PHYS 1040 - General Physics II Lab
Resistors, Ohm's Law and Equivalent Resistance

In this lab you will perform an experiment to understand the relationship between applied voltage, current and resistance in a circuit explore equivalent resistance when two or more resistors are connected together.

INTRODUCTION AND THEORY:
Electricity is due to motion of the electrons – whether it is in a light bulb, electric heater or stereo system. An electric circuit is formed when a conductive path is created to allow electrons to continuously move. In the world of electronics, it is important to understand the basics of voltage, current and resistance in a circuit.

The factors that affect the flow of electrons (or charge) are:
- Current, I is the amount of charge flowing through a circuit in a certain time.
- Voltage, V is amount of electrical potential difference between two points in a circuit.
- Resistance, R is the material's tendency to resist the flow of charges.

Ohm's Law:
The amount of current flowing in a completed circuit is directly proportional to the applied voltage. The relationship among the above three parameters is given by Ohm's Law -

$$V = I\,R$$

V = Voltage (units volts) I = Current (units Ampere, A) R = Resistance (units Ohms, Ω)

A wide range of materials and resistors obey Ohm's law. But some components (diodes and transistors) which are used in electronic devices do not obey this law. Components that extract work from the electric current may also depart from ohm's law.

Resistors in series: Two or more components are connected along a single path – similar to connecting two water pipes end to end.

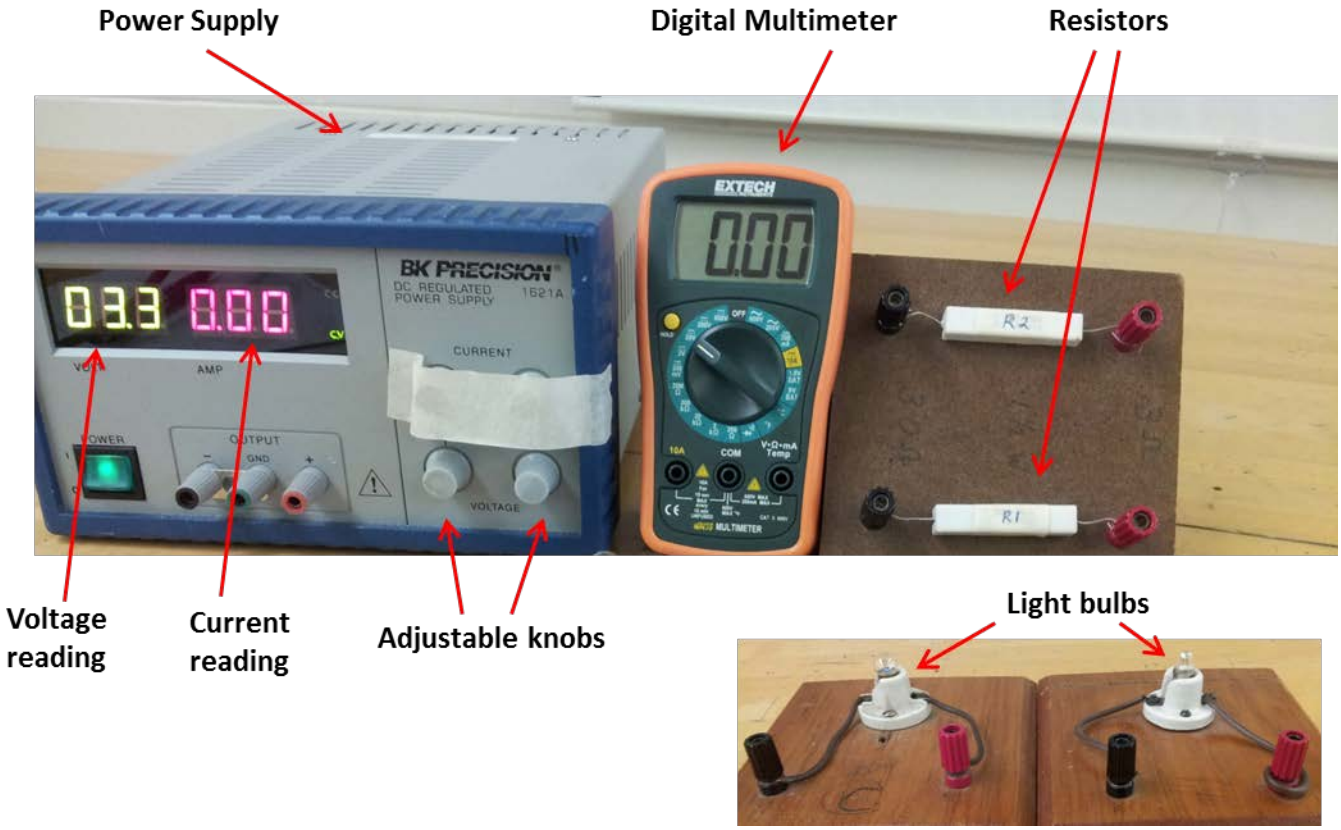
Resistors in Parallel: Two or more components when connected in parallel – similar to a water pipe branching off.

CHECKPOINT 1:
Discuss the following questions with your group and write your expectations and answers.

1) Explain in words the relationship between applied voltage and current for an ordinary resistor. Show this relationship by drawing a graph of *voltage (V) vs. current (I).*
2) How can you find the resistor value from the above graph?
3) Can you measure these factors? If so how?
4) In your lab notebook draw a circuit diagram that you plan to build to measure the resistance of a resistor. This diagram should include the resistor (R) and applied voltage (V).

Show your TA your expectations before proceeding.

EQUIPMENT:



Power Supply: This gives a variable potential difference (applied voltage) across its red and black terminals.

Adjustable knobs: The applied voltage can be varied using these adjustable knobs on the power supply. One of them is for fine adjustment, the other for coarse.

Digital Multimeter: This can be used to measure the voltage between two points. When the dial is set to "20V"  , the meter measures voltage across "COM" and "V·Ω·mA" terminals.

Resistors: Components that resist the flow of charges.
Light Bulbs: To connect together to get maximum or minimum brightness.

CAUTION - Do not exceed 6V on the power supply voltage.
– turn down the voltage to zero, turn off the power supply and then build the circuit.

EXPERIMENT

Part 1 – Conduct the experiment to measure the resistance of a resistors.

Plan your experiment to determine the resistance R_1 (or R2) of a resistor.
You need to create a data table in your lab notebook, deciding on number of columns to be included in the table. Record all the data you take, even though some data may not be within the expected value. This is an experiment and hence uncertainty is associated with any measurement.

Analyze your data performed in part 1 of the experiment:

- Does the current change with applied voltage?
- In your lab notebook, for each resistor plot a graph of *voltage (V) vs. current (I).*
- From these graphs, calculate the resistance of each resistor - R_1 and R_2 .

CHECK POINT 2:
Show your TA your experimental data, graphs and calculated values of R_1 and R_2 for part-1 of the experiment.

Part 2 – Conduct the experiment when two resistors are connected in series or parallel.

CHECK POINT 3:
If you have two resistors, how will you connect them to get -
(a) maximum equivalent resistance (b) minimum equivalent resistance

For each of the above cases discuss with your lab partner(s)

- When two resistors R_1 and R_2 are connected together, is the value of R greater than or less than or equal to R_1 or R_2? Explain why.
- Write an expression relating R, R_1 and R_2.
- In your note book draw a circuit diagram that you plan to build to measure the equivalent resistance, R of the two resistors. This diagram should include R_1, R_2, and applied voltage (V).

Show your TA your experimental plan and circuit diagrams before proceeding.

Plan your experiment to determine the equivalent resistance for series or parallel configurations.
Create a data tables in your lab notebook.
Conduct the experiment and record all the data you take for series and parallel configurations.

Analyze your data performed in part 2 of the experiment:
For each case of series or parallel -

- In your lab notebook, plot a graph of *voltage (V) vs. current (I).*
- Calculate the resistance, R from the above graph.
- How well did your predicted value of R agree with the experimental value?
- Set the voltage of the power supply to any desired value (**less than 6V)**. Measure the voltage drop across each resistor using Digital Multi Meter.
- What is your conclusion about applied voltage and measured voltage drops?

CHECK POINT 4:
Show your TA your experimental data, graphs and analysis of series and parallel configurations for the part-2 of the experiment.

Part 3 – Observations - when two light bulbs are connected in series or in parallel.

CAUTION - Do not exceed 2.5 V on the power supply voltage.

- What is your observation about the brightness of the light bulbs when they are connected to the power supply in: (a) series (b) parallel.
- Explain in words the above observations.

- For one of the light bulbs, take measurements of voltage and current.
  Plot a graph of *voltage (V) vs. current (I).* What can you infer from this graph?
  Plot a graph of *power (P) vs. voltage (V).* What can you infer from this graph?

CHECK POINT 5:

Show your TA all the experimental data, analysis, and graphs for all parts of the experiment.
Explain to the TA whether the measured data support your expectations.
Do not leave the laboratory until you have collected all data that you need to write the report.

LAB REPORT – due one week after the lab.

The procedure you followed should be clearly written and all the analysis should be included. You can include the computer plotted graphs showing the trend-line with display equations. Make sure you address the questions posed at the beginning of this handout, your expectations before conducting the experiment and use to your experimental data to support your conclusions. Your conclusion should indicate whether or not you were able to confirm your expectations.