THE BEHAVIOUR OF RESISTIVE COMPONENTS

OBJECTS
♦ To study the current-voltage relationship for a carbon resistor;
♦ To study the current-voltage relationship for a light bulb filament;
♦ To study the current-voltage relationship for a junction diode;
♦ To study the behaviour of carbon resistors connected in series and in parallel;
♦ To study the behaviour of a simple half-wave rectifier.

EQUIPMENT
A DC/AC power supply, digital multimeters (DMMs), and an oscilloscope are provided. See the Equipment Reference document for detailed information.

Note that a plot of current versus voltage for a resistance obeying Ohm's Law is linear with slope equal to the inverse of the resistance. A plot of current versus voltage is called the current-voltage characteristic.

THEORY (in addition to the information presented in the lecture)
NONLINEAR RESISTANCE
A nonlinear resistance is one whose resistance is NOT constant. The current-voltage characteristic of a nonlinear resistance will be a curve rather than a straight line.

The DYNAMIC resistance of a nonlinear resistance at a specific value of voltage or current is the inverse of the slope of the tangent to the current-voltage characteristic at that value of voltage or current. That is, the dynamic resistance is the change in voltage divided by the change in current where the (small) voltage and current intervals are taken around the value at which the dynamic resistance is to be determined.

EXPERIMENT
CARBON RESISTOR(S)
1. Measure the resistance of resistor AB on the resistor circuit board by using the DMM as an ohmmeter. Repeat this measurement for resistor EF.
2. Now connect resistors AB and EF in series and use the DMM to measure the equivalent resistance of this combination.
3. Design a circuit that will determine the relationship between current and voltage for resistor AB by using the power supply, the DMMs and the oscilloscope. (Use the oscilloscope and one of the DMMs to measure the voltage drop across the resistor. This will provide a check of your ability to use the oscilloscope to measure DC voltage.)

Remember that the black scope input terminal must be connected to the side of resistor AB that is connected to the black terminal of the power supply.

Draw the diagram of the circuit that you will use and have it and your connections checked by the instructor before proceeding.
Measure the relationship between current and voltage for resistor AB. Use a voltage range of 0-12 V.

4. After taking your last measurement in step 3, leave the power supply on and add resistor EF in parallel with resistor AB. Record the voltage across the parallel combination and the current that is now flowing in the circuit.

**LIGHT BULB FILAMENT**

1. Using the same circuit as in step 3 of the carbon resistor procedure (except without the oscilloscope), measure the relationship between current and voltage for the light bulb filament. Use a current range of 0 to 350 mA.

**JUNCTION DIODE**

1. Measure the relationship between current and voltage for the forward-biased junction diode by connecting this circuit:

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\[ R \]
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Use a current range of 0-50 mA.

2. Now reverse the diode in the circuit and measure the relationship between current and voltage for the reverse-biased junction diode. Use a voltage range of 0-6 V.

3. Connect the following circuit using the AC supply and slowly increase the voltage to 4.0 V:

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\[ R \]
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where \( R \) is resistor AB. Use channel 1 of the oscilloscope to view the output of the AC supply and channel 2 of the oscilloscope to view the voltage across the resistor. Sketch these voltages. **Be sure to respect the polarity of the oscilloscope connections (Red / Black).**
ANALYSIS
CARBON RESISTOR(S)
1. Using your individually-measured values for $R_{AB}$ and $R_{EF}$, calculate the theoretical series equivalent resistance. Compare with your directly-measured value of the series resistance.

2. Plot a graph of current versus voltage for resistor AB. Analyse the graph appropriately.

3. Using your individually-measured values for $R_{AB}$ and $R_{EF}$, calculate the theoretical parallel equivalent resistance.

4. Using Ohm’s Law and the values measured in step 4 of the procedure, calculate the equivalent resistance.

5. Compare the values calculated in steps 3 and 4 of the analysis.

LIGHT BULB FILAMENT
1. Plot a graph of current versus voltage for the light bulb filament.

2. Determine the dynamic resistance of the light bulb filament at a current of 200 mA.

3. Using Ohm’s Law, calculate the resistance for a current of 200 mA and the appropriate value of voltage.

4. Compare the values calculated in steps 2 and 3. Discuss.

JUNCTION DIODE
1. Plot a graph of current versus voltage for the junction diode. Determine approximate values for the forward and reverse resistances of the diode.

2. Do the signals observed in part 3 of the procedure agree with the prediction of theory? Discuss.

NOTE: In the Conclusion, be sure to discuss all of the observations and results and relate them to the predictions of theory as appropriate.