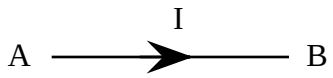
ECE 109 - THE VERY BASICS - INVESTIGATION 3
VOLTAGE AND CURRENT SOURCES

FALL 2006 **A.P. FELZER**

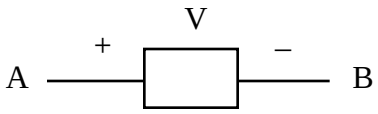
To do "well" on this investigation you must not only get the right answers but must also do neat, complete and concise writeups that make obvious what each problem is, how you're solving the problem and what your answer is. You also need to include drawings of all circuits as well as appropriate graphs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

From the last two Investigations we know that voltages and currents are the fundamental quantities that tell us what's going on in our circuits. The objective of this and the next Investigation is to determine how the voltages and currents of individual voltage and current sources and individual resistors are related. We will then use these results in subsequent Investigations as we develop methods to analyze complete circuits. We begin with ideal voltage sources. Be sure to take a look at the **Computer Demos** on Voltage and Current Sources.

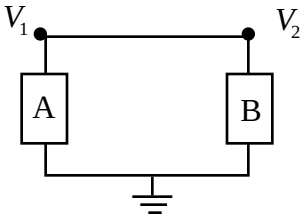
1. We begin with a review problem
   a. Which way is epc flowing through the following wire



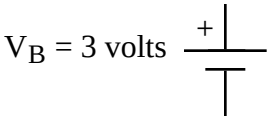
   b. Which node is at a higher potential in the following



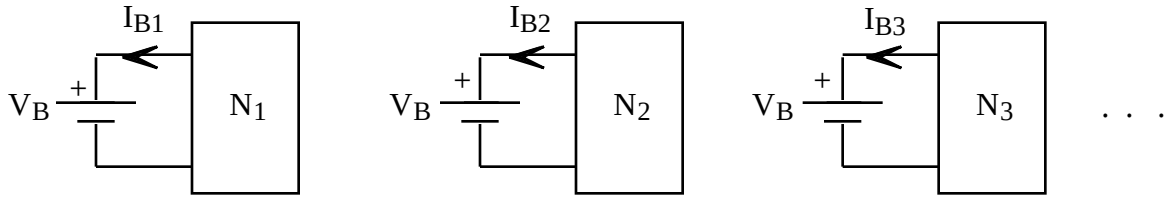
   c. Draw a graph of the potential as a function of position for the following circuit if equivalent positive charge flowing clockwise around the circuit are gaining energy as they flow through A. Then make use of your graph to find how V_1 and V_2 are related. **Memorize** this result



2. Now suppose we go into the lab and connect an ideal 3 volt battery as follows



   across a number of different circuits N_1, N_2, N_3, . . . as follows



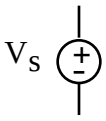
and obtain the following data

CIRCUIT	V_B (volts)	I_B (ma)
N1	3	-2
N2	3	0
N3	3	5
.	.	.
.	.	.

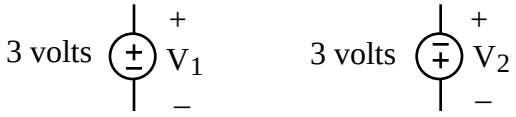
a. As usual, graphs are helpful. So plot V_B as a function of I_B for the given data points and then draw the curve that seems to go through them. Describe your curve.
b. Make use of your graph in part (a) to find an equation for V_B
c. What does your model - your equation - predict for V_B when $I_B = 2$ ma. How about when $I_B = 10$ ma.
d. Explain why we refer to our battery as an *ideal* 3 volt voltage source.

3. Draw graphs of V as a function of I (referred to as the I-V characteristic curve) and write the corresponding equations for
   a. An ideal +5 volt voltage source
   b. An ideal –5 volt voltage source

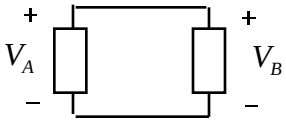
4. Note that we usually represent general voltage sources with the symbol



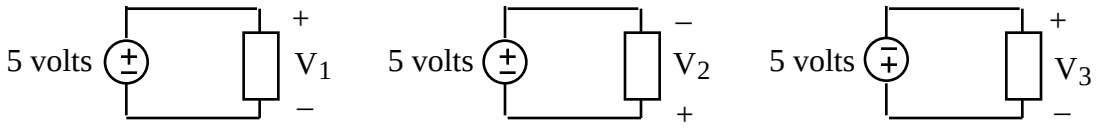
where the plus and minus signs are the reference directions for V_s. Find V_1 and V_2 in



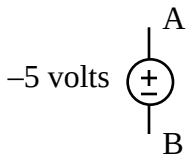
5. Make use of the fact that $V_A = V_B$ in circuits connected as follows



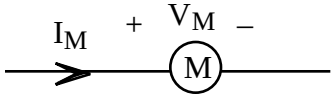
to find V_1, V_2 and V_3 in the following circuits



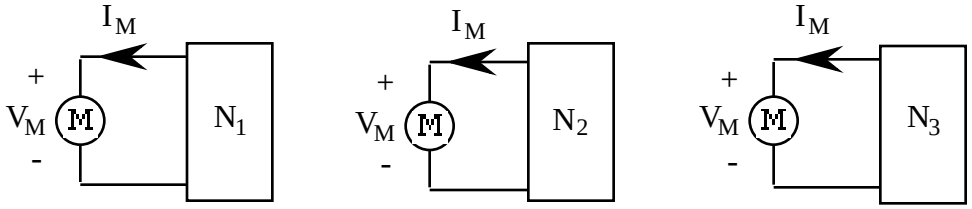
6. Which point in the following circuit is at the higher potential



7. Suppose we go into the lab and connect a mystery circuit element M as follows



across a number of different circuit elements as follows



and obtain the following data

CIRCUIT	V_M (volts)	I_M (ma)
N1	-1	5
N2	2	5
N3	4	5
.	.	.
.	.	.

a. Plot I_M as a function of V_M for the data points and then draw the curve that seems to go through them. Describe your graph.
b. Make use of your result in part (a) to obtain an equation for I_M.
c. Explain in words why we refer to M as an *ideal* current source

8. Unlike batteries, we can't go to the grocery store and buy constant current sources as follows

like the one in Problem (7) above. But they do indeed "exist" in integrated circuits where they are built from transistors powered by constant voltage sources. And they are often helpful in helping us understand circuits. Draw I as a function of V and find the corresponding equations for

a. An ideal 7 ma current source
b. An ideal –7 ma current source

9. Math Review: Find V as a function of I for the following graph