

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

SUMMER 2007

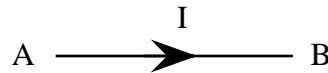
A.P. FELZER

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.

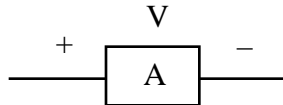
From the last two Investigations we know that voltages and currents are the fundamental quantities that tell us what's going on in our circuits. The objective of this and the next Investigation is to determine how the voltages and currents of individual voltage and current sources and individual resistors 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 some review problems

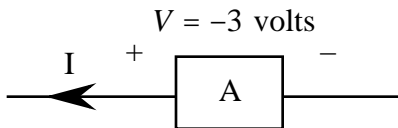
a. Which way is epc flowing through the following wire



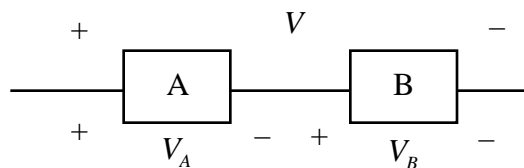
b. Which way is energy being transferred between A and the equivalent positive charge flowing through it in the following circuit



2. What is the sign of the current I in the following circuit if A is receiving energy from the equivalent positive charge flowing through it



3. Given the following circuit with  $V_A = 3$  volts and  $V_B = 4$  volts

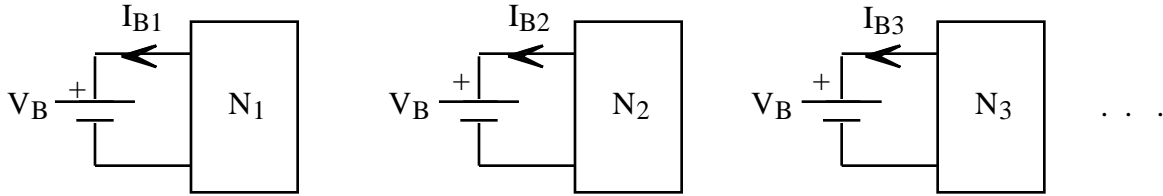


- a. Find the magnitude of the voltage V equal to the net amount of energy transferred between A and B and the equivalent positive charge flowing through them
- b. Find the sign of V

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

$$V_B = 3 \text{ volts } \begin{array}{c} + \\ | \\ - \end{array}$$

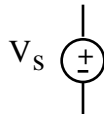
across a number of different circuits  $N_1, N_2, N_3, \dots$  as follows



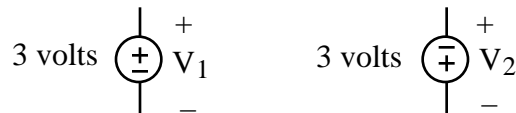
and obtain the following data

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

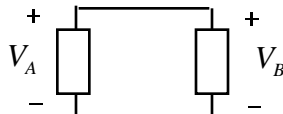
- As usual, graphs are helpful. So plot  $V_B$  as a function of  $I_B$  for the given data points and then draw the curve that seems to go through them. Describe your curve.
  - Make use of your graph in part (a) to find an equation for  $V_B$
  - What does your model - your equation - predict for  $V_B$  when  $I_B = 2$  ma. How about when  $I_B = 10$  ma.
  - Explain why we refer to our battery as an *ideal* 3 volt voltage source.
5. Draw graphs of  $V$  as a function of  $I$  (referred to as the I-V characteristic curve) and write the corresponding equations for
- An ideal +5 volt voltage source
  - An ideal -5 volt voltage source
6. Note that we usually represent general voltage sources with the symbol



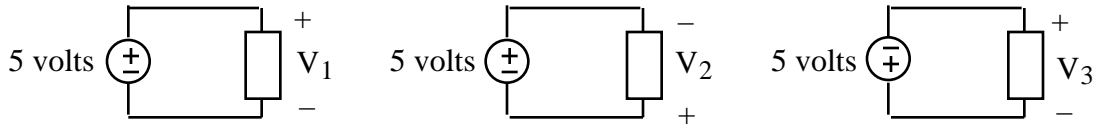
where the plus and minus signs are the reference directions for  $V_s$ . Find  $V_1$  and  $V_2$  in



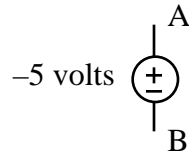
7. Make use of the fact that  $V_A = V_B$  in circuits connected as follows



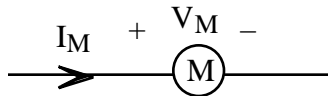
to find  $V_1$ ,  $V_2$  and  $V_3$  in the following circuits



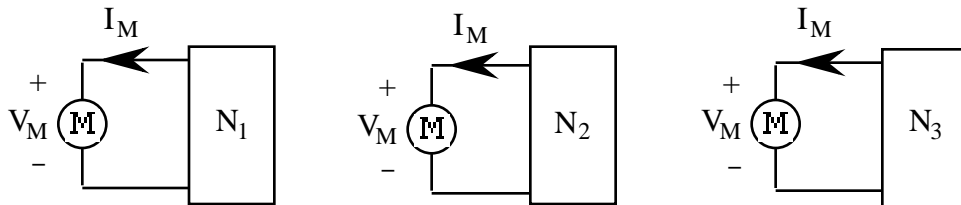
8. Which point in the following circuit is at the higher potential



9. 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
.	.	.
.	.	.

- 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.
- Make use of your result in part (a) to obtain an equation for  $I_M$ .
- Explain in words why we refer to  $M$  as an *ideal* current source

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



like the one in Problem (9) 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

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

