

# PhyzLab: Batteries & Bulbs

an investigation of electric circuits

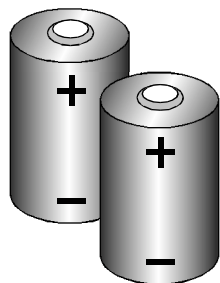
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## • Purpose •

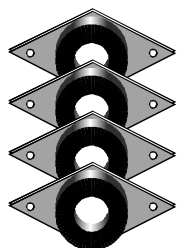
A battery (or batteries) can be used to light a light bulb (or series of light bulbs). A variety of wiring schemes may be used to accomplish this. In this lab, you will explore various arrangements for delivering energy from the battery to the bulbs, and how each arrangement compares with the others.

## • Apparatus •

- \_\_\_ 2 1.5V batteries
- \_\_\_ 4 magnetic battery connectors or equivalent
- \_\_\_ 4 mini bulbs (6.3 V) [#46, #50, white socket]
- \_\_\_ 1 mini bulb (2.5 V) [#14, red socket]
- \_\_\_ 1 mini bulb (14.4 V) [#1487, blue socket]
- \_\_\_ 8 connecting wires

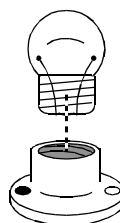


1.5 V batteries



magnetic battery connectors

mini bulb



mini bulb socket



connecting wires

**REMOVE ONE OF THE BULBS FROM ITS HOLDER.** Examine a “naked” 6.3 V bulb and draw it in detail below. (Hey, look at all the space you’ve got—draw it BIG!) *Not all 6.3V bulbs look alike: some have more spherical glass bulbs, some are more cylindrical; some have larger diameter bulbs than others.* Label the following items:

THINGS YOU CAN TOUCH

(ON THE OUTSIDE OF THE BULB)

**glass bulb**

**screw base**

**lead (Pb - “led”) contact**

**base/contact insulation ring**

THINGS YOU CAN'T TOUCH

(INSIDE THE BULB)

**filament leads**

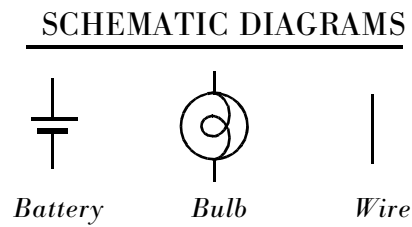
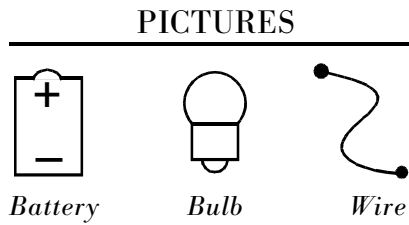
**lead (“leed”) separator.**

**filament**

You were not born knowing which part is which in the bulb, but you do possess the ability to deduce and eliminate.

**Diagram Note:**

Throughout this lab, you will be asked to draw both **pictures** and **schematic diagrams**. Use the following conventions when drawing:



• **Procedure** •

1. SEEING THE LIGHT

a. Using **one** battery, **one** naked 6.3 V bulb and **two** wires, get the bulb to light.

**DON'T TRY TO HOLD A BULB IN THE JAWS OF AN ALLIGATOR CLIP; IT DOESN'T WORK AND IS DANGEROUS.**

- i. Draw **pictures** of two different configurations that work.
- ii. Draw a **diagram** of one working configuration.

b. Using **one** battery, **one** naked bulb and **one** wire, can you get the bulb to light? **Yes      No**

**DON'T TRY TO HOLD A BULB IN THE JAWS OF AN ALLIGATOR CLIP; IT DOESN'T WORK AND IS DANGEROUS.**

- i. Draw a **picture** of a configuration that works (if one can be found) and label it "WORKS."
- ii. Draw a **picture** of a configuration that doesn't work (even though it seems like a plausible design) and label it "DOESN'T WORK."
- iii. Include a **diagram** of a working configuration (if one can be found).

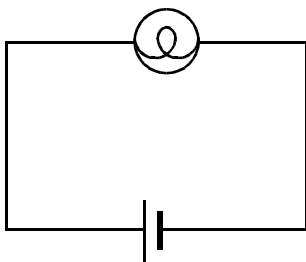
- c. Using **one** battery and **one** naked bulb (but **no** wires), can you get the bulb to light?      **Yes**      **No**  
 i. Draw a **picture** of a configuration that works (if one can be found) and label it "WORKS."  
 ii. Draw a **picture** of a configuration that doesn't work (even though it seems like a good design) and label it "DOESN'T WORK."  
 iii. Include a **diagram** of a working configuration (if one can be found).

d. From your experience, describe how to make the bulb light up (i.e., define the conditions necessary to make the bulb light—BE SPECIFIC).

e. Return to the labeled picture you drew on the first page. With dotted lines, show the interior connections of the filament leads. (Do both leads connect to the screw base, the lead contact, what?)

f. Draw a picture of an arrangement that corresponds to the schematic diagram shown below. **Label the BULB, WIRE, and BATTERY in both the schematic and pictorial diagrams.**

**SCHEMATIC DIAGRAM**

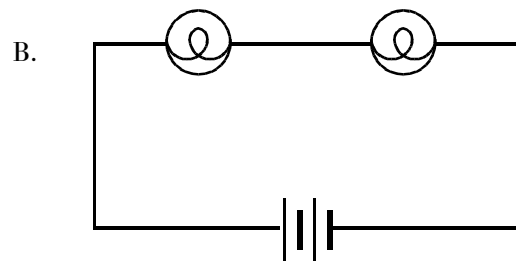
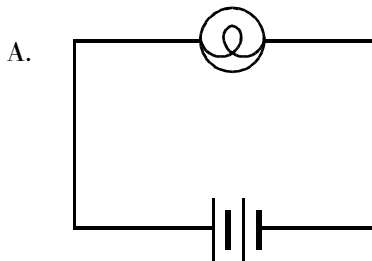


**PICTURE**

g. What is going on in the circuit? Describe in terms of electrons, electron motion, energy, etc. Why the connections from opposite sides of the battery and different parts of the bulb?

2. "THE BIG SERIES" AND "THE PARALLEL PARADOX"

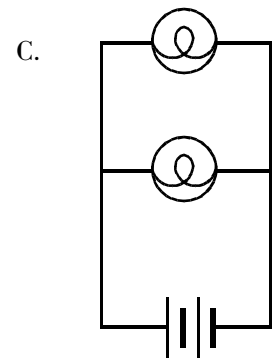
a./b. Using two batteries and some 6.3 V bulbs **in sockets**, construct each of the circuits shown below (first A, then B). **Use the battery connectors if you have them.** Circuit A is the old simple circuit, circuit B is called a **series** circuit.



c. Do the bulbs light in both of the circuits shown above? Do the bulbs in B light up **more** brightly or **less** brightly than the bulb in A (or is there no appreciable difference)?

d. What happens if one of the bulbs in circuit B is loosened (but not completely removed) in its socket?

e. Connect the circuit shown to the right. Circuit C is a **parallel** circuit.



f. Do the bulbs light in the circuit shown to the right? Do the bulbs in C light up **more** brightly or **less** brightly than the bulb in A (or is there no appreciable difference)?

g. What happens if one of the bulbs in circuit C is loosened?

h. Describe—in your own words—the difference between a **series** circuit and a **parallel** circuit.

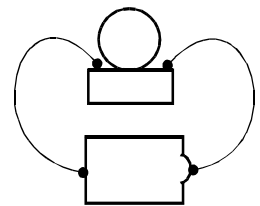
3. GO CRAZY WITH THESE THINGS

a. Using the batteries and connecting wires, connect a circuit to light **four** 6.3 V bulbs simultaneously as brightly as possible. Draw a schematic diagram of your circuit below.

b. Using two batteries, three bulbs, and connecting wires, connect a circuit that meets the following criteria: if **one** bulb is removed the others remain lit, but if **two** bulbs are removed, the third bulb also goes out. (You may specify **which** bulbs are to be pulled out.) Draw a schematic diagram of your circuit below. Label bulbs 1, 2, and 3 so that if bulb 1 is removed, 2 and 3 remain lit; if bulbs 1 and 2 are removed, 3 goes out. This type of circuit is commonly referred to as a **compound** circuit.

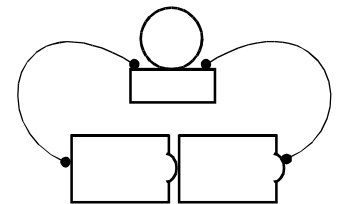
4. BATTERIES IN SERIES, IN PARALLEL, AND FACE TO FACE

a. Construct a simple circuit using one battery, one bulb in its socket, and two wires.

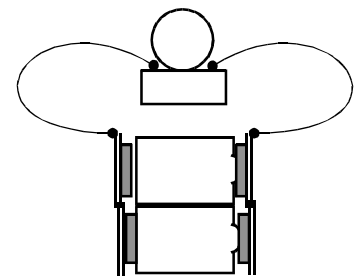


b. **Predict** what difference—if any—will occur if you use two batteries in the circuit instead of one.

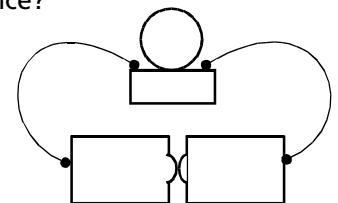
c. Construct circuits using two batteries, one bulb in its socket, and two wires  
i. with the batteries in series. (See diagram.) What differences do you notice?



ii. with batteries in parallel. (See diagram. Interleave the battery connectors to connect the batteries + to + and - to -.) What differences do you notice?



iii. with batteries facing each other. (See diagram.) What differences do you notice?



## 5. BULB VARIETY

a. **NOTE: Light bulbs are not batteries; they do not provide voltage. They are given different voltage ratings based on how they were designed to operate. For example, a 6.3 V bulb is designed to operate with 6.3 V applied to it, etc.** Construct a simple circuit using two batteries, one bulb in its socket, and two wires

- i. using the standard (6.3 V) bulb. Observe the brightness.
  
- ii. using the 2.5 V bulb. What difference—if any—do you see? (If you see nothing, ask for a new bulb.)
  
- iii. using the 14.4 V bulb. What difference—if any—do you see?

b. Rank the bulbs

- i. from brightest to dimmest.
  
- ii. from highest to lowest power (brighter bulbs use more power).

c. Rank the bulbs from highest to lowest resistance.

i. Draw three “circuit slides” (corresponding to the three different bulb circuits), each having the same “voltage” but having different “power” values. From the diagrams, determine a rank for the “resistance” values of each. (See *PhyzJob: Bun-Burning and Power* to review.)

ii. Examine your diagrams and rank the bulbs from highest to lowest current.

iii. Rank the bulbs from highest to lowest resistance.

6. PUTTING IT ALL BACK. Make sure all apparatus is correctly returned: pay particular attention to the correct placement of the #46 or #50 (6.3 V) bulbs in the white sockets, the #14 (2.5 V) bulb in the red socket, and the #1487 (14.4 V) bulb in the blue socket.

## Post-Lab Question

Suppose you want to make as many bulbs light up as possible in a single electric circuit. You are given 10 batteries, 10 bulbs, and an unlimited supply of wires. Describe how you would connect the batteries and how you would connect the bulbs. Use words **and** a diagram.