A Light Bulb and Ohm's Law

Purpose: To use a voltmeter and ammeter to measure the voltage and current through a light bulb and determine the relationship between V, I, R, and P. To determine the factors influencing the resistance of a light bulb.

Procedure:
If your lab table has two bulbs, use the one with a higher power rating.
First you will calculate the operating values for your bulb (while it is running at 120V)

1. What is the operating voltage for your light bulb(V_B)? It is written on the top of the bulb.
2. What is the operating power for your light bulb? It is written on the top of the bulb. (P_B)
3. Use the equation P=VI to solve for the operating current. (I_B)
4. Use Ohm's law to calculate the operating resistance. (R_B)
5. Use a computer to look up the resistivity of tungsten at its operating temperature (near 2900K) in a common light bulb. ρ_B
6. Draw a circuit with one battery and one resistor. Add to that an ammeter and voltmeter properly connected.
7. Set up this circuit with your light bulb. Make sure the Voltmeter is connected in parallel and the Ammeter is connected in series. Your group may be using a digital multimeter in place of either the voltmeter or ammeter. Set the multimeter to the correct units for which quantity you want to read (A for current and V for voltage.)
8. Adjust the voltage knobs on the power supply (PS) to take readings of current (I) through the bulb and voltage (V) across the bulb, and follow these guidelines:
    a. Do not leave the circuit connected for long periods of time… just long enough to get a constant current reading for each voltage, otherwise the bulb will heat and the resistivity could change
    b. Use voltage values of approximately 15V, 12.5V, 10V, 7.5V, 5V, and 2.5V. Do not try to get exactly these values, just get the voltage close and then record the value read by the voltmeter.
9. Turn the power supply back to 15V and calculate the resistance at 15V for your other bulb.

Analysis:

1. Use Ohm's Law to find the resistance at each voltage. Include the operation point as well.
2. Calculate the actual power output at each voltage.
3. Is there a relationship between the power output and the voltage supplied?
4. Use the values in your table to complete a graph of V vs I on graph paper. Add the operation point for your bulb as well (I_B, V_B). Connect the plotted points with a smooth curve. Make sure you label your graph completely. How would R be found based on this graph?
5. What kind of curve does your graph look like?
6. What does this imply about the resistance of your bulb?
7. Using the formula $R_B = \frac{\rho_B L}{A}$ and the fact that the diameter of the tungsten filament of your bulb is about 0.0046cm, calculate the length of the filament inside your bulb.
8. Using this value of L, calculate the resistivity of the filament for each of your experimental voltages. Calculate the approximate operating temperatures at these voltages (again from information you can research.)
9. If you were to look inside your bulb, the apparent length of the filament would be at first glance about 2cm. How can this be?
10. What is the relationship between the power rating of a light bulb and its resistance?