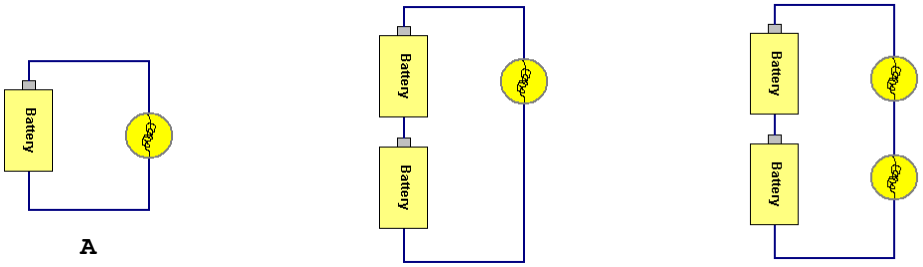
DAY 11 -- Homework

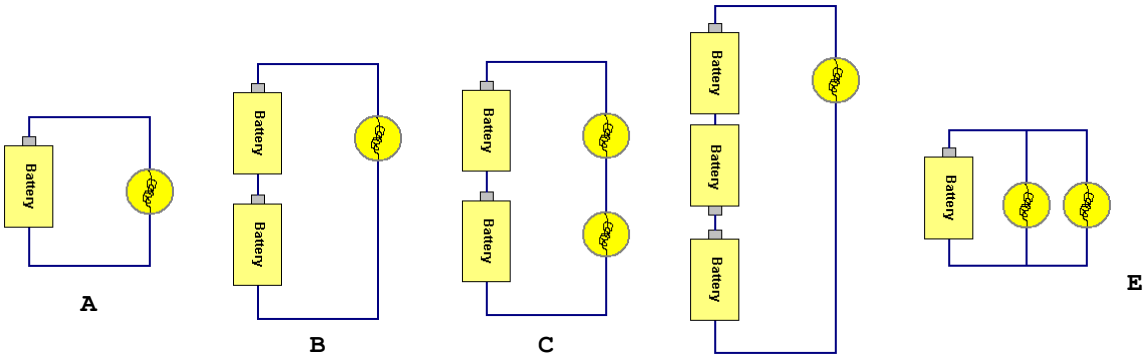
1. A battery is hooked up to a bulb as shown in A below. A second battery is added in series as shown in B, and the bulb gets brighter. Now a second bulb is added in series as shown in C. Use Kirchoff's Laws to explain whether the bulbs in C will be the same brightness as the bulb in A, or whether they will be the same brightness as the bulb in B, and why.



A B C

2. Draw a circuit containing three light bulbs and one battery in which two of the bulbs are in series with each other and the third is in parallel with them. Draw an X at the points in the circuit where a wire could be cut with the result being that only one bulb is extinguished.

3. In the figure below which bulbs have the same brightness (same current through them). All bulbs and batteries are identical.



A B C D E

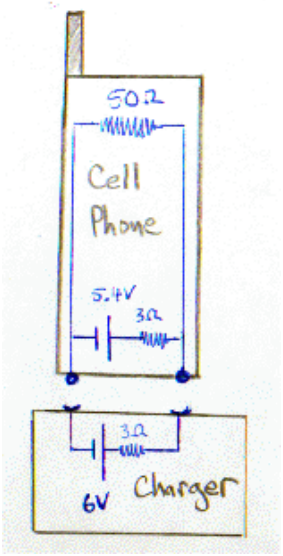
4. Suppose the batteries in the above problem have capacities of 2 A-hrs, and the bulb in Figure A is drawing 2 A of current. How long will the batteries last in each of the figures (A-E)?

5. A 5.4 V NiMH battery powers a cell phone. The battery has an internal resistance of 3 Ω, and the phone itself has a load resistance of 50 Ω. The phone can be placed in a charger, which produces 6 V and also has an internal resistance of 3 Ω.

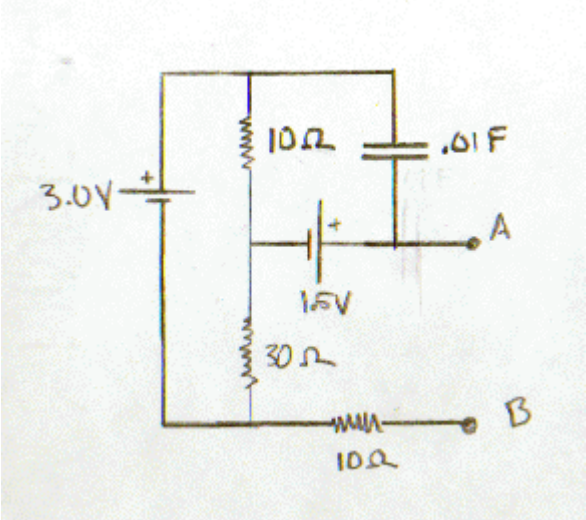
   (a) Find the current through each branch of the circuit when the phone is off the charger.

(b) Find the current through each branch of the circuit when the phone is on the charger.

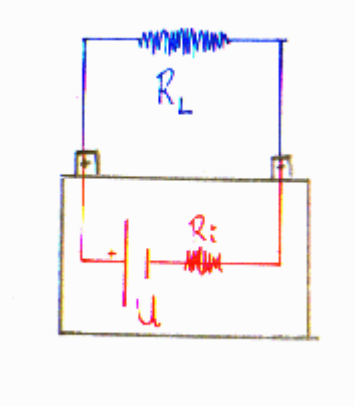
HINT -- You may need to use multiple equations in multiple unknowns.



6. Find the current through the 30 Ω resistor, the charge on the capacitor, and the potential difference between points A & B.

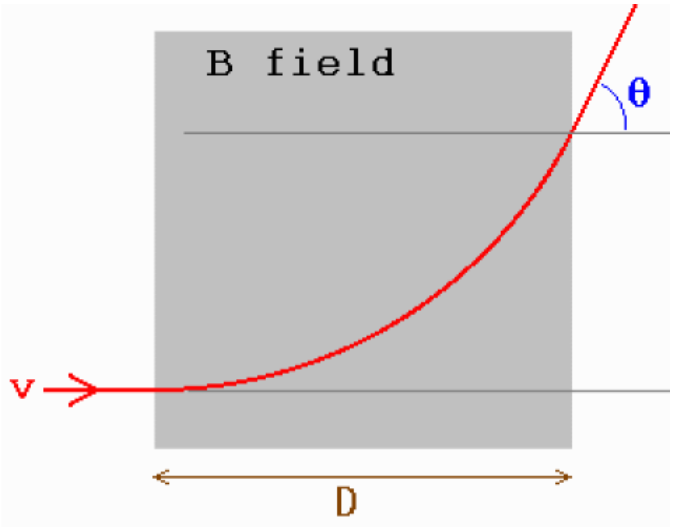


7. **PHY 232 ONLY**
The *maximum power transfer theorem* says that a battery can deliver the most power to a load R_L when the resistance of the load equals the internal resistance. Derive an equation for power to R_L in the figure, and prove the maximum power transfer theorem. Hint -- use max/mins.



8. **PHY 232 ONLY**
The battery in the above problem has U = 6 V and R_i = 2 Ω. Make a plot of the potential difference between the battery terminals vs. R_L for 0 < R_L < 20 Ω. Make a plot of current vs. R_L for 0 < R_L < 20 Ω.

9. A *mass spectrometer* uses a magnetic field to deflect a beam of ions. The amount of deflection can be used to identify the ions. The ions have mass m and charge q and are moving at a speed v when they enter a region of magnetic field (B). The magnetic field region has width D. Determine an equation for the deflection angle (θ) in terms of these variables.



10. A charged particle moving in a uniform magnetic field need not always move in a circle. In fact, it is most likely that a charged particle in a uniform magnetic field will follow a *helical* path. Explain why this is.

11. Can a magnetic field do work on a charged particle? Can a magnetic field change the speed of a charged particle? Explain.