Name: _____
Partner(s): _____
1225 Section: _____
Desk # _____
Date: _____

Simple Resistive Circuits

This lab is due at the end of the laboratory period

Your observations will be checked for correctness, completeness and clarity.
The material covered in this lab, as in ALL other labs, is testable and may be on exams.

Purpose

- To learn to set up and analyze basic resistive circuits.
- To use an ammeter to measure current.

Report format: Record your observations in the spaces provided on these pages. Note: If you see only a slight change in brightness when changing the circuit, you can say the brightness is the same.

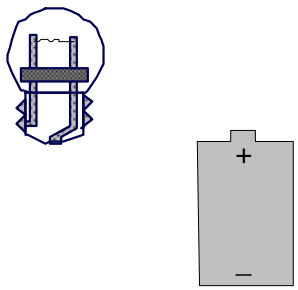
(This lab is based on Chapter 5 of *Electric and Magnetic Interactions*, Chabay and Sherwood, 1999.)

Apparatus

Kaise analog ammeter, two 1.5 V D-cell batteries with battery holder, three #14 light bulbs (round), one #48 light bulb (long), four bulb sockets, ten alligator-to-alligator wires, two alligator-to-plug wires, one compass.

Part 1 Basic Observations

1.1 Lighting a bulb: Using one battery without the holder, two connecting wires, and a round bulb without the socket, make the bulb light up. Draw your connections below, and mark the direction of the current flow through the wires and the filament of the bulb.



1.2 Filament thickness:

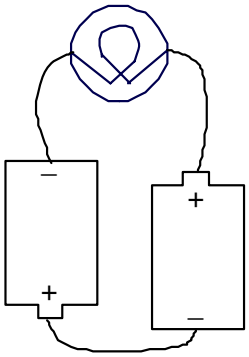
(a) Judging by your eyes, which light bulb has the thicker tungsten filament?

long bulb round bulb same thickness

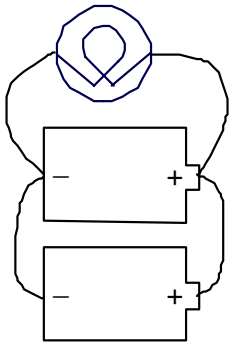
(b) Which filament would allow electrons to pass more easily?

thinner thicker

1.3 Battery connection: Connect a round bulb in a socket to two batteries “in series” and “in parallel”, as shown below:



batteries in series



batteries in parallel

(a) In which case is the bulb brighter?

batteries “in series” batteries “in parallel”

(b) How does the brightness of the light bulb using two batteries “in series” compared to the brightness when using one battery?

brighter dimmer the same

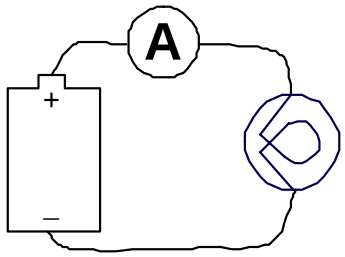
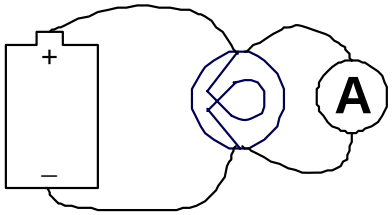
(c) How does the brightness of the light bulb using two batteries “in parallel” compared to the brightness when using one battery?

brighter dimmer the same

To get the most voltage from the batteries, the batteries should be connected “in series”.

1.4 Using an Ammeter: First familiarize yourself with the ammeter. Make sure you know how to read the 10 A and 1 A scales. Then connect your ammeter with the round bulb "in series" and "in parallel", as shown below. Use only one battery. For each case, observe the brightness of the round bulb, and the current through the bulb.

Note: for "ammeter in parallel", connect only long enough to take a rough measurement! It is the wrong connection and will deplete the battery very quickly.

Ammeter in series	Ammeter in parallel
Use 1 A scale for the ammeter	Use 10 A scale for the ammeter
	
The light bulb is _____ (on off). If it is on, how does the brightness compared to that without the ammeter? brighter dimmer same	The light bulb is _____ (on off). If it is on, how does the brightness compared to that without the ammeter? brighter dimmer same
The reading of the ammeter is _____±_____ A.	The reading of the ammeter is _____±_____ A.

1.5 Compare the currents through different bulbs: Re-connect the ammeter in series, using 1 A scale.

With the round bulb, the reading of the ammeter is _____±_____ A.

With the long bulb, the reading of the ammeter is _____±_____ A.

(a) Which light bulb has more electrons flowing through it per second?

long bulb round bulb the same

(b) Which light bulb should have the thicker filament? (It is okay if you failed to tell by eyes.)

long bulb round bulb the same

(c) Which light bulb has the higher resistance?

long bulb round bulb the same

A quick review of Part 1

A thicker filament means _____ resistance to the current flow. (higher/lower/the same)

To achieve a higher voltage, the batteries should be connected in _____. (series/parallel)

To measure the current, the ammeter must be connected in _____. (series/parallel).

After the ammeter is connected correctly, the brightness (and the current) of the light bulb should be _____ compared to before the ammeter was connected. (more/less/about the same)

Part 2 Magnetic effects of currents

Compass deflection: Keep the compass away from steel objects, such as the steel-jacketed batteries, the table legs, the alligator clips on the ends of your wires, etc.

(a) Make a two-battery circuit with a round bulb in a socket. Place your compass on a flat surface under one of the wires.

With the bulb glowing:
- Position the wire about 15- 20 cm above the compass.
- Orient the wire to be horizontal and lined up with the compass needle.
- Lower the aligned wire down onto the compass.

What happens to the compass needle?

(b) Reverse the connections to the battery (or reverse the direction of the wire over the compass).

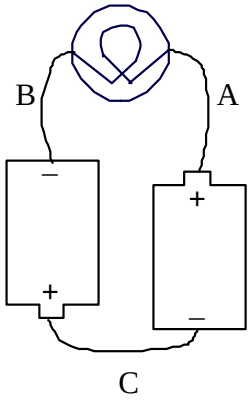
How is the deflection of the compass needle affected?

(c) What happens when the wire is initially aligned perpendicular to the needle?

(d) Replace the round bulb with a long bulb. How is the deflection of the compass needle affected?

Part 3 Current in different parts of a circuit

Construct a circuit consisting of two batteries and a round bulb in series, as shown below.



(a) How do you expect the current at location A will compare to the current at location B?

bigger at A bigger at B the same

Explain:

(b) Now connect the ammeter (the right way!) and record the readings, together with the uncertainty.

location	current I (A)
uncertainty in readings	
reading at A	
reading at B	
reading at C	

Which is the correct statement regarding the currents at A and B? (circle one)

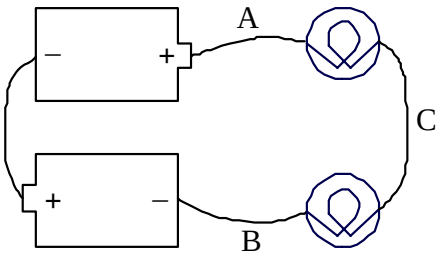
(1) There should be no current at all at B, because all of the current coming from the battery is used up in the bulb.

(2) The current at B should be less than the current at A, because some of the current is used up to make the bulb give off light and heat.

(3) The current should be the same at A and B because charge is conserved. *But, over time, what is being used up in the bulb?* Answer:_____

Part 4 Current in a two-bulb series circuit

Set up a series circuit consisting of two round bulbs in series with two batteries, measure the current at the locations A, B, and C, and record the results below.



location	current I (A)
uncertainty in reading	
reading at A	
reading at B	
reading at C	

(a) What happens when you unscrew one of the bulbs from its socket?

Why?

(b) Is a round bulb in series in this two-bulb circuit with two batteries brighter, dimmer or the same as the single round bulb in the one-bulb circuit with the two batteries?

brighter dimmer same brightness

(c) Is the current in the two-bulb circuit more, less or the same as the current in a one-bulb circuit?

more less the same

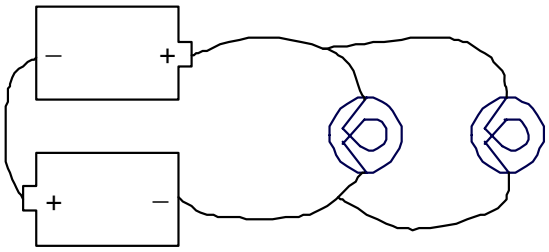
(d) Connect one round bulb and one long bulb in series. What do you observe? Explain what happened.

(e) Connect four, five, or six long bulbs in series. Do they still glow?

yes no

Part 5 Parallel circuit

Connect two round bulbs in parallel, so that each has the potential of the two batteries across it. See the picture below.



(a) Are the round bulbs in this parallel circuit brighter than, dimmer than or the same as, the round bulbs when two round bulbs are connected in series?

brighter dimmer the same

(b) Are the round bulbs in this parallel circuit brighter than, dimmer than or the same as, a single round bulb connected to two batteries?

brighter dimmer the same

(c) Unscrew one of the round bulbs in the parallel circuit. What happens to the remaining bulb?

gets brighter gets dimmer remains the same brightness

(The bonus question at the end of this lab is related to this question.)

(d) Replace the round bulb that you removed with a long bulb. Is the long bulb brighter than, dimmer than or the same as, a single long bulb connected to two batteries?

brighter dimmer the same

(e) Connect two, three, then four round bulbs in parallel. Measure and record the current coming out of the batteries in each case.

number of round bulbs in parallel	current from batteries I (A)
uncertainty in reading	
reading with 2 bulbs	
reading with 3 bulbs	
reading with 4 bulbs	

How does the current from the batteries change as more bulbs are added?

more less the same

Does the battery always output a constant current?

yes no

(f) For two round bulbs connected in parallel, measure the current through each bulb and record the results below.

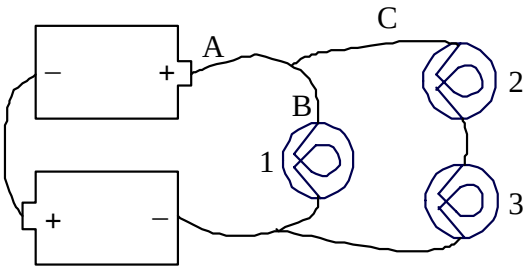
	current I (A)
uncertainty	
current through bulb 1	
current through bulb 2	

Taking the uncertainties into account, does your data show that current is conserved for two round bulbs in parallel? (Does the current entering a junction equal to the current coming out of the junction?)

yes no

Part 6 A series and parallel circuit

Connect two round bulbs in series with two batteries and connect the third round bulb in parallel with the two bulbs in series, as shown below.



(a) Is round bulb 1 in this circuit brighter than, dimmer than or the same as, a single round bulb connected to two batteries?

brighter dimmer the same

(b) Is round bulb 2 brighter than, dimmer than or the same as, round bulb 3?

brighter dimmer the same

(c) Is round bulb 2 brighter than, dimmer than or the same as, round bulb 1?

brighter dimmer the same

(d) Measure and record the current at A, B, and C.

location	current I (A)
Uncertainty	
reading at A, I_A	
reading at B, I_B	
reading at C, I_C	

Again taking the uncertainties into account, does your data show that current is conserved?

yes no

Write an equation relating the three currents to support the conservation of the current:

(e) Observe the brightness of bulb 2, then unscrew bulb 1. Is bulb 2 now brighter, dimmer or the same as before?

brighter dimmer the same

(f) Put back bulb 1 and note its brightness then unscrew bulb 2. Is bulb 1 now brighter, dimmer or the same as before?

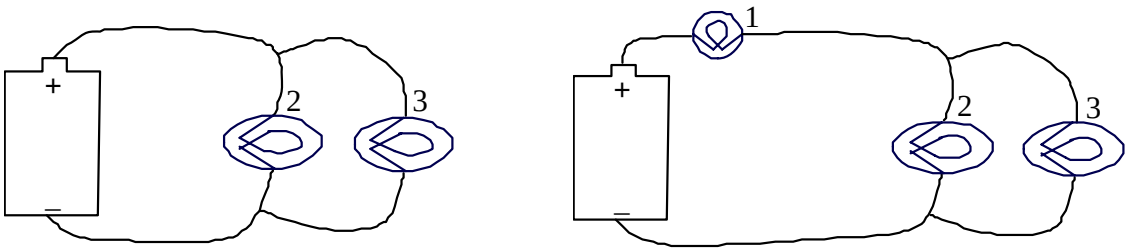
brighter dimmer the same

If you have time left, you may try the bonus question on the next page. Otherwise return all apparatus (except the ammeter) to the small boxes and leave your desk neat and tidy.

Bonus question:

When you have two bulbs connected in parallel, ideally, unscrewing one of the bulbs should not affect the other. However, during the experiment, you may have noticed that when you unscrew one of the bulbs, the other bulb becomes slightly brighter (you should have called it "the same".) Why?

To help you answer this question, connect following circuits with one new battery, one round bulb (bulb 1) and two long bulbs (bulb 2 and 3).



First connect the circuit on the left, with two long bulbs in parallel. Both bulbs should be lit. Unscrew bulb 3. What happens to the brightness of bulb 2? (If you do see any change, ask for a newer battery.)

brighter dimmer hardly any change

Now, add in bulb 1 and connect as the circuit on the right. You should see bulb 2 and 3 lit, just as before. Now unscrew bulb 3. What happens to the brightness of bulb 2?

brighter dimmer hardly any change

Can you understand what has happened? Bulb 1 is acting as the *internal resistance* of the battery and the rest of the circuit is the "load". Because the load and the internal resistance are in series connection, the voltage on the "load" depends on its resistance relative to the internal resistance. (In series circuit, voltage is shared.) A heavier load gets more voltage from the battery than a lighter load.

Which case below has a heavier "load" (more resistance in the load)?

two long bulbs in parallel single long bulb

In which case does the load get a higher voltage?

two long bulbs in parallel single long bulb

Now you should understand why unscrewing one bulb in parallel will make the other slightly brighter. All real batteries have some internal resistance, which takes away a portion of the voltage of the battery. Bulb 1 in the above circuit exaggerated this effect.

Return all apparatus (except the ammeter) to the small boxes and leave your desk neat and tidy.