

Sunday Academy

2010-2011

Basic Laws of Electricity

Objectives and Standards

Objectives:

Students will understand how to:

- simulate and create circuits using Multisim software and Breadboard by following simple circuit diagrams.
- connect to a 9V battery to the Breadboard.
- measure dc voltages using a multimeter.
- build Ohm's Law and Kirchhoff's voltage law (KVL) circuits.
- measure dc currents using a multimeter and understand Kirchhoff's current law (KCL).

North Dakota Standards

- 11-12.2.2. Abilities to do scientific inquiry, select and use appropriate instruments, measuring tools, and units of measure to improve scientific investigations.
- 11-12.2.7. Design and conduct an independent investigation.
- 9-10.5.14. Mathematical modeling, draw conclusions about a situation being modeled.
- 9-10.5.9. Solve linear algebraic equations and inequalities, systems of two linear equations or inequalities, and quadratic equations having rational solutions; e.g., factoring.
- 9-10.3.10. Electricity and Magnetism, describe the differences between series and parallel circuits.

Timeline and Materials needed

Timeline

11:00 – 11:30: Cultural Connection/brief Introduction

11:30– 12:00 : Powerpoint Introduction to Laws

12:00 – 12:45: Lunch

12:45 – 1:30: Activity 1, Ohms Law

1:30 –2:00: Activity 2, Kirchoff's Current Law (KCL)

2:00–2:30: Activity 3: Kirchoff's Voltage Law (KVL)

2:30 -3:15: Q & A session

Materials Required: Sensor Lab Kit, Multimeter, 9V Battery, Multisim (free evaluation software, provided on a CD).

Fundamental parameters in Electricity

- Voltage
- Current

[Video](#)

[LEMON Battery](#)

Units

Voltage: _____

Current: _____

Resistance: _____

milli(m): _____

Kilo(K): _____

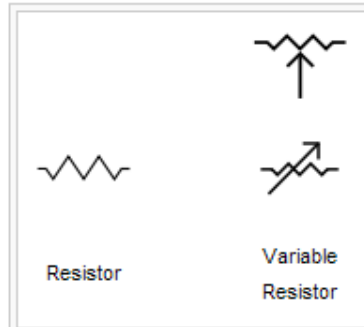
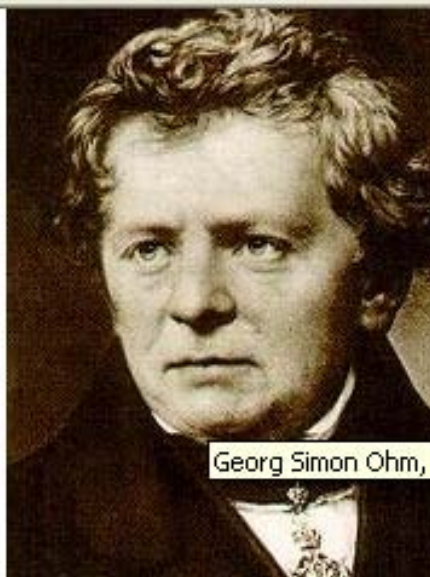
Electrical Resistance (Ohms Law)

Resistance: Impede the flow of current

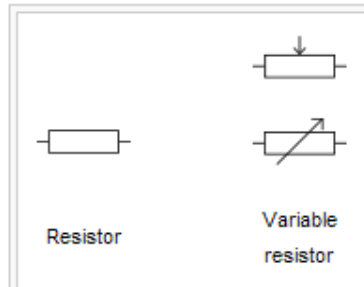
Circuit: Resistor

Symbol: tooth like structure

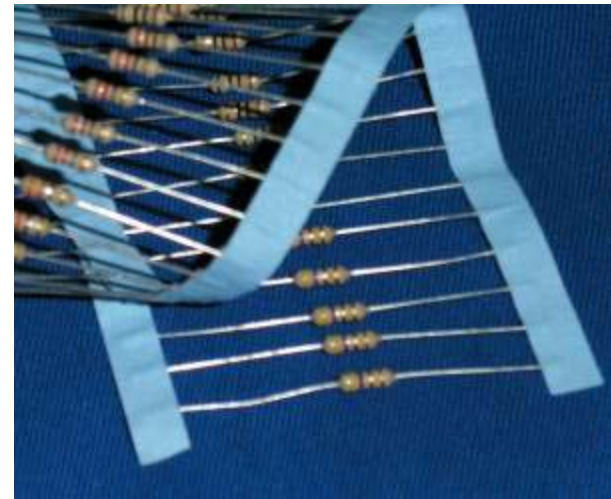
Unit: Ohms



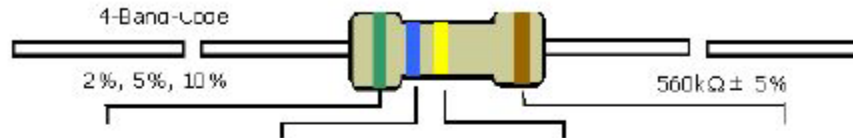
Resistor symbols (American)



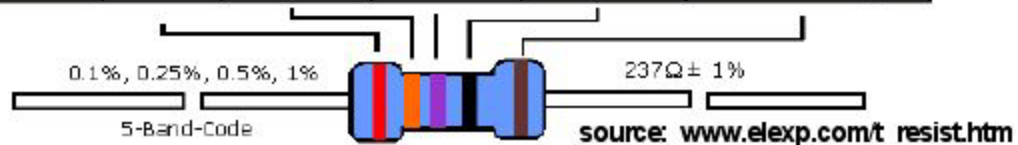
Resistor symbols (Europe, IEC)



Resistor Color Code Guide



COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE
Black	0	0	0	1Ω	
Brown	1	1	1	10Ω	± 1% (F)
Red	2	2	2	100Ω	± 2% (G)
Orange	3	3	3	1KΩ	
Yellow	4	4	4	10KΩ	
Green	5	5	5	100kΩ	±0.5% (D)
Blue	6	6	6	1MΩ	±0.25% (C)
Violet	7	7	7	10MΩ	±0.10% (B)
Grey	8	8	8		±0.05%
White	9	9	9		
Gold				0.1	± 5% (J)
Silver				0.01	± 10% (K)



Laws of Electricity

- Ohms Law

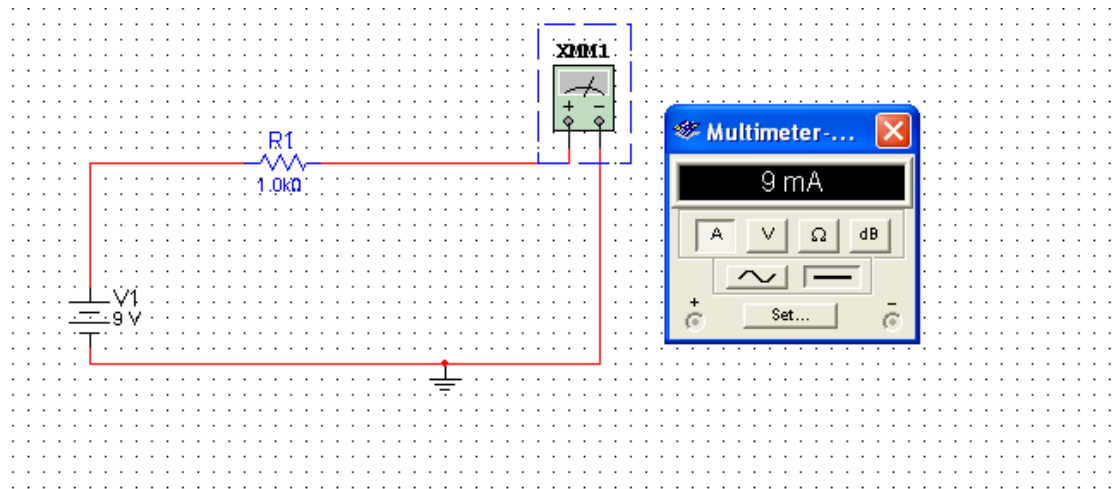
[Video](#)

Simulating circuits on Multisim

Activity 1: Ohms Law

Pre-lab Procedure for Activity 1

Connect the circuit as shown below and measure the current using multimeter:



- Step 1: Open the Multisim Software, See under National Instruments.
- Step 2: Choose Place>>Component>> Sources>>Power Sources>>DC Power for Selecting 12V Battery
- Step 3: Choose Place>>Component>> Sources>>Power Sources>>Ground for Ground connection
- Step 4: Choose Place>>Component>>Basic>>Resistors>>1kohms
- Step 5: Select Multimeter block from the right side of the software window.

Pre-lab questions:

- A. Record the values in Table 1 for I by changing the Voltages on the simulation? What happens to the current (I) readings?. Is it increasing or decreasing?.

Please select (circle) any one option inside the bracket for the following:

V is (proportional or inversely proportional) to I

Table 1 : VI characteristic

V	I
9	
10	
12	
15	
20	
30	

- B. Record the values in Table 2 for I, if you vary the resistor values. What happens to the current readings (I)?. Is it increasing or decreasing?.

Please select (circle) any one option inside the bracket for the following:

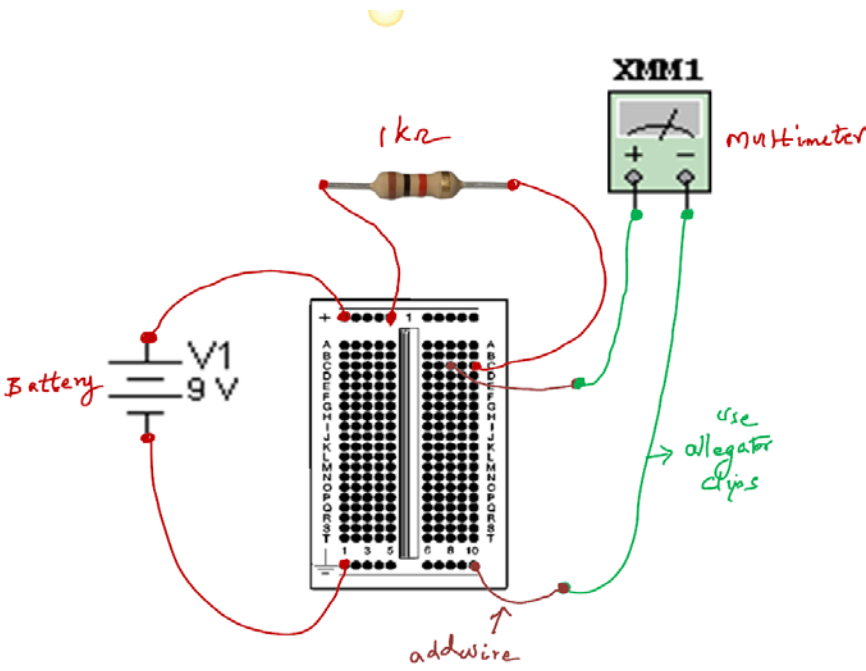
R is (proportional or inversely proportional) to I

Table 2: IR characteristic, keeping V=9V

R (kohms)	I
2	
3	
4	
5	
6	
10	

Note: If you cannot find the correct R take some other resistance values that are in increasing order.

Ohms Law on Breadboard check to see ohms law satisfies



Measuring I and V

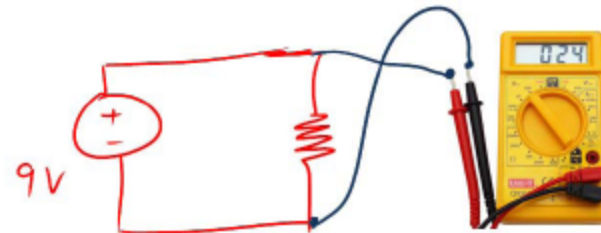
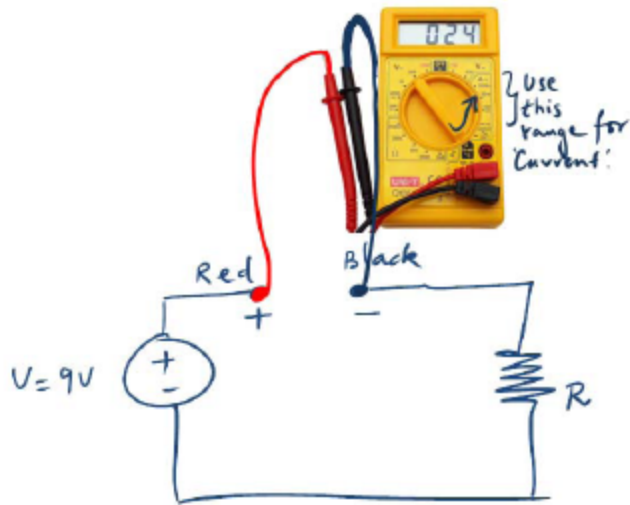


Figure 3: a) Measuring I in multi-meter (first diagram) b) measuring voltage (second)

Activity 2: KVL

KVL Definition: Kirchhoff's voltage law states that **“the sum of the voltages around a circuit loop must equal zero”**, when following a consistent measurement direction of voltages for each element around the loop. In other words, the total of the voltage steps as you go around a circuit loop must end up back where you started. Assign a negative sign for Voltage rise (- to +) and positive sign for Voltage drop (+ to -).

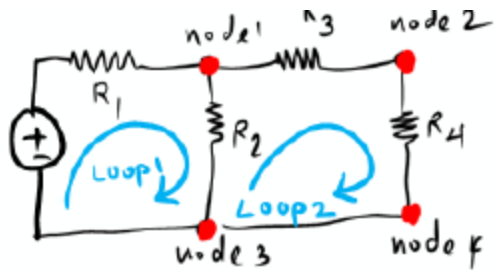
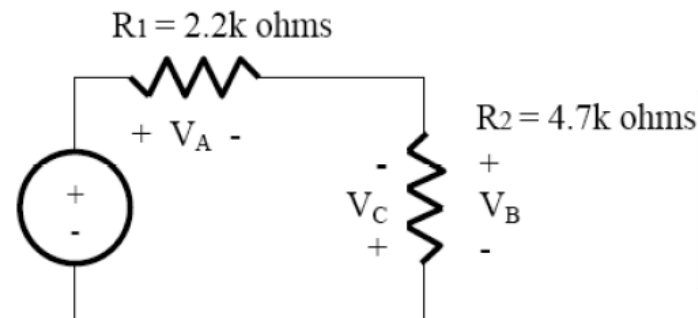
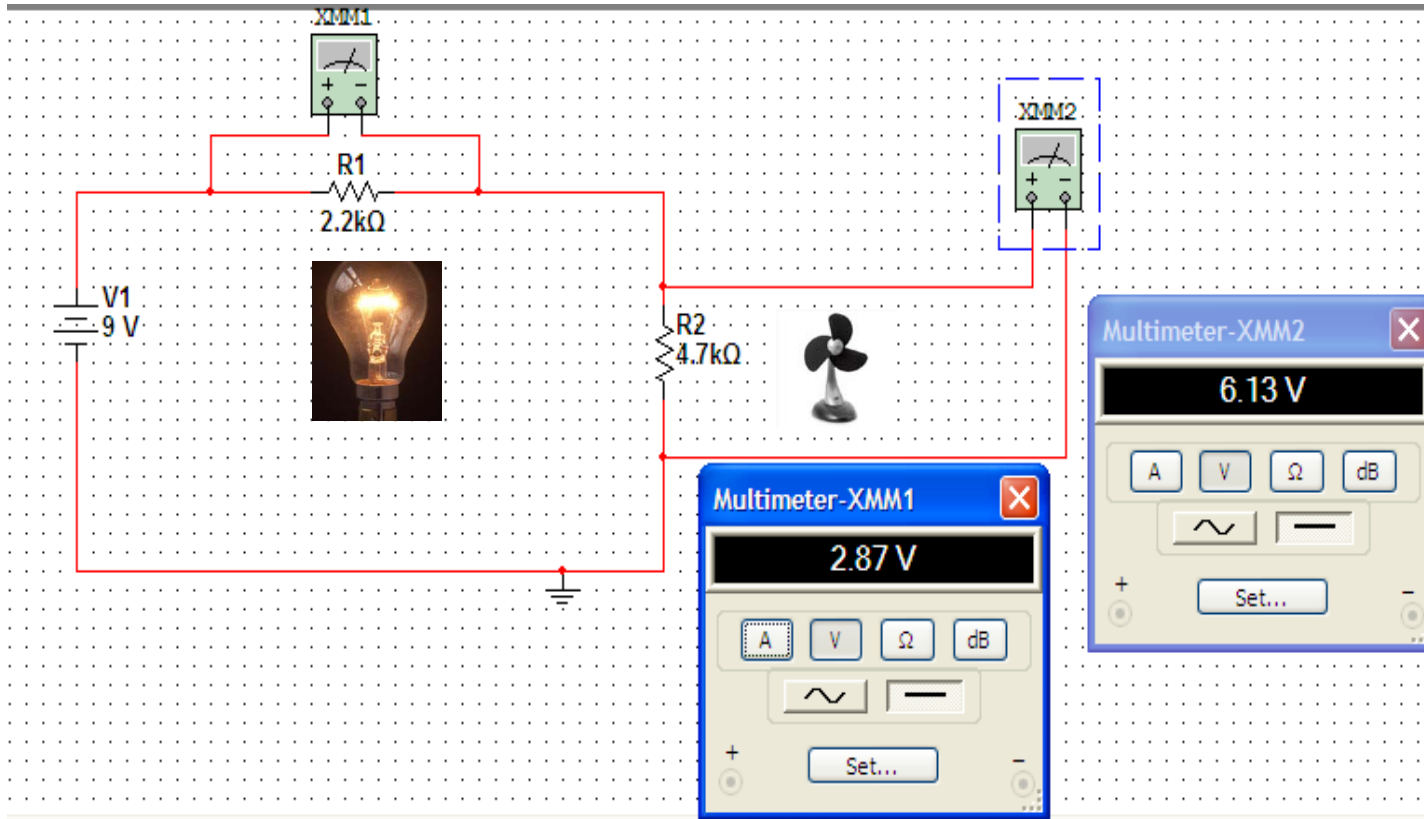


Figure 6: defining a 'loop' in a circuit



Simulating KVL



Measurement Analysis

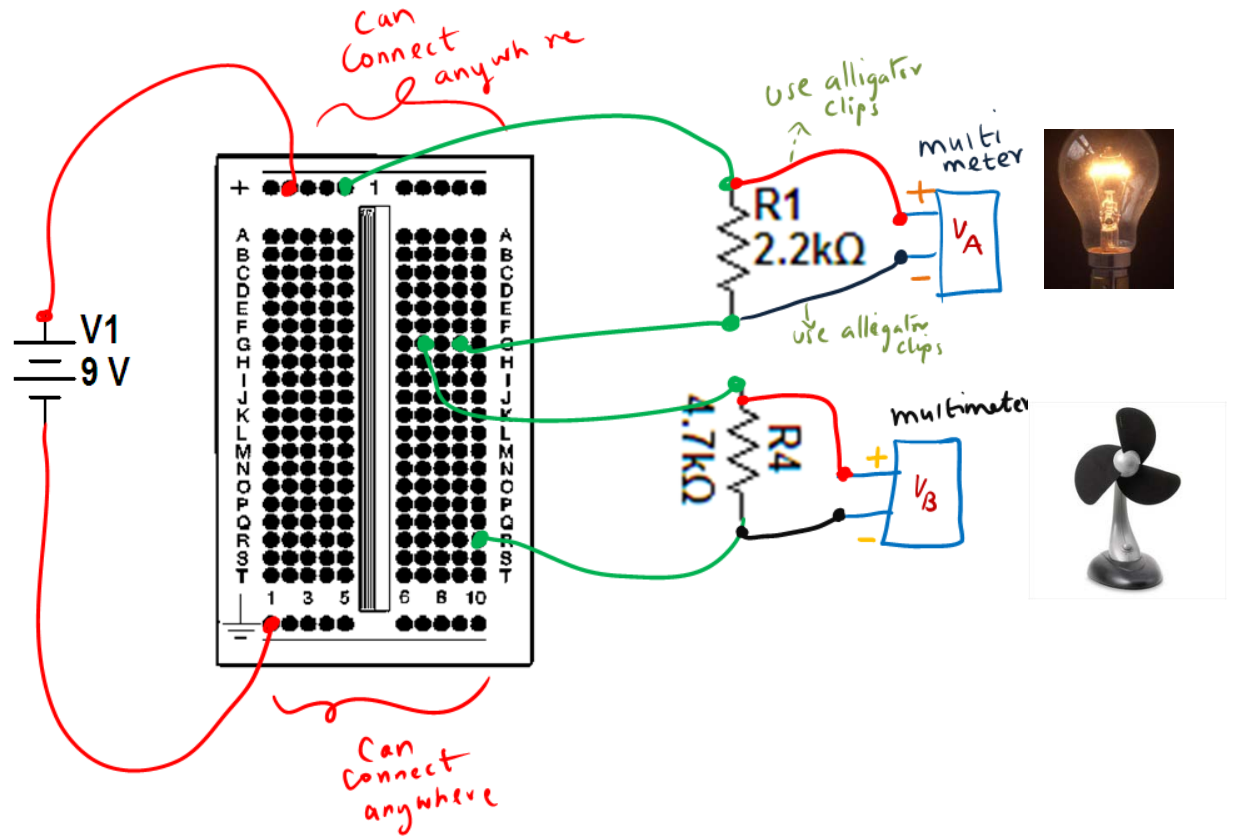
Part 1: Measure the multiple voltages, V_A , V_B and V_C

- V_A : _____
- V_B : _____
- V_C : _____

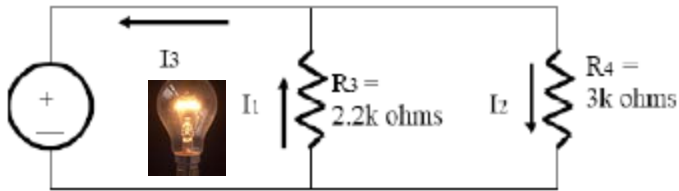
Part 2: Using the voltages you measured in Part1, show two examples of Kirchhoffs voltage law:

- 1. An expression using your measurements for V_A , V_B and the 9V battery, and
- 2. Another expression using your measurements for V_A , V_C and the 9V battery.
- Explain the reason for any discrepancy in your measurements.

Breadboarding KVL



Activity 3: KCL simulation and breadboarding



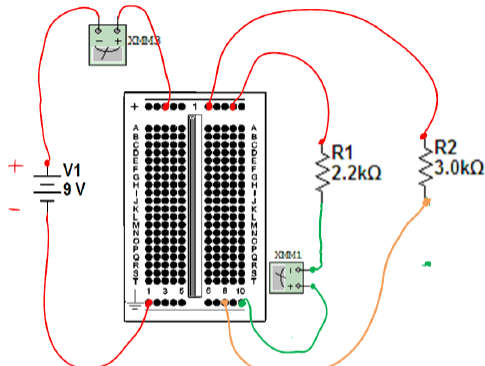
Record current values:

I1: _____

I2: _____

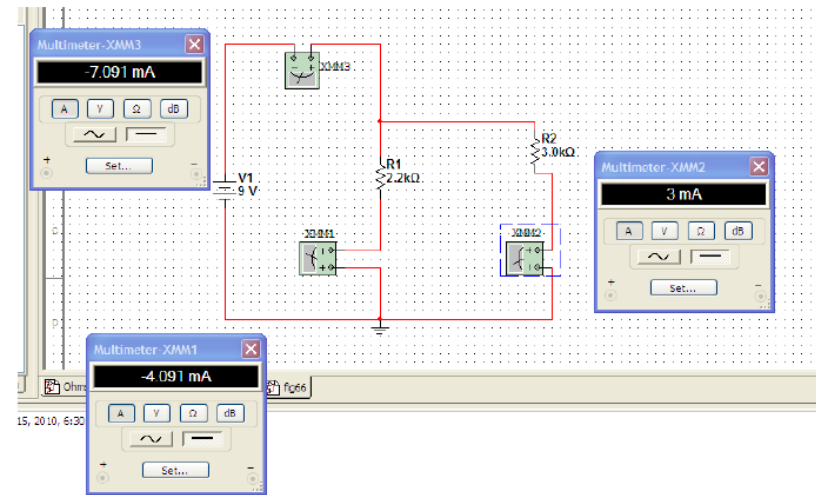
I3: _____

Figure 10: Measure currents i1, i2, i3



Connect to ground directly, if you don't want to measure I_2 .

Figure 12: KCL Implementation on Breadboard



Q & A Session

Answer the questions in the table below. *Carefully* check for units and proper abbreviations.

- State Kirchoff's Current Law
- State Kirchoffs Voltage Law
- State Ohms Law
- 725 is how many volts?_____
- 10.5 A is how many mA?_____
- What is the sum of 650 mV and 1.2 V (in volts)?_____