# Problem Set 1 (rev B)
Due Friday (5pm), Feb. 3, 2012

Please complete this homework and turn it in to the drop box location in 240 Cory Hall (labeled EE 100).

1. Suppose that we want to charge up a 9 V battery and increase its energy by 500 J. How much charge must be pumped through the battery? How many electrons is this? Suppose a is the positive terminal and b is the negative terminal. Should the electrons flow from a to b or b to a?

2. Let's analyze your PG&E bill. In 2011 the average cost of residential electricity was about $0.16 per kWh. Suppose that for the month of November (30 days) your bill came out to be $30. Assuming a line voltage of 120 V, what was the average current draw into your house? You then realize you always left your powerful 150 W desktop computer running. How much money did that alone cost you?

3. As great as smartphones are, one of the main gripes about them is that they need to be recharged too often. Suppose my Samsung Galaxy S2 requires about 0.4 W to maintain a signal and data connection to the nearest tower, as well as my regular activities. My battery provides 1650 mAh and a voltage of 3.7 V. How long will one full charge last before the phone dies out?

4. Suppose that you have two light bulbs, one rated for 35 W and another rated for 85 W. Assuming a line voltage of 120 V, find the effective resistance of each bulb. Now consider connecting them in series vs. in parallel. What are the current, voltage, and power across each bulb in both cases (note that the power does NOT necessarily have to be 35 W and 85 W!)? Which bulb is brighter in each case?

5. Using the following information:

   - Residential electric power costs $0.10 per kW hr

   - Gasoline costs $3.20 per U.S. gallon, has a density of $720 \,{}^{\text{kg}}\!/_{\text{m}^3}$, and an energy density of $4.5 \times 10^7 \,{}^{\text{J}}\!/_{\text{kg}}$

   - An AA battery costs $0.75, and supplies $100 \,\text{mA}$ with terminal voltage of $1.5 \,\text{V}$ for 20 hours before it is completely discharged

   Convert the cost of all three sources of energy into ${}^{\$}\!/_{\text{J}}$ and compare.

6. The current through a 5 V battery is $i(t) = -85 \,\text{mA} \cos(\omega t) e^{-t/\tau}$ where $\tau = 20 \,\text{ms}$ and $\omega = 2\pi f$, where $f = 2 \,\text{MHz}$. Find the net charge and net energy supplied by the battery from $t = 0$ to $t = \infty$.

7. What is the purpose of a fuse or circuit breaker installed in residential homes? What are the differences between them?

8. Suppose that you have two batteries, A and B. The first battery (A) has an open-circuit voltage of $V_A = 3V$ and an internal resistance of $R_{i,A} = 10\Omega$. The second battery (B) has an open-circuit voltage of $V_B = 5V$ and an internal resistance of $R_{i,B} = 50\Omega$. (a) Suppose the batteries are connected in series. What's the maximum current that can be delivered to a load $R_L = 100\Omega$? In the process of calculating the current, also calculate the voltages drop across the load. (b) Suppose the batteries are connected in parallel and recalculate the current to the $R_L = 100\Omega$ load. What is the voltage drop across the load? Calculate the current flow through each battery. (c) If each battery is rated at 100mA*hr capacity, how long does it take to discharge the batteries? For simplicity, assume that the open-circuit voltage and internal resistance stay constant as the battery discharges but then suddenly the voltage goes to zero as the battery discharges. (d) Comment on any potential issues with connecting the batteries in series or parallel.

9. Use KCL to find the values of i_a, i_c, and i_d for the circuit shown below. Which elements are connected in series?
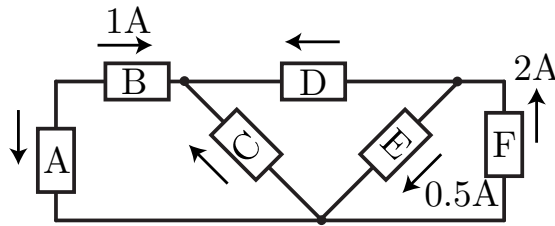
10. Use KCL to find the values of i_e, i_f, and i_g for the circuit shown below. Which elements are connected in series?
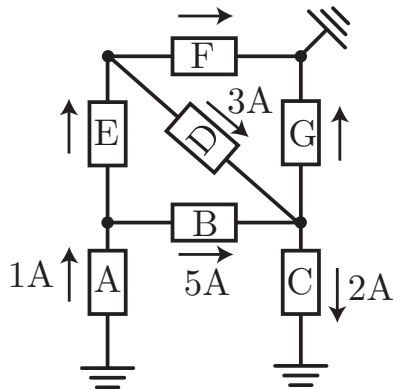
11. Use KVL to find the values of v_b, v_c, and v_e for the circuit shown below. Which elements are connected in shunt?
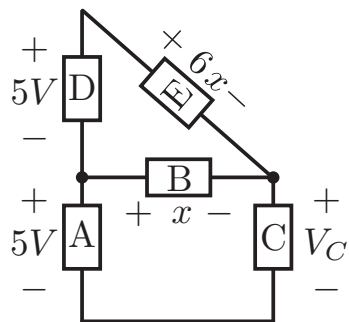
12. Use KVL to find the values of V_B, V_D, V_E and V_F for the circuit shown below. Which elements are connected in shunt?