



CIRCUIT SIMULATOR

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Va. SOL:

PH.13 The student will investigate and understand how to diagram and construct basic electrical circuits and explain the function of various circuit components. Key concepts include

- a) Ohm's law;
- b) series, parallel, and combined circuits; and
- c) circuit components including resistors, batteries, generators, fuses, switches, and capacitors.

National Standards:

- Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces. These effects help students to understand electric motors and generators.

Topic/Concept

Allows students to design circuits with all types of components without having to have them on hand. You can encourage students to design their own circuits, solve them on paper and then check their work using the online circuit designer. Additionally, students can test complex circuits safely on the computer prior to actually building them.

Materials

- Computer with a JAVA 1.1 enabled browser

Safety Considerations

None

Presentation

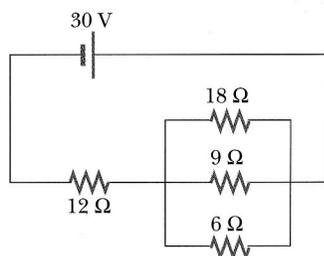
Students have already been taught how to design and solve simple circuit and combination circuit problems. Students are given this lab as a prelude to a lab using actual resistors and power supplies.

Circuit Simulator

Directions: In this lab you will be using an online circuit builder program to test the validity of the circuit solving methods taught in your physics class. First, you will solve two circuits using the traditional resistor reduction method or by using Kirchoff's junction and loop rules. Second, you will build these circuits and test your calculated results using the web based Java circuit simulator called Circuit Builder.

Part I:

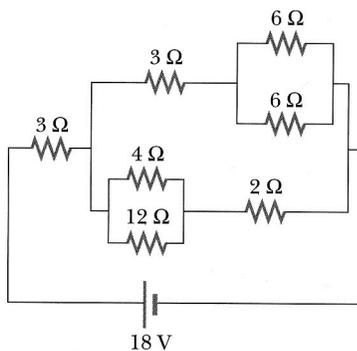
- Find the current in each branch of the following circuit.



$$i = \underline{\hspace{2cm}} \quad i_1 = \underline{\hspace{2cm}} \quad i_2 = \underline{\hspace{2cm}} \quad i_3 = \underline{\hspace{2cm}}$$

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Part II

Now you are going to build the circuits. Below are some of the symbols that will be useful in the construction of your circuits. These are just a part of the total symbols available to you in Circuit Builder.

—— Resistor

—— Battery

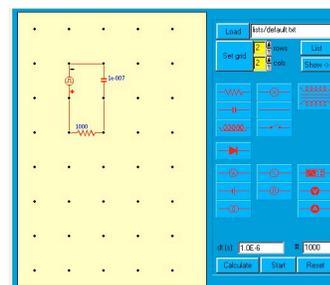
—— Wire

—— Ammeter- measures the current in a branch of the circuit. Must be placed in line with the resistor through which the current is being measured.

—— Voltmeter – measures the voltage across a branch of the circuit or across a resistor. Must be put in parallel with the portion of the circuit being measured.

1. Get a laptop, boot it up and log in. Start Internet Explorer and enter the URL <http://webphysics.davidson.edu/Applets/circuitbuilder>.

2. This will open a screen that looks like the picture to the right. The circuit board is on the left (the yellow section) and the buttons will all the components are on the right. On the circuit board is a circuit that must be deleted. To delete a component, place the mouse over one of the components and press the right mouse button. This will bring up a menu that contains the option **Delete Component**. Select this menu option. Note that the color of the circuit board background is no longer yellow. This means that the circuit is no longer a complete circuit (that means it is not a closed loop). Repeat this for each of the remaining 5 components.



3. Now you are all set to build your own circuit. Circuit Builder is a drag and drop interface. That means you select which component you wish to use and drag it to its location on the circuit board. You can select the component and move it later if you wish. First, select the battery. Place the mouse over the battery () and press the left mouse button. Now drag the mouse over to the circuit board and place the battery where you want it. Once the battery is placed a small pop-up window will open. In the pop-up window you will see a line that looks like:

$$v=0.0, r=1.0E-9$$

where you see the 0.0 you want to type in the value of your battery from Circuit 1. The $r=1.0E-9$ is the internal resistance of the battery. For your purposes, you want to leave this the way it is.

4. Next you are going to connect the battery with a wire (). Place the mouse over the wire and press the left mouse button. Drag the mouse over to the circuit board and place it next to the battery. This will automatically connect the wire to the battery.

5. Now you are going to place a resistor on the circuit board. Place the mouse over the resistor () and press the left mouse button. Drag the mouse over to the circuit board next to the wire and place the resistor next to the wire. When you drop the resistor, a pop-up window will open. In this window you will see a line that looks like:

$$r=0.0$$

where you see the 0.0, you want to type in the value of the specific resistor.

6. Now select the ammeter (—A—) and drag it next to the resistor and drop it to place the ammeter in the circuit. You are going to repeat this for each circuit branch for which you want to determine the current.
7. Continue building Circuit 1 using the steps above.
8. When the circuit is complete the background will turn from gray to yellow. Next, right click on one of the ammeter symbols in the circuit and a menu will open. Select the **Display Amperemeter** option. This will open up a window that shows the current flowing through that branch of the circuit. If the current is negative, you can reverse the polarity of the ammeter by moving the cursor over the ammeter you are reading and press the right mouse button. This will open the menu. Choose the **Reverse Polarity** option. This will reverse the direction of the ammeter and make the current positive.
9. If you want you can add a voltmeter (—V—) in parallel with one of the branches of your circuit and prove to yourself that the voltage drop is the same as the one you calculated.
10. Calculate the percent error for each of the currents on the front of the sheet.
11. Repeat steps 2-9 for Circuit 2 on the front of the lab. You may have to turn the circuit sideways or reconfigure the circuit to get all the components on the circuit board.



Challenge:

Design and solve your own circuit using multiple power sources and at least 8 resistors, 3 series sections and 3 parallel sections. Test your circuit using Circuit Builder.



Teacher Tips Regarding Lab

The biggest pitfall with this lab is helping students to understand that the circuit on the paper does not have to look exactly like the circuit you build on Circuit Builder.

Sources & References