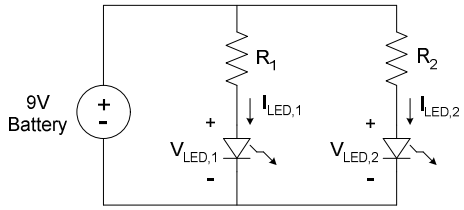
EE221 Lab Experiment #2 Fall 2011

Engineering Problem:
Most electrical "loads" are described by nominal operating parameters, generally given in terms of a voltage, current, and/or power. For instance, suppose that you have two light-emitting diodes (LEDs) that you need to place into a circuit and their rated parameters are given as follows:

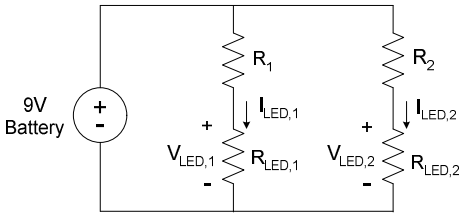
GREEN: $V_{LED,1} = 5.2V \quad I_{LED,1} = 11mA$ RED: $V_{LED,2} = 2.2V \quad I_{LED,2} = 22mA$

What is an LED and how does it work? Find out before reading further.

Consider next that we have a 9V alkaline battery that will power the two LEDs as shown in the circuit below. We place the LEDs in parallel paths so we could have switches independently turning them ON (maybe status indicators for different parts of our circuit).



In this instance, circuit biasing means choosing values for R_1 and R_2 so that the desired voltage is across each LED and the required current flows through it. To do this, we will first ***model*** each LED by an equivalent resistor as shown below.



Note, the combination of R_1 and R_{LED1} is in parallel with the 9V source as is the combination of R_2 and R_{LED2}. We will limit the choices of R_1 and R_2 to commercially-available values that we have in the lab.

- Find R_{LED1} and R_{LED2}
- Using KVL and KCL, determine the required voltage across and current through R_1 and R_2
- Determine the required values of R_1 and R_2, choose the closest values available.

- Determine the power consumed by these resistors and ensure that the rated values of the lab resistors are adequate
- Build the circuit on your bread board (use the power supply to model the battery and resistors for the LEDs and R_1 and R_2). Before wiring up your circuit, measure and record all of your resistor values. Measure the voltage and current for R_{LED1} and R_{LED2}.
- Demonstrate your results to the instructor
  INSTRUCTOR LAB NOTEBOOK SIGN OFF
- Swap in the actual LEDs to confirm circuit operation

Follow up work:

1. If the LED resistors constitute the power out and the battery supplies the power in, determine the efficiency of your design ($efficiency\% = \frac{P_{OUT}}{P_{IN}} 100$)
2. A 9V alkaline battery has an effective capacity of 200 mAh. Determine how long the battery will last in this application. If you desire for the battery to last at least 2 hours, how much additional load current can be added to the circuit?
3. Repeat the design calculation assuming a 12V battery (assume that non-standard resistor values are OK). Calculate the efficiency for this new circuit.
4. Based on the above observations, what would be the optimal source voltage and what would be the maximum achievable efficiency (assuming no additional load)?