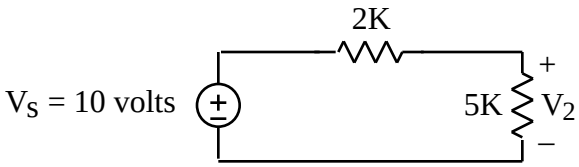


   a. Find V_1 as a function of V_s, R_1, and R_2. Hint - first find an expression for I
   b. Find V_2 as a function of V_s, R_1, and R_2

4. The results from Problem (3) as follows

$$V_1 = \frac{R_1}{R_1 + R_2} V_s \quad \text{and} \quad V_2 = \frac{R_2}{R_1 + R_2} V_s$$

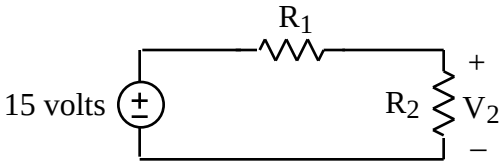
   are referred to as the *voltage division equations* for series circuits. **Memorize** these equations forever. Then make use of them to find V_2 in the following circuit



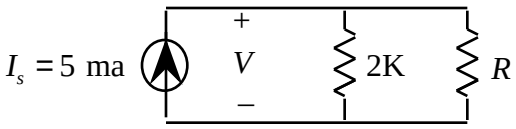
   Voltage division is an easy way to find voltages in series circuits

5. Which of n resistors connected in series will have the largest voltage. How do you know

6. Choose reasonable values for R_1 and R_2 in the following circuit so that $V_2 = 5$ volts

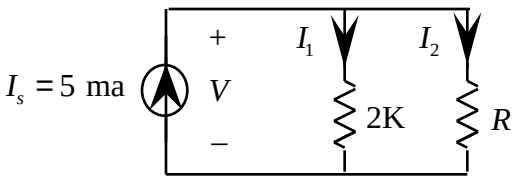


7. Now for parallel circuits. Given the following parallel circuit



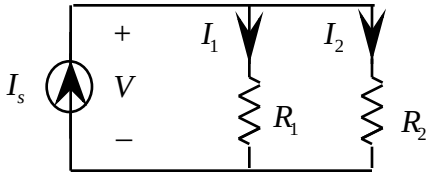
   a. First find V when $R = 0$. Hint: draw the circuit with $R = 0$
   b. Find V when $R = 2$K
   c. Find V when R is 4K
   d. Find V when $R = \infty$. Hint: draw the circuit with $R = \infty$
   e. What happened to V when the value of the parallel resistor R was increased from 0 to ∞
   f. Now make use of your results to sketch V as a function of R

8. The objective of this Problem is to make use of our result in Problem (7) to see how varying R affects the currents I_1 and I_2 in our parallel circuit as follows



a. How does increasing R affect I_1. Make use of the fact that V increases as R increases
b. Make use of your result in part (a) to sketch I_1 as a function of R. Describe what's going on
c. How does increasing R affect I_2
d. Make use of your result in part (c) to sketch I_2 as a function of R. Describe what's going on

9. The objective of this Problem is to obtain general equations for I_1 and I_2 as functions of R_1 and R_2

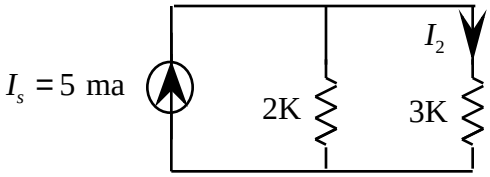


a. Find I_1 as a function of I_s, R_1, and R_2. Hint - first find an expression for V
b. Find I_2 as a function of I_s, R_1, and R_2

10. The results from Problem (9) as follows

$$I_1 = \frac{R_2}{R_1 + R_2} I_s \quad \text{and} \quad I_2 = \frac{R_1}{R_1 + R_2} I_s$$

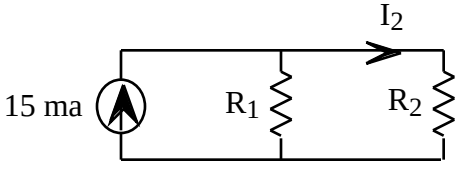
are referred to as the *current division equations* for parallel circuits. **Memorize** these equations forever. Then make use of them to find I_2 in the following circuit



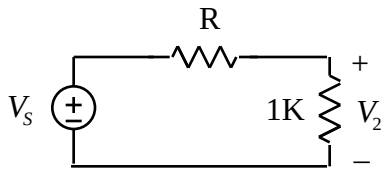
Current division is usually the easiest way to find currents in parallel circuits

11. Which of n resistors connected in parallel will have the largest current. How do you know

12. Choose reasonable values for R_1 and R_2 in the following circuit so that $I_2 = 5$ ma

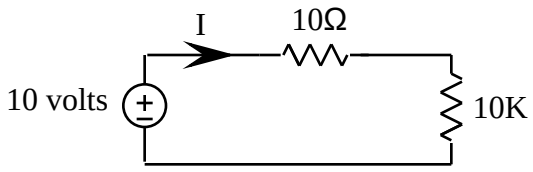


13. Given the following circuit

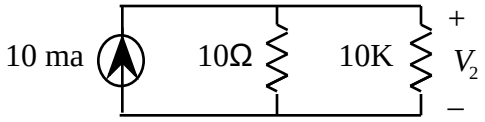


a. Sketch V_2 as a function of V_S if $R = 1K$
b. Sketch V_2 as a function of R if $V_S = 5$ volts

14. Without using a calculator
    a. Estimate the current in the following series circuit



    b. Estimate the voltage in the following parallel circuit



15. Math Review: Given $x(t)$ as follows sketch $x(-t)$