Lab D5: *The Resistance of Light Bulbs* *2/10/03*

Goal: to determine if a light bulb behaves as a resistor and to determine the temperature of the filament

Materials: several clip leads, multimeter, light bulb (6.3 volt maximum) and socket, 4 batteries

You may use: your notes, lab book, textbook, lab D4 instructions, Cutnell/Johnson reading (green sheet).
ALL WORK IS TO BE DONE IN YOUR LAB BOOK

Unfortunately, due to a shortage of equipment you will have to share use of a multimeter with your table partner. We will try to have some extra multimeters around that can float to whoever needs them.

Also, you might have to share a battery pack with your partner; BOTH people at a table can be using the battery pack simultaneously without affecting each other's measurements.

WARNING: IF YOU DO ANY OF THE BAD THINGS TO THE MULTIMETER, 10% WILL BE DEDUCTED EACH TIME. IF YOU BLOW A MULTIMETER FUSE, AN ADDITIONAL 25% PENALTY WILL BE ASSESSED. Penalties are large because you are allowed to use your lab D4 instructions. Note "CHECKs" below; call teacher or lab assistant over for signature at those checkpoints.

Procedure:

1. Make sure that your light bulb lights by connecting it to batteries.

2. Next, you will use the multimeter to measure/determine the light bulb's resistance in two ways:

   a) direct measurement (You should leave the bulb screwed into the holder. Think of the bulb for now as a resistor whose two ends are the two places where you clipped alligator clips in lab D3.)
   CHECK AFTER

   b) calculation from measurements (use 3 different battery voltages & circuit currents) BUT

before starting measurements, think about your method & state it briefly. Organize your measured data neatly in a table. Leave room for at least three more columns beyond your measurements of voltage and current. The three additional columns are for calculated Resistance, Temperature, and Power.

REQUIRED CHECK BEFORE 1ST MEASUREMENT of CURRENT and of VOLT DIFFERENCE

3. Explain why your four values for the bulb resistance are different. (Aren't you glad you read Walker section 21-2 or the green sheet reading in advance?) **CHECK AFTER**

4. What metal is the light bulb filament made of? (If you don't know from the TWTW reading you were supposed to do or because you know it's the metal with the highest melting temperature, you can find the answer in *The Way Things Work*, p.193, 1st edition or p. 181, New edition somewhere in the classroom.)

5. Use the relevant formulas in C/J (green sheet) reading and your determined resistance values to calculate the four temperature values of the glowing bulb filament. You'll need to estimate the room temperature. You'll also need a number that's not given in C/J - you can find it in the table on the back of this lab sheet. Enter your calculated values for temperature in the table in your lab book.
   CHECK AFTER FIRST CALCULATION

6. Calculate the power of the lit bulb in each case, and enter your values in your table. Make sure that your results match what you saw when the bulbs were lit.

7. In the Ohm's law discovery lab (D4), you used resistors with resistances of hundreds or thousands of ohms. Now you should know why. Why didn't we use small resistance values (under 10 ohms) in that lab? **CHECK AFTER**

8. Based on the results of your investigation, does your light bulb obey Ohm's Law? Explain why/why not or how you knew. **CHECK AFTER**

Extension

Goal: to determine how the power (or in everyday terms, "brightness") of the bulb depends on its temperature.

a. On your graphing calculator, plot the bulb power versus Kelvin temperature (temperature is the *independent* variable). Do a power-law regression to fit your curve. (This is all the way at the bottom of the CALC Menu under STAT; it's called PwrReg).

b. Notice that this regression fits your data with a $y = ax^b$ type of curve. Sketch the graph and list the fit parameters (a,b) in your lab book. (And you have, of course, included a translation table.)

Table of resistivity and temperature coefficient of resistivity (called ρ in C&J):

Material	Resistivity (Ω - m)	Temperature coefficient of resistivity ($^\circ C^{-1}$)
Aluminum	2.82×10^{-8}	0.00429
Copper	1.72×10^{-8}	0.0068
Iron	9.71×10^{-8}	0.00651
Silver	1.59×10^{-8}	0.0061
Tungsten	5.6×10^{-8}	0.0045