Name: ___________________________________

Partner(s): ________________________________

1114 section: _______

Desk # _____________

Date: ______________

Circuits

This lab is due at the end of the laboratory period.

Purpose

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

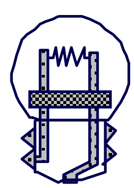
Introduction and Theory

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.

Apparatus One ammeter, one voltmeter, two 1.5 V D-cell batteries with battery holder, two round bulbs, one long bulb, three bulb sockets, 8 alligator-to-alligator wires, two alligator-to-plug wires.

Experiments

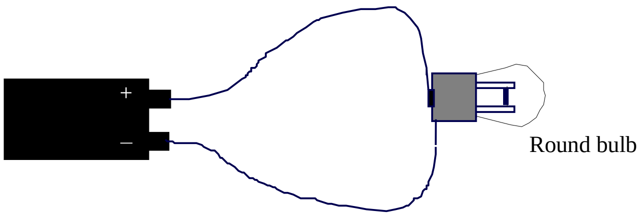
Light a round bulb using one battery and 2 connecting wires. *Do not put the bulb in a socket yet!* In the diagram below, draw lines to show where you connected the wires to make the bulb light up. Your lines should not cross each other, as this would indicate a short circuit!

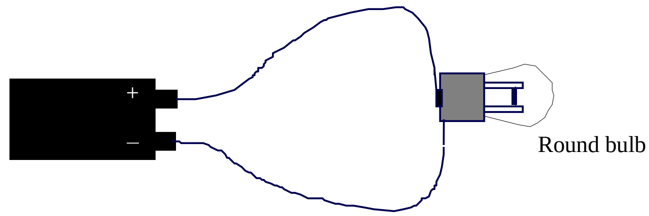


Round bulb

Now put the battery in a holder and the round bulb in a socket, and set up the above circuit using two alligator-alligator wires. The bulb should light up.

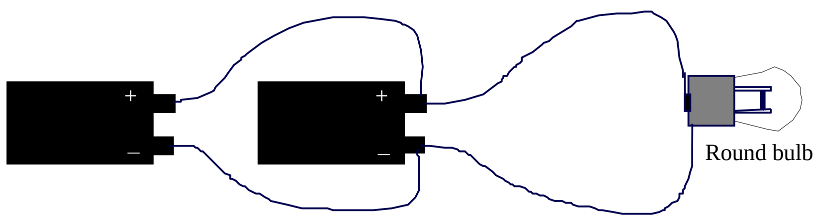
In metals, such as the wires and light bulb filament, the positive charges (protons) are bound in the atoms and unable to move. Some of the negative charges (electrons), however, move easily throughout the metal. Using your knowledge from the static electricity section, draw arrows on the lines in the left hand diagram below to represent the direction electrons are moving in the circuit. However, by convention, conventional current (I) is defined as the movement of positive charges. Draw arrows on the right hand diagram showing the conventional current.





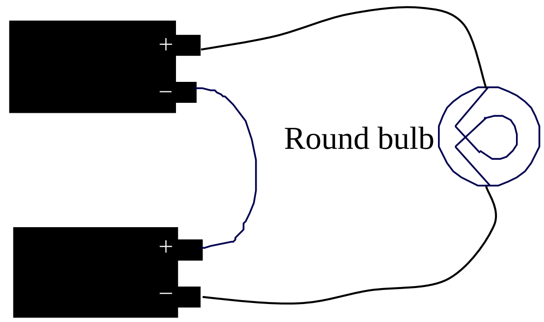
Direction of electron motion	Direction of conventional current, *I*

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



no light dimmer same brighter

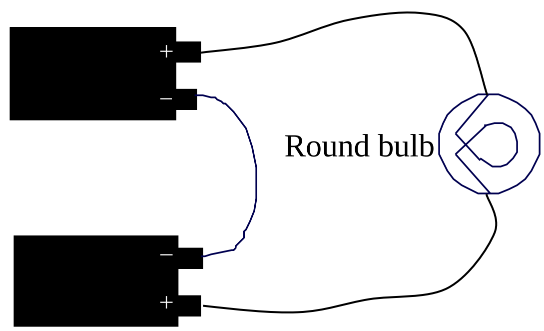
Now connect the 2 batteries in series so that the current going through them is the same. See the following diagram. Is the round bulb brighter, dimmer, or the same as before? If the bulb appears to go out, you may have a dead battery. Ask for a new one. You may have to repeat the previous experiments with the new battery.



no light   dimmer   same   brighter

The polarity of the batteries is given by the positive and negative terminal markings. What happens if the polarity of one of the batteries is reversed? Reconnect the circuit as shown below.

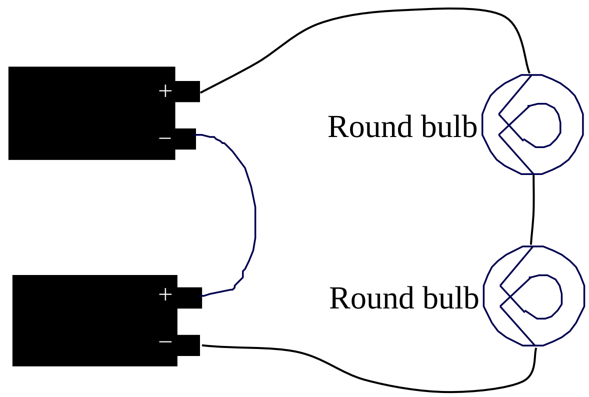
How does the brightness of the round bulb in this circuit compare to the previous circuit?



no light   dimmer   same   brighter

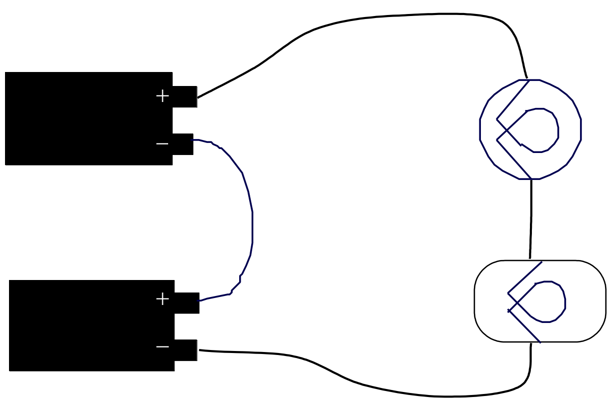
Why?

Reconnect the batteries with the proper polarities, and make sure the round bulb is nice and bright. Add another round light bulb in series with the first round bulb. See the next diagram. Compare the brightness of the round bulbs in this circuit to the brightness of the single round bulb circuit.



no light dimmer same brighter

Replace one of the round bulbs with a long light bulb. See the next diagram. What has happened? Describe the behaviour of both bulbs. *You will explain the reasons for this behaviour later.*



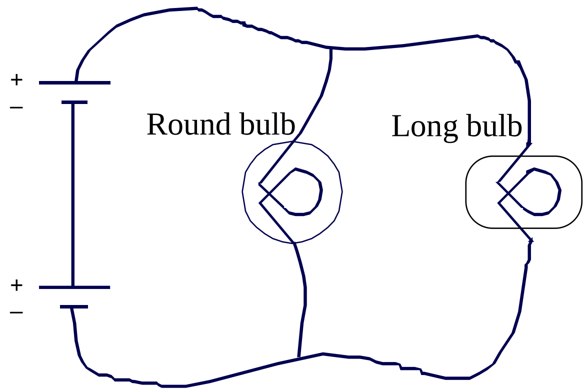
Describe:

Unscrew the round bulb. Choose what happens to the long bulb and explain why.

no light dimmer same brighter

Explain:

Now connect the 2 bulbs in parallel. See next diagram. 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

We just tried different ways to connect a round bulb and a long bulb. Answer the following questions:

When different light bulbs are connected in series, do they all work as expected?   Yes   No

How about in parallel?   Yes   No

When different light bulbs are connected in series, does turning one on/off affect others?   Yes   No

How about in parallel?   Yes   No

How should you connect the appliances in your home?   in series   in parallel

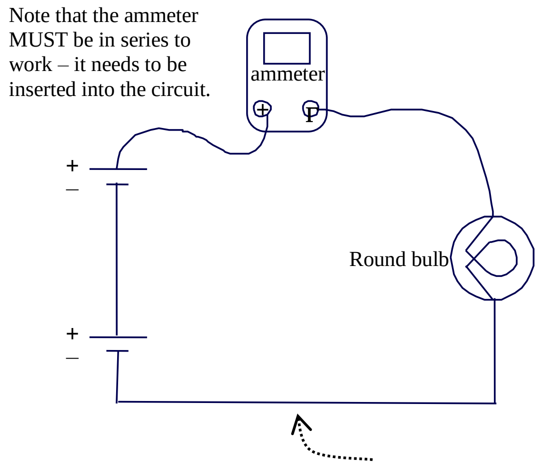
Based on what you learned so far, draw a circuit you would use to obtain the maximum amount of light with 2 batteries and 3 bulbs.

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

The ammeter is connected in such a way that the current flowing through the ammeter is the current to be measured. To achieve this, you *must break the circuit* at some point in order to insert the ammeter. We say the ammeter is connected *in series*.

Set up the simplest circuit with the batteries and one round bulb, without the ammeter. To measure the current through the light bulb, first decide which point you are going to break to insert the ammeter. This point must not have branches: that is, after you break that point, you have only two wires that used to connect to the point, and these two wires are to be connected to the ammeter.

Break the circuit at one side of the bulb, insert the ammeter with its + terminal toward the + side of the batteries ("+ to +"), as shown below. Record the reading of the current:



I = ___________________ (Range:)
Do not forget the units (A) and the uncertainty (take half of the smallest division).

Now measure the current on the other side of the light bulb as shown with the dotted arrow. Keeping "+ to +" (in this case, it should be "− to −"). Is the current approximately the same?

Yes No

Should it be the same?

Yes No

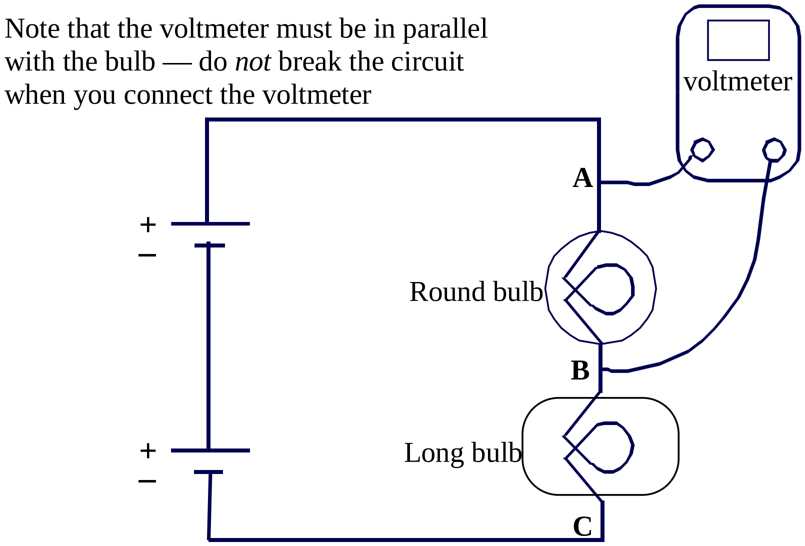
In the circuit above, add a long bulb in series. Is the current less, more, or the same?

less more same

Remove the ammeter from the circuit, but keep the light bulbs connected for the next activity.

Now we will learn to use the voltmeter to measure the potential difference, also called the voltage, across a component in the circuit. The voltmeter is connected in *parallel* with the component, so you do not need break the circuit. Instead, just connect the two terminals of the voltmeter to the two points across the component.

Start with the circuit that has one round bulb and one long bulb connected in series to the batteries, without any meters. Then, *do not break the circuit*, connect the two terminals of the voltmeter as probes to the two sides of the light bulb, keeping "+ closer to +".



Measure and record the potential difference ΔV_{AB} across the round bulb, keeping "+ to +". Note what range you use. Always keep the units (here it is V) and the uncertainty (here is it half of the smallest division) when recording data.

ΔV_{AB} = ____________________ (Range:)

Measure and record the potential difference V_{BC} across the long bulb.

ΔV_{BC} = ____________________ (Range:)

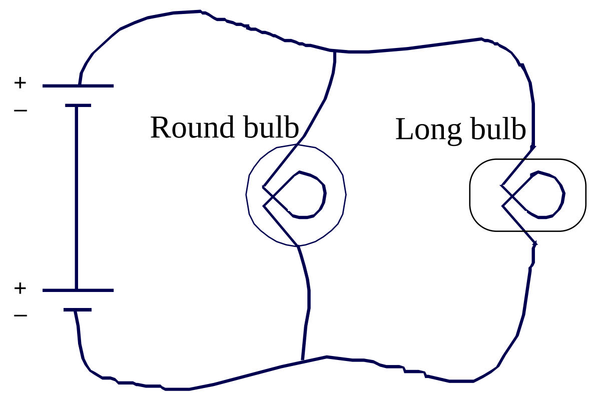
Measure and record the potential difference V_{AC} across both bulbs.

ΔV_{AC} = ____________________ (Range:)

Write an equation relating the three potential differences ΔV_{AC}, ΔV_{AB} and ΔV_{BC}:

Explain why the round bulb in this circuit doesn't appear to be lit:

Now measure currents and potential differences for the parallel circuit shown below (same as Page 5).



$I_{\text{batteries}}$ = ____________________ (Range:)

I_{round} = ____________________ (Range:)

I_{long} = ____________________ (Range:)

ΔV_{round} = ____________________ (Range:)

ΔV_{long} = ____________________ (Range:)

Write an equation relating the three currents:

Write an equation relating the two potential differences:

Return the apparatus to where you get them and tidy up your desk.