Northeast Community College
Diversified Manufacturing Technology

Introduction to Circuit Construction Simulation

INTRODUCTION:

This laboratory activity will introduce the student to use of the Circuit Construction Interactive Simulation tool that will be utilized to further investigate electrical concepts and circuits. PhET provides fun, interactive, research-based simulations of physical phenomena. The program(s) enables students to make connections between real-life phenomena and the underlying science, deepening their understanding and appreciation of the physical world.

To help students visually comprehend concepts, PhET simulations animate what is invisible to the eye through the use of graphics and intuitive controls such as click-and-drag manipulation, sliders and radio buttons. In order to further encourage quantitative exploration, the simulations also offer measurement instruments including rulers, stop-watches, voltmeters and thermometers. As the user manipulates these interactive tools, responses are immediately animated thus effectively illustrating cause-and-effect relationships as well as multiple linked representations (motion of the objects, graphs, number readouts, etc.)

The simulations were developed by University of Colorado at Boulder.

ACTIVITY:

The Circuit Construction Simulation is an electronics kit in your computer! Students will utilize this program to build circuits with resistors, light bulbs, batteries, and switches. Take measurements with the realistic ammeter and voltmeter. View the circuit as a schematic diagram, or switch to a life-like view. Students will also use the program to discuss basic electricity relationships, build circuits from schematic drawings, provide reasoning to explain the measurements and relationships in circuits, discuss basic electricity relationships in series and parallel circuits, and determine the resistance of common objects.

1. When a student first opens the program they will see a blank screen (Figure 1-1) with options on the side. These options are the tools that you will be utilizing are similar to what you would be using if testing circuits on a circuit board. The primary difference between a circuit board and the simulation is that the simulation is two dimensional, but also has advantages in that one can see electron flow and can control a number of variables instantly.

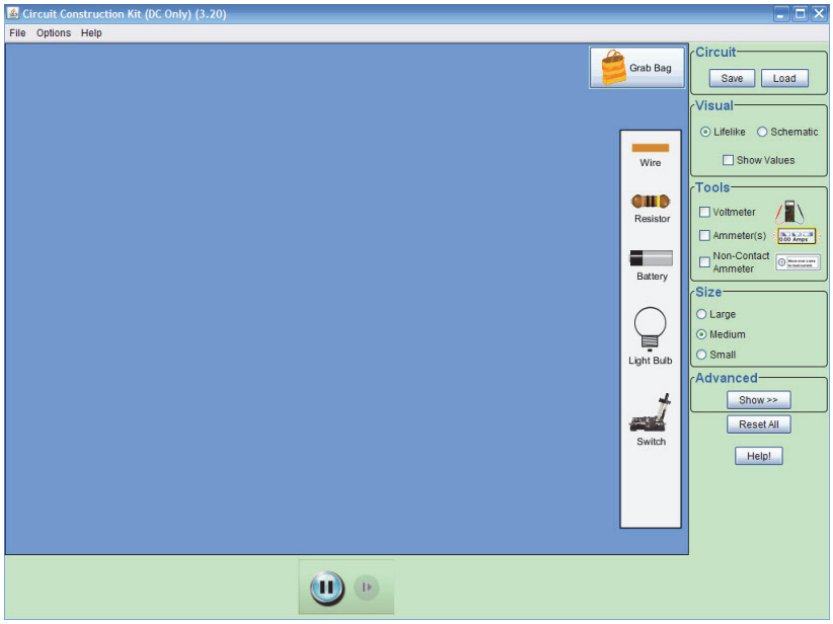

Figure 1-1

2. To work with an object located on the right side such as a wire, a resistor, a batter, a light bulb or a switch simply click on the object of interest and while holding down your left mouse key drag the object onto the screen.

3. We'll now take a look at the wire or conductor as it may be termed. In figure 1-2, the red dashed circles are the connection junctions. By clicking on and holding down the left mouse key on a connection junction the length of the wire can be increased or decreased simply by dragging the mouse.

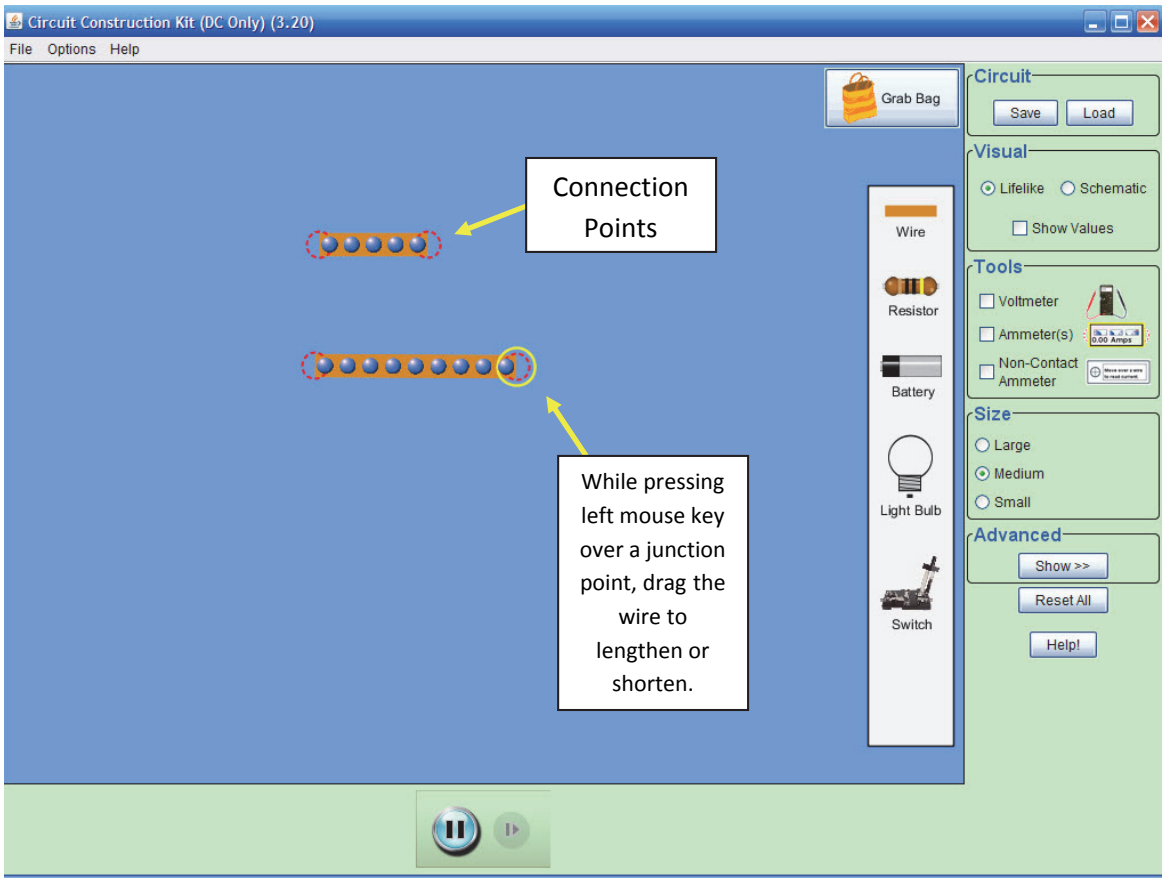

Figure 1-2

The wire resistance can also be adjusted to fit the experimental design by selecting the “show>>” button under the *Advanced* section on the far right-hand side of the simulation page. The blue dots shown in the wire represent electrons and demonstrate movement through a circuit. The electrons can be hidden by checking the “hide electrons” box under the advanced section as well. (Figure 1-3)

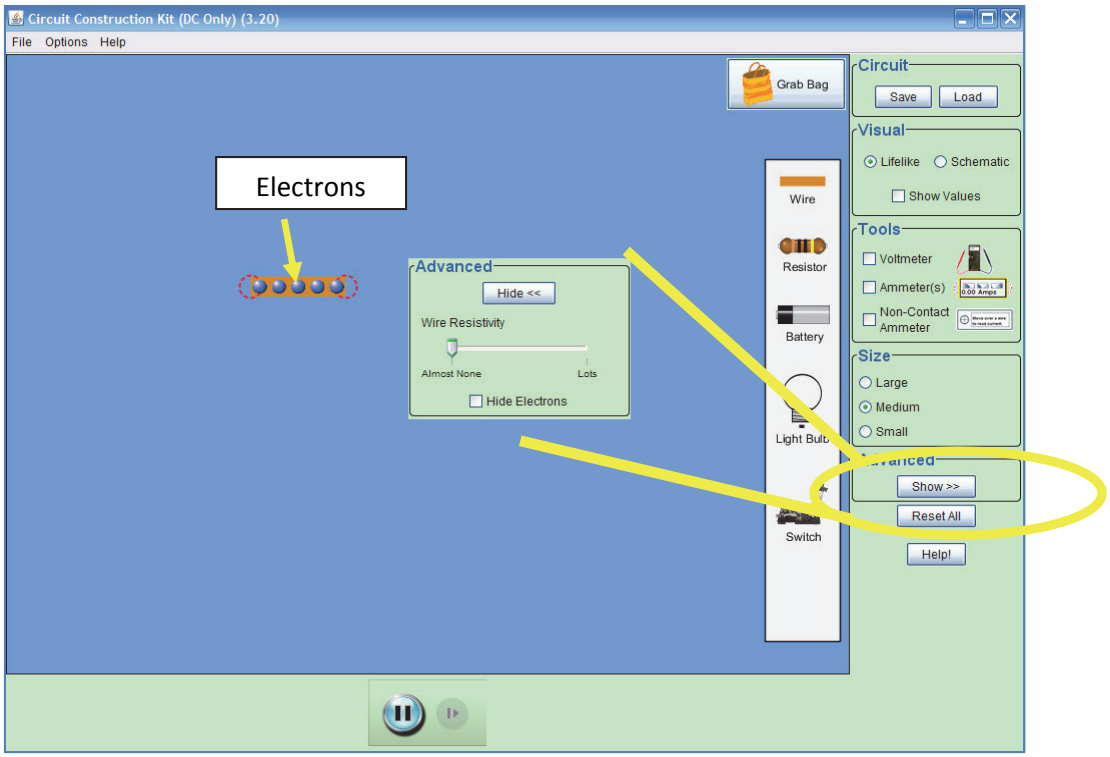

Figure 1-3

To connect the components, the junction points must be overlapped as shown in figure 1-4. To disassemble, simply right-click over the junction point and select “split junction”.

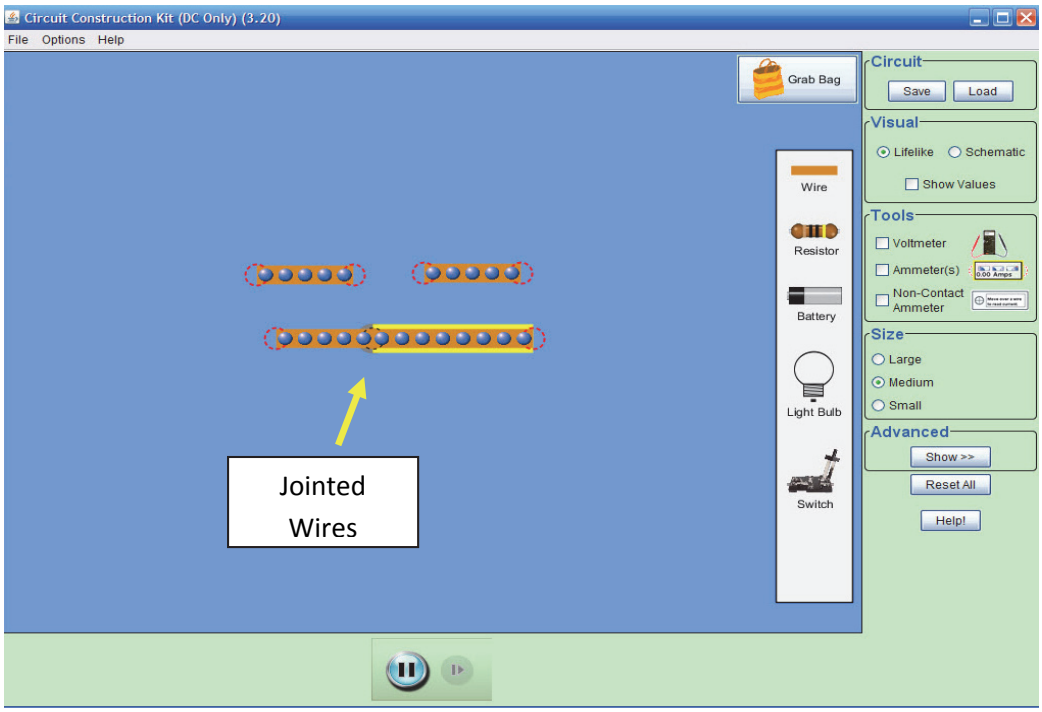

Figure 1-4

4. The second component is a resistor.

Figure 1-5

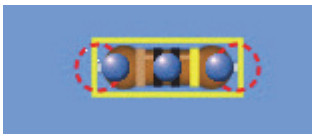

Figure 1-6

Again the resistor can be introduced into the circuit by dragging the component into a place in the circuit. The user can manipulate the resistance of the resistor by right-clicking the computer mouse over the center of the components. The user will also have the option of showing the components set values by right-clicking the computer mouse over the center of the components. (Figure 1-7)

Figure 1-7

To remove the resistor, or any component from the circuit simply right-click the computer mouse over the center of the component and then select “remove”.

5. A third component critical to a circuit is a power source, which in the simulation is a battery.

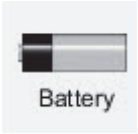

Figure 1-8

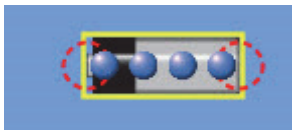

Figure 1-9

Like the other components, the battery can also be manipulated to fit the needs of the experimental design. The voltage of the battery can be adjusted from 0 to 100+ voltage by right-clicking on the battery and selecting “Change Voltage”. The user may also display the current settings by selecting “show settings”.

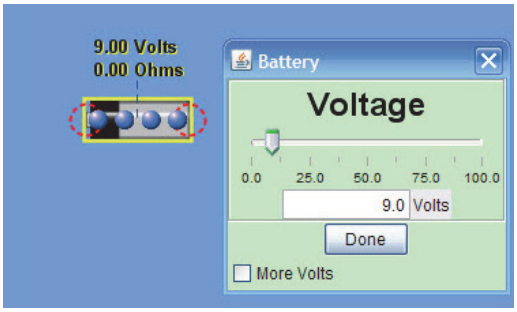

Figure 1-10

As batteries typically have some amount of resistance, the resistance can be adjusted by right-clicking on the battery and selecting “change internal resistance”.

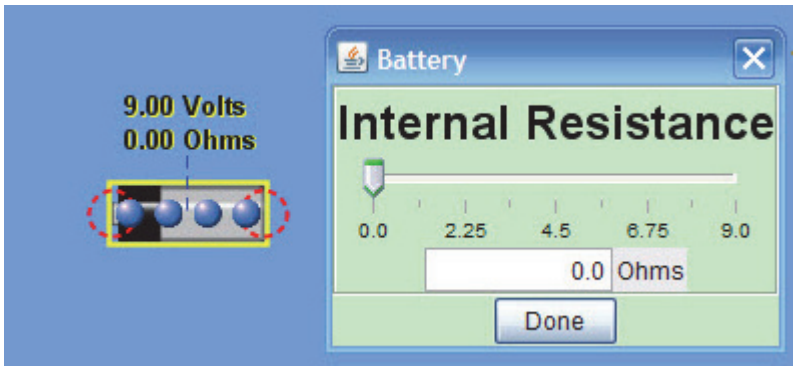

Figure 1-11

A third manipulation in which can be conducted in the simulator is the reversal of polarity meaning to reverse the positive and negative terminals therefore reversing the flow of current as shown in figure 1-12.

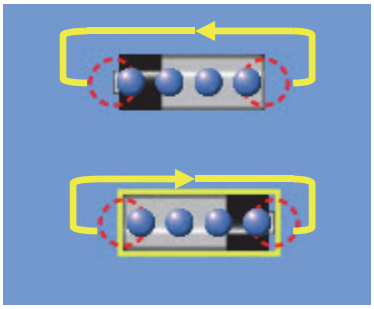

Figure 1-12

6. You are also provided with an optional light bulb to help visualize the concepts in which you are studying. Like the other components the resistance through the light bulb can be adjusted. The connection points on the bulb can also be shifted from left to right.

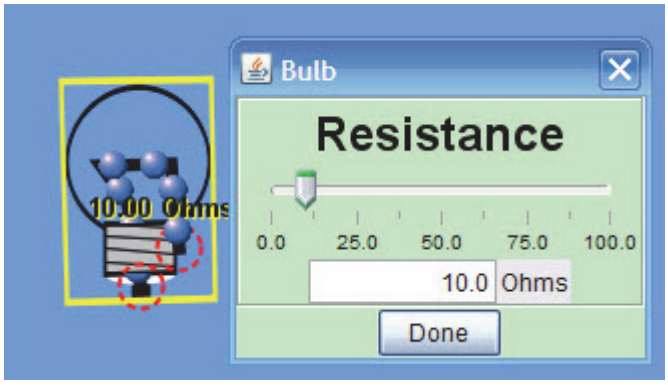

Figure 1-13

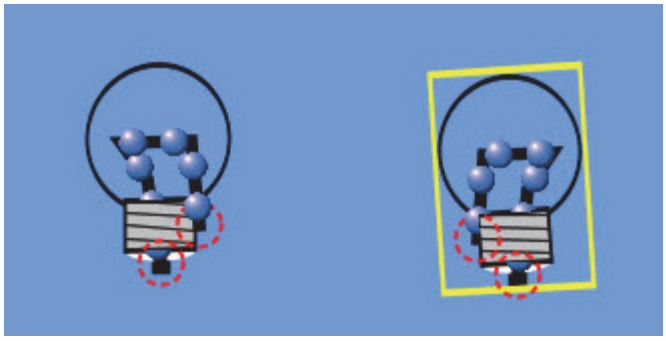

Figure 1-14

7. The final component in which you will begin with is a lever switch. The switch can be opened and closed by holding your left key of your computer's mouse down and moving the level towards or away from the base. (Figure 1-15)

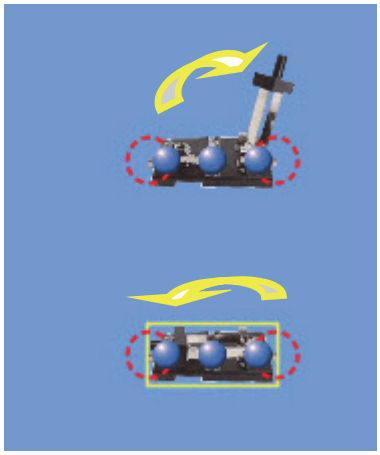

Figure 1-15

8. In the upper right corner of the page you will also view a grab bag of goodies. These materials will be utilized to demonstrate conductivity and resistivity of various materials (figure 1-16). The materials in the grab bag can be selected by clicking on the name.

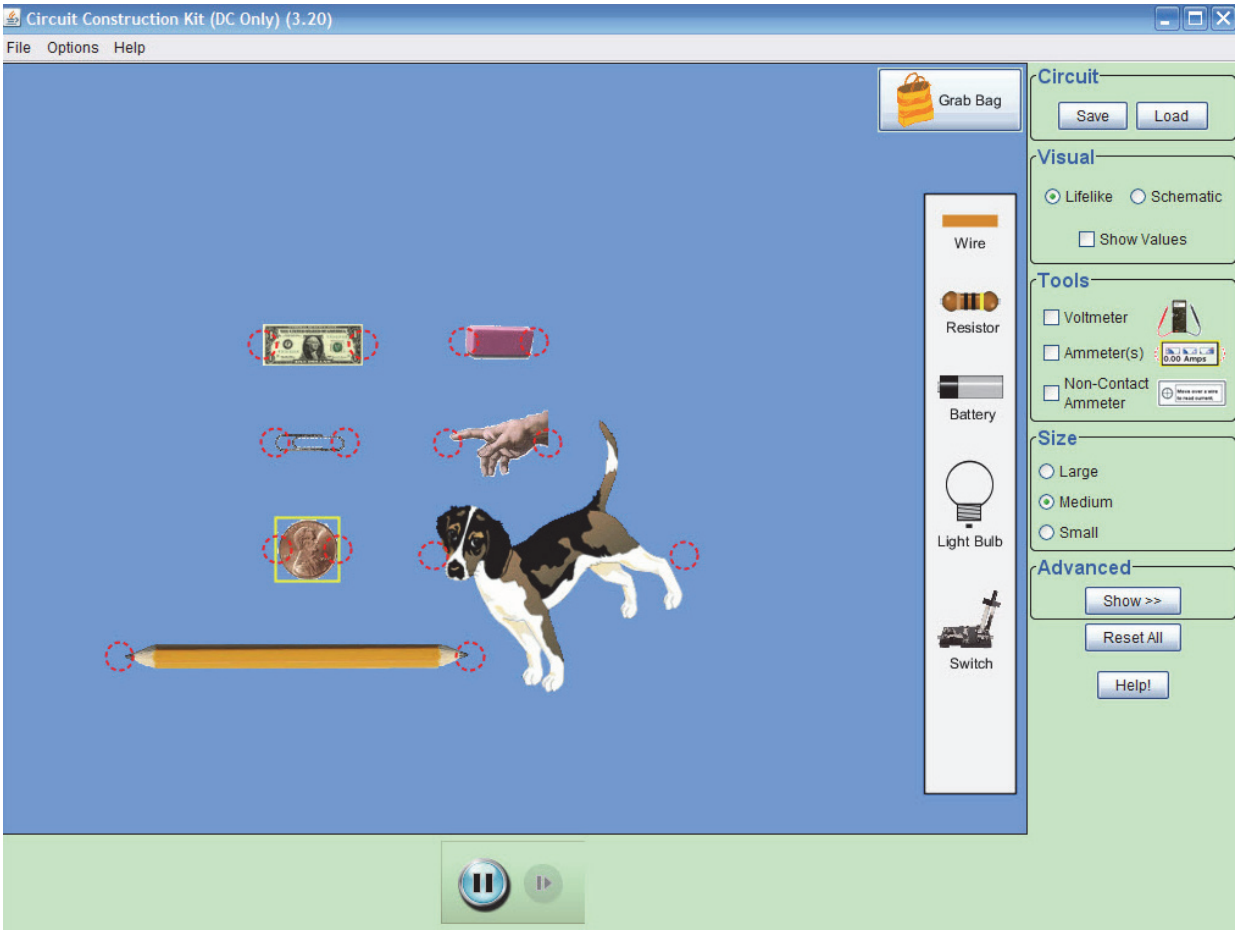

Figure 1-16

9. To far right side of your screen when using the simulation you will also see the boxes “Circuit”, “Visual”, “Tools”, “Size” and the “Advanced”.

The “Circuit” is to save and load circuits that have been designed. YOU WILL NOT USE THIS FEATURE. Because the circuits utilized Java and Flash programming media and work that is saved must also utilize those programs. Most systems are not set up to read those scripts without further software.

The “Visual” section will allow the user to view their circuits in “lifelike” format or as a schematic (electrical diagram). Figure 1-17 shows what your circuit will resemble when using schematic form.

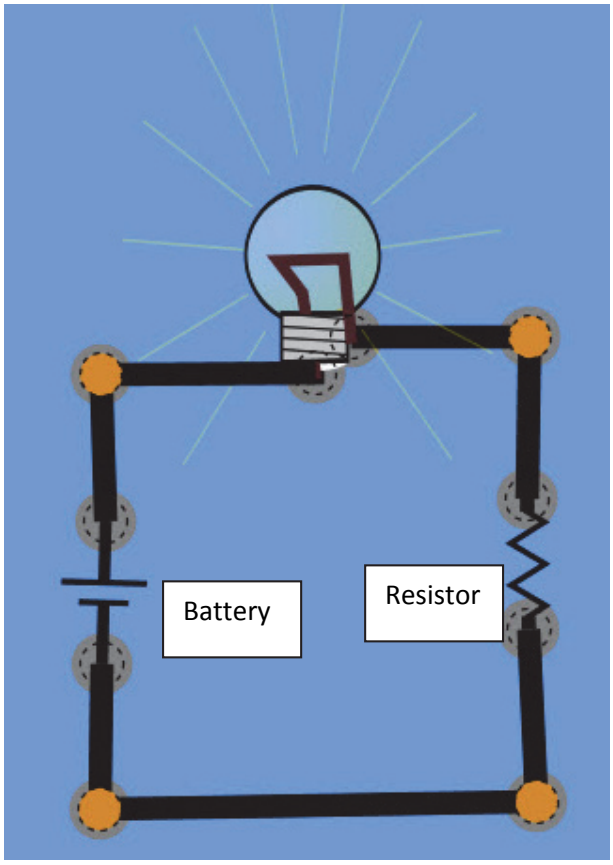

Figure 1-17

You can also select “show value” to display the resistance, voltage, etc throughout the circuit.

The tools section will utilize a voltmeter, an ammeter, and a non-contact ammeter. The volt meter works very similar to the common multimeter in which you will have to make contact between the conductors and the meter leads. The ammeter requires that the circuit be broken and the meter inserted into the system. The non-contact ammeter will allow the user to measure the amperage without breaking the circuit by simply passing the device over the circuit.

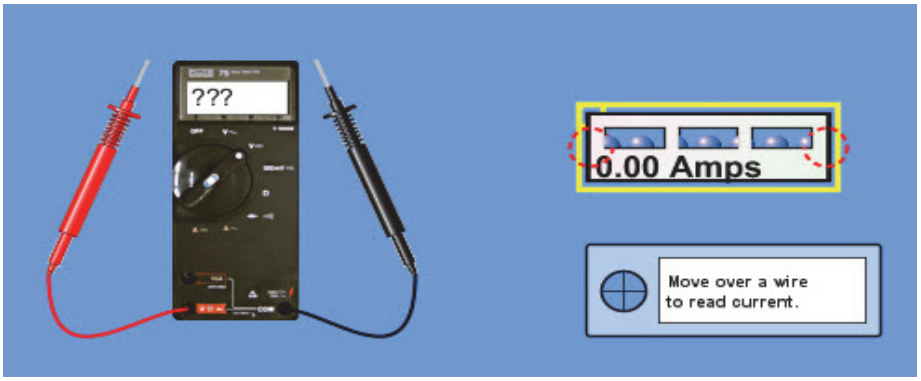

Figure 1-18

The size section will let you adjust the size of the images on the screen. Please note that it will adjust all of the components size for viewing preference.

We have already discussed the “advanced” options.

10. Take a few minutes to play around and try a few designs. This or a similar program will be utilized for most of the work in this course.

Resources:

1. University of Colorado Boulder (n.d.). PhET - Circuit Construction Kit.

   Founded in 2002 by Nobel Laureate Carl Wieman, the PhET Interactive Simulations project at the University of Colorado Boulder creates free interactive math and science simulations. PhET sims are based on extensive education research and engage students through an intuitive, game-like environment where students learn through exploration and discovery.

2. Grant Statement

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This product was funded partial or in full by a grant awarded by the U.S. Department of Labor's Employment and Training Administration. The product was created by the grantee and does not necessarily reflect the official position of the U.S. Department of Labor. The Department of Labor makes no guarantees, warranties, or assurances of any kind, express or implied, with respect to such information, including any information on linked sites and including, but not limited to, accuracy of the information or its completeness, timeliness, usefulness, adequacy, continued availability, or ownership.