ECE 109 - SERIES AND PARALLEL - INVESTIGATION 9
PARALLEL RESISTOR CIRCUITS

FALL 2006 **A.P. FELZER**

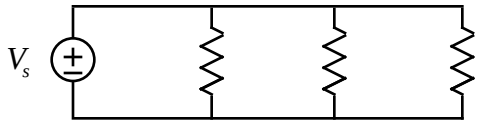
To do "well" on this investigation you must not only get the right answers but must also do neat, complete and concise writeups that make obvious what each problem is, how you're solving the problem and what your answer is. You also need to include drawings of all circuits as well as appropriate graphs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

From the last two Investigations we obtained

(1) Kirchhoff's Current Law from the fact that equivalent positive charge enters nodes at the same rate it leaves nodes and

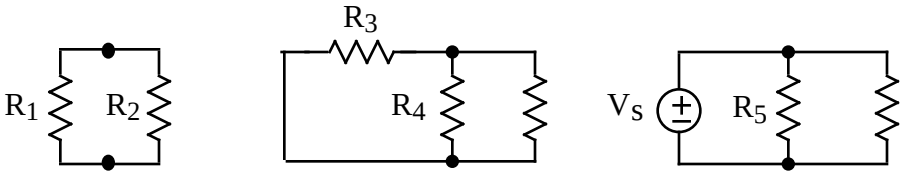
(2) Kirchhoff's Voltage Law from the fact that equivalent positive charge going around a closed loop always returns with the same amount of potential energy it started out with

So we are now ready to start analyzing more general circuts. The objective of this Investigation is to make use of Kirchhoff's Laws introduced to analyze relatively straightforward *parallel circuits* like the following

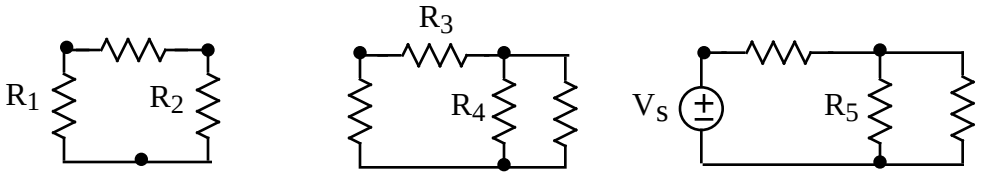


Do **not** use anything you may know about equivalent resistance to solve **any** of the problems in this Investigation. Be sure to take a look at the **Computer Demos** on Parallel Circuits.

1. Given that R_1 and R_2, R_3 and R_4, and V_S and R_5 **are** connected in **parallel** in the following circuits



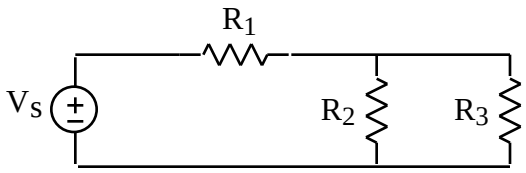
but they are **not** connected in parallel in these circuits



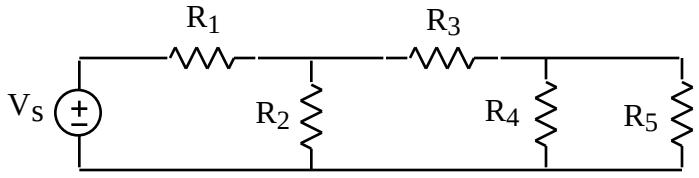
Come up with a definition in terms of nodes and what's connected to them that a person who knows *nothing* about voltage or current can use to determine if two circuit elements are in parallel. **Memorize** this result.

2. Use your definition from Problem (1) to identify which pairs of circuit elements in the following circuits are in parallel

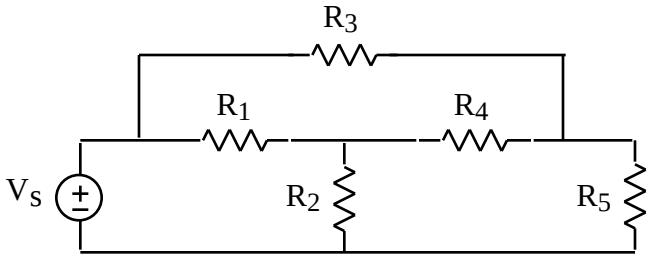
a.



b.



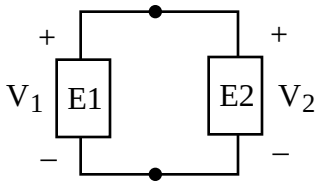
c.



3. Explain how you know that R_2 and R_5 in circuit (b) of Problem (2) above are not in parallel

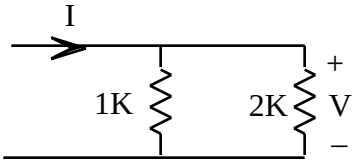
4. What would you expect we mean when we say a circuit is a **parallel circuit**. Draw one. Then draw a circuit that is not a parallel circuit.

5. Make use of KVL to find the relation between the voltages across circuit elements connected in parallel as follows

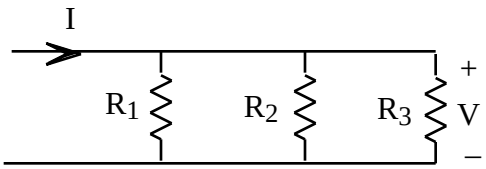


Memorize this result forever.

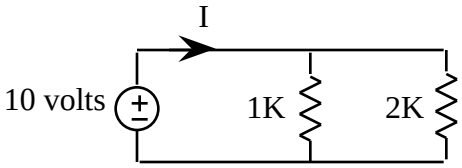
6. From Problem (5) we know that circuit elements in parallel all have the same voltage across them. Now suppose we have two resistors connected in parallel as follows



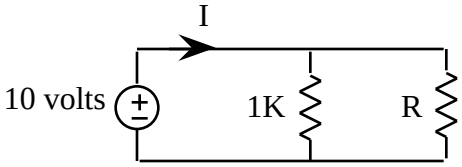
   a. Which resistor has the larger current. How do you know
   b. Which of two parallel resistors $R_1 > R_2$ has the larger current. How do you know.
   c. Which of three or more resistors in parallel as follows will have the larger current



7. Calculate the current I in the following parallel circuit

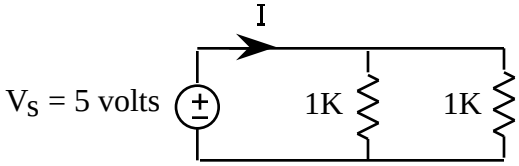


8. Now suppose we take the parallel circuit in Problem (7) and replace the 2K resistor by a general resistor R as follows

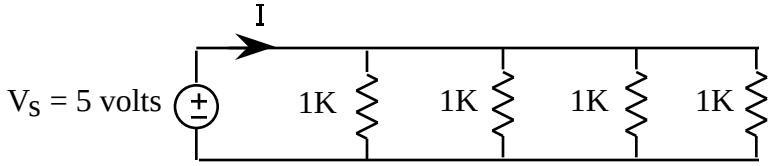


   a. Find and sketch I as a function of R.
   b. Make use of your result in part (a) to describe how I varies as a function of R.
   c. Explain why I varies as a function of R the way it does.

9. Now suppose we start with a parallel circuit



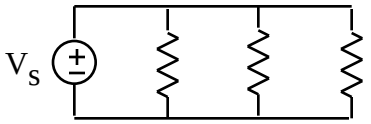
   and add more resistors in parallel as follows



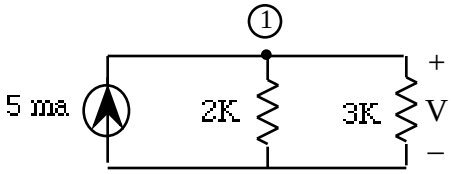
   a. How did adding the parallel resistors affect the value of I
   b. How would adding more parallel resistors affect I. Why

10. Would you connect a string of lights in series or in parallel with a voltage source. Why. How do you think your house is wired. What makes you think so

11. How many nodes does the following circuit have. Be careful - we're assuming that the wires are ideal

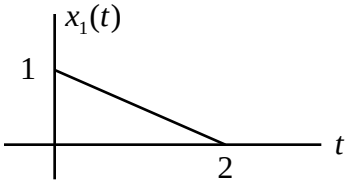


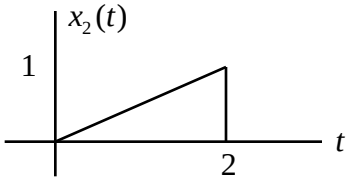
12. See if you can come up with a scheme for calculating V in the following parallel circuit



Justify each step. Remember that you can't use anything you may know about equivalent resistance. Hint - Start by writing the KCL equation at node 1 and then make use of Ohm's Law to express the resistor currents in terms of their common voltage V. **Memorize** your scheme for analyzing parallel resistor circuits.

13. Math Review: Given the following graphs for $x_1(t)$ and $x_2(t)$





a. Sketch $y_1(t) = x_1(t) + x_2(t)$
b. Sketch $y_2(t) = x_1(t) + 2x_2(t)$