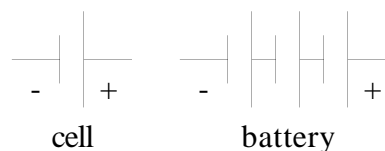


Physics

Activity - Measuring and Combining EMF's

Purpose: To measure electromotive force (voltage) and determine how electromotive forces “add” when combined.

Bkgrnd: An electrochemical cell is comprised of two electrodes, the cathode (-) and the anode (+), and an electrolyte solution. A chemical reaction takes place when the electrodes are immersed in the electrolyte and a potential difference is maintained between the electrodes. When a series of electrochemical cells are connected a *battery* is formed. The symbol for a cell is two vertical lines of different sizes (see below) and the symbol for a battery is just a series of cells placed next to each other.



In this activity you will learn to measure electromotive force with a *voltmeter* and how electromotive forces ‘add’ when cells are combined.

Materials: Digital multi meter (2) 1.5V- dry cell 6V dry cell connection wires
various voltage sources

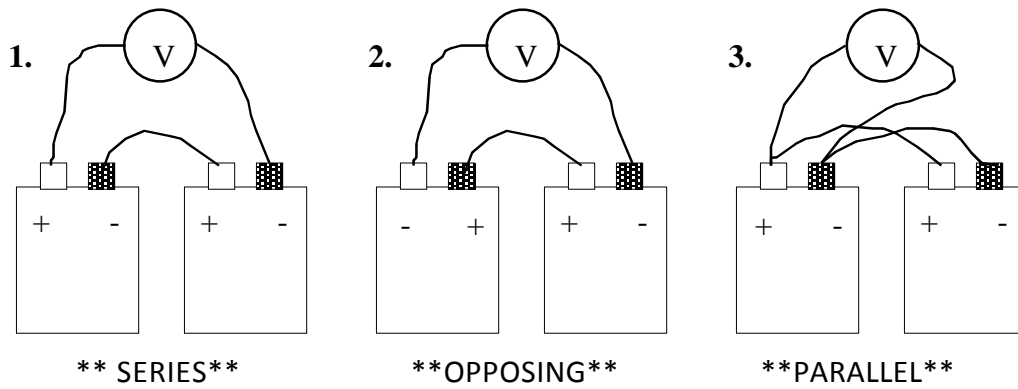
Procedure: *-measuring voltages-*

- Use the multi meter set on the *DC voltage function* and *20 volt range* to measure the voltage of each of your dry cells. Record. ****Always be sure that your meter is set on the correct function and range before hooking it up!**
- Measure the voltage of the hand generator, the car battery, a camera battery and record (be sure to adjust the range accordingly--always assume that unknown voltages are high if you don't know and start on the highest range setting).
- Set your multi meter to AC Voltage and the 200V range**. Get teacher approval, then place the leads into a wall socket. Record.

-combining voltages-

- Connect the two 1.5 V cells as shown below. Measure their combined voltage and record results. Repeat with one 6 V cell and one 1.5 V cell. Record results.
- Now, choose 2-4 voltages sources and connect them together to get the highest voltage possible. Record.

Voltage source	predicted Voltage (V)	measured Voltage (V)
6V cell		
1.5V cell		
1.5V cell		
car battery		
camera battery		
generator		
lemon		
wall socket**		



configuration	Voltage	2	3
1.5V & 1.5V	V	V	V
1.5V & 6.0V	V	V	V
your own 1	V		
your own 2	V		

Questions:

1.) Why might the measurements of the 1.5 V and 6V cells be less than you expected?

2.) What does it mean to say a battery is “dead?”

3.) What generalization can you make about emf’s connected in *series*?

4.) What generalization can you make about emf’s connected in *parallel*?

5.) Draw a *picture* and a *schematic diagram* of four 2.0 V cells connected in series and indicate the combined voltage.

6.) Describe your own configurations in part 2 above?

7.) How many lemons (0.20 V) would need to be connected to briefly run a 9.0V radio? How would they need to be connected?