Name: _____

Partner(s): _____

1118 section: _____

Desk # _____

Date: _____

Circuits

Purpose

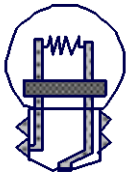
The purpose of this lab is to gain experience with setting up electric circuits and using meters to measure currents and potential differences.

Introduction and Theory

In this section you will compare the brightness of light bulbs in various circuits. Because the batteries you are using are not ideal voltage sources, you may see slight brightness changes where you would not with an ideal voltage source. If you see only a slight change in brightness when changing the circuit, then you should conclude the brightness is the same.

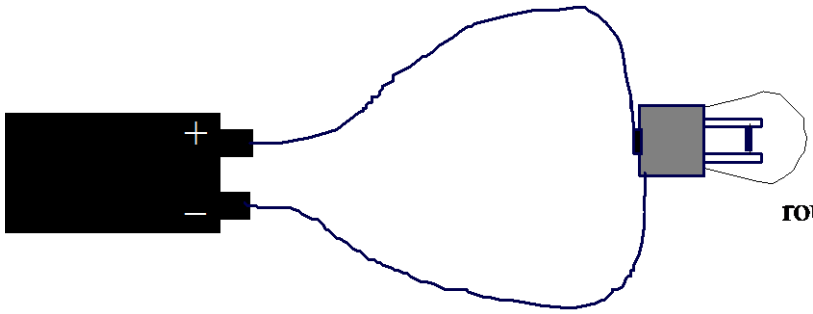
Experiments: Obtain needed equipment.

Light a round bulb using one battery and 2 connecting wires. Do not put the bulb in a socket yet! In the diagram below, **draw lines** to show where you connected the wires to make the bulb light up. Your lines SHOULDN'T cross each other, as this would indicate that the wires are connected where the lines cross.

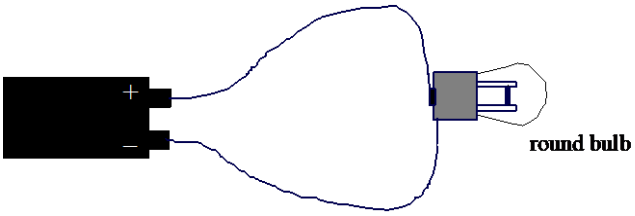


round bulb

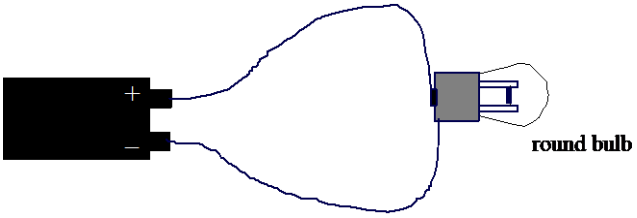
Now put the round bulb in a socket and set up the following circuit. The bulb should light up.



In metals, such as the wires and light bulb filament, the positive charges (protons) are bound in the atoms and unable to move. Some of the negative charges (electrons), however, move easily throughout the metal. Draw arrows on the lines in the left hand diagram below to represent the direction electrons are moving in the circuit. By convention, though, conventional current (I) is defined as the movement of positive charges. Draw arrows on the right hand diagram showing the conventional current. From here on, we will be referring to conventional current whenever we talk about current and flow of charge in a circuit.

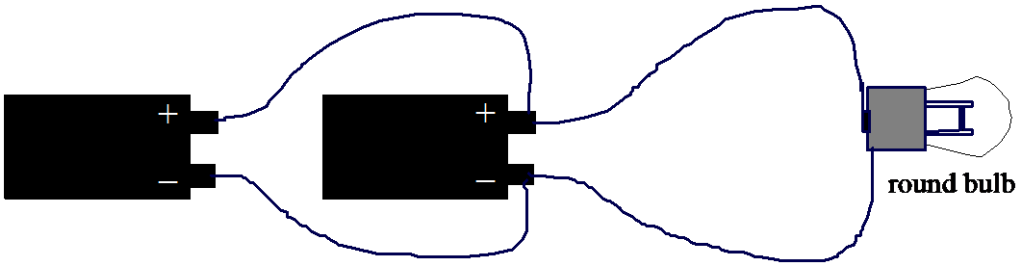


Direction of electron motion



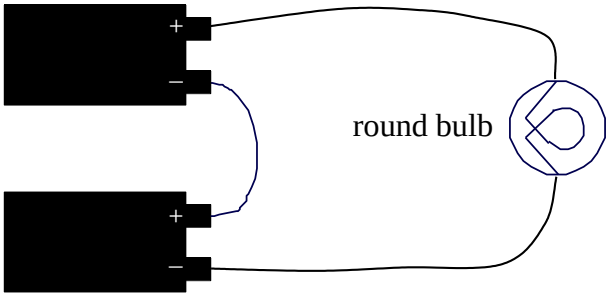
Direction of conventional current, *I*

Connect batteries in parallel: Add another battery parallel to the first one as shown below. Compare the brightness of the round bulb below to that of the round bulb in the circuit above (remembering that small changes are due to imperfect batteries).



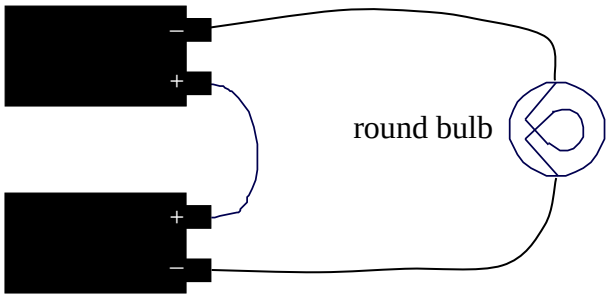
no light **dimmer** **same** **brighter**

Connect batteries in series, same direction: Connect the 2 batteries in series as in the following diagram. Is the round bulb brighter, dimmer, or the same as before?



no light dimmer same brighter

Connect batteries in series, opposite directions: Swap the polarity of one of the batteries, as displayed in the following diagram. What happened to the round bulb?

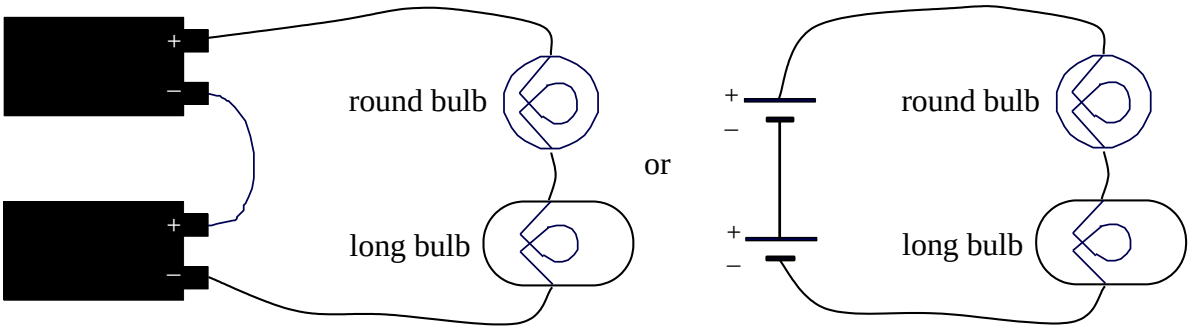


no light dimmer same brightness brighter

How should you connect two batteries to achieve the maximum voltage output?

Series connection of light bulbs

Connect two different bulbs in series as below, note the symbols of the batteries.



Are both bulbs lit? Yes No

If not, which bulb is lit? round bulb long bulb none

Switch the order of the bulbs; do you see any difference in which bulb is lit? Yes No

Unscrew the unlit bulb. What happens to the other bulb?

no light dimmer same brightness brighter

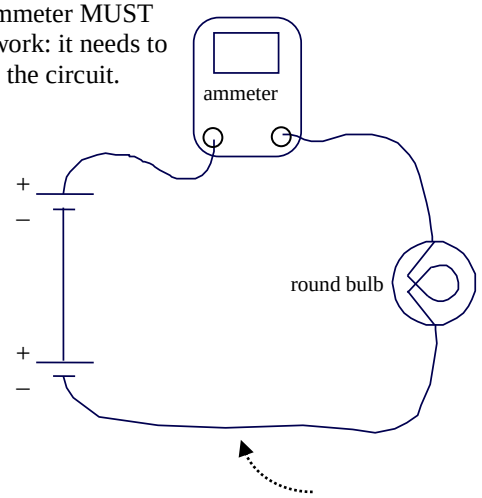
You will explain these behaviours on Page 5.

Measure the current and potential difference in a series circuit.

We have been using the brightness of bulbs as a qualitative measure of the number of electrons passing through the light bulb. Now, we will use an ammeter to measure the current flowing *through* the light bulb.

Set up a series circuit as shown in the next diagram, using the round bulb. Note that the ammeter is always connected in *series* with its + connection towards the + connection on the battery. **You *must break the circuit* at some point in order to insert the ammeter.** It is a good idea to set up the basic circuit without any meters first, then decide where you are going to break the circuit. This point should not have branches so that you are sure which current you are measuring. Record below the conventional current *I* in A (amperes), together with the uncertainty (use half of the smallest division).

Note that the ammeter MUST be in series to work: it needs to be inserted into the circuit.



The current is *I* = _____ (Scale: 1A). (Remember the units and the uncertainty!)

Now measure the current on the other side of the light bulb as shown with the dotted arrow. Is it approximately the same?

Yes No

Should it be the same?

Yes No

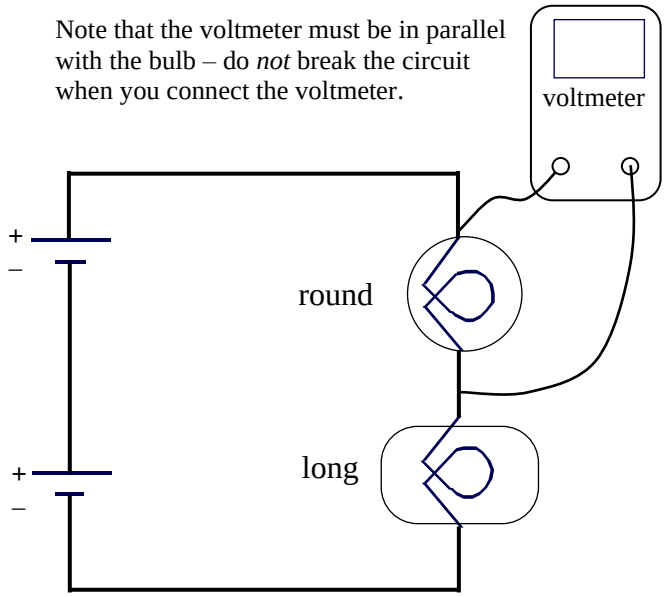
Explain:

In the circuit above, add a round bulb in series. What happens to the first round bulb?

no light dimmer same brighter

What do you expect will happen to the current? Why?

We will now measure the potential difference in volts (V) *across* the light bulbs with a voltmeter. The voltmeter is connected with its + terminal towards the + terminal of the battery as well. However, it is connected in *parallel* with the light bulb being measured. Again, connect the circuit without any meters first, then, (*without breaking the circuit)* connect the two terminals of the voltmeter as probes to each side of the light bulb.



Measure the potential differences and currents for the series circuit above. (<u>Always remember the units and the uncertainties!</u>)

$\Delta V_{\text{batteries}} =$ _____ (Scale: ____)

$\Delta V_{\text{round}} =$ _____ (Scale: ____)

$\Delta V_{\text{long}} =$ _____ (Scale: ____)

$I_{\text{round}} =$ _____ (Scale: ____)

$I_{\text{long}} =$ _____ (Scale: ____)

Write an equation relating the 3 potential differences:

Write an equation relating the 2 currents:

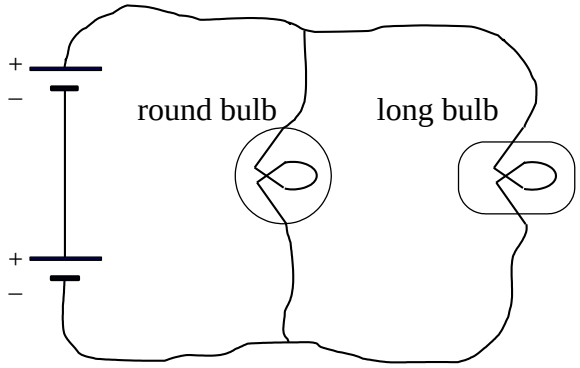
For components connected in series, the potential difference is _____(the same/shared), while the current is _____(the same/shared).

Why doesn't the round bulb appear to be lit?

Which light bulb has higher resistance? How can you tell?

Measure the current and potential difference in a parallel circuit.

Now connect the 2 bulbs in parallel. See the diagram below. Are both bulbs lit? Yes No



Unscrew the round bulb. What happens to the long bulb?

no light dimmer same brighter

Screw the round bulb back. Unscrew the long bulb. What happens to the round bulb?

no light dimmer same brighter

Based on our experiments on two connections, how should the wiring be done? Compare from two situations below:

	Light bulbs wired in parallel	Light bulbs wired in series
Can all light bulbs light up brightly when you want them to?		
Will turning one light bulb on/off affect the others?		

As a summary, will you wire your light bulbs in parallel or in series? parallel series

In the space below, draw the circuit to obtain the maximum amount of light with 2 batteries and 3 bulbs. Same connection will work for more bulbs, but it may cause a problem (see Page 7).

Measure the currents and potential differences for the parallel circuit shown in page 6.

$I_{\text{batteries}} =$ _____ (Scale: ____)

$I_{\text{round}} =$ _____ (Scale: ____)

$I_{\text{long}} =$ _____ (Scale: ____)

$\Delta V_{\text{round}} =$ _____(Scale: ____)

$\Delta V_{\text{long}} =$ _____ (Scale: ____)

Write an equation relating the 3 currents:

Write an equation relating the 2 potential differences:

For components connected in parallel, the potential difference is _____(the same/shared), while the current is _____(the same/shared).

Which light bulb has higher resistance? How can you tell?

Is this consistent with the answer from the series circuit? Yes No

From this exercise and the ones on Page 4, we see that the parallel connection allows multiple appliances to work together, but the total current increases as more appliances are connected. High current through a wire is a fire hazard. That is why we need fuse or jumper in our home, which stops the current if it is too high. Strictly speaking, one cannot say parallel appliances work independently: if you connect too many appliances, total current will be too high, and the jumper will disconnect power to every appliance.