NAME: _____ SECTION DAY/TIME: _____
GSI: _____ LAB PARTNER: _____

Lab 3: Introduction to DC circuits

Introduction

This lab introduces direct-current (DC) circuits, focusing on *conceptual understanding*. On a later worksheet, you'll integrate this qualitative understanding with mathematical problem-solving. Although everybody should do questions 1 through 4, people who already know a lot about circuits will be able to get to the challenge problems at the end.

Technical hints

- When your two batteries are hooked up in series; you can think of them as a single, double-strength battery.
- Your GSI will show you how to "transform" one circuit into another. Ask for help if you're having trouble achieving a clean transformation.

Questions

IMPORTANT NOTE: For each question, first write your answer (prediction), then do the experiment. Finally, amend your original answer, if necessary. But don't erase your original prediction—it's helpful to have a record of what mistakes you're liable to make in the future.

1. In circuit 1, which (if either) is bigger: The current through wire A or the current through wire B? What gets "used up" when current flows through a light bulb?

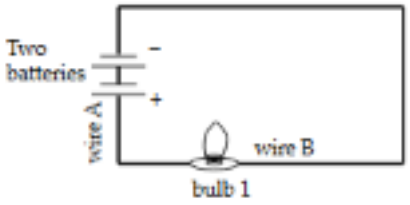
2. When circuit 1 is transformed into circuit 2 (by hooking up the 2nd light bulb), what happens to

(a) The brightness of light bulb 1?

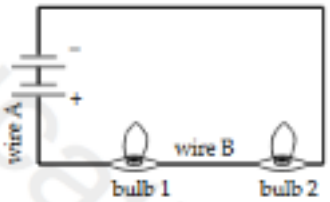
(b) The current through wire A? Why?

3. When circuit 1 is transformed into circuit 3, what happens to

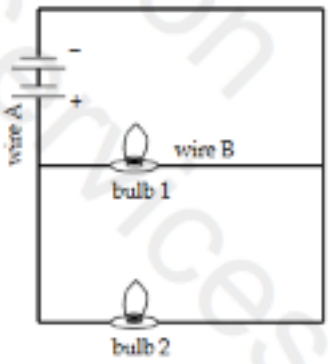
CIRCUIT 1



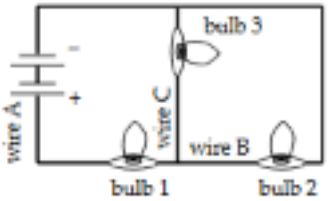
CIRCUIT 2



CIRCUIT 3



CIRCUIT 4



(a) The brightness of bulb 1?

(b) The current through wire A?

(c) The current through wire B? Explain all your answers. If the experiment comes out different from your prediction, you can amend your answer by trying to explain the discrepancy.

Because the rest of the lab builds on questions 1 - 3, your GSI will go over those three questions with the whole class. If you try question 4 before this discussion, please look over your answers *after* the discussion, to take your GSI's ideas into account.

4. (*This one is hard, but very important.*) When circuit 2 is transformed into circuit 4 (by hooking up the third bulb), what happens to

(a) The current through wire A?

(b) The brightness of bulb 1?

(c) The brightness of bulb 2? Explain your answers intuitive (*not* just with formulas). Check your answers with your GSI.

5. Let I_1 denote the current through wire A in circuit 1. In terms of I_1, what is the current through wire A in. . .

(a) circuit 2? Is it $2I_1$, *or* $I_1/2$, or what? Explain conceptually, even if you know a formula.

(b) circuit 3? Explain.

(c) *(harder)* circuit 4? Explain.

6. With your battery, your three light bulbs, and all the wires you want, build a circuit that produces as much light as possible. Diagram the circuit here, and explain why it's the brightest.

7. With that same equipment, build a circuit that produces as *little* light as possible. Should the circuit use all three bulbs? Be sure to test this issue experimentally. Diagram your circuit, and explain why it's the dimmest.

8. In this lab, you've built a total of six circuits: the four on page 1, the "brightest" circuit from question 6, and the "dimmest" circuit from question 7.

(a) Of those six circuits, which one has the *most* current flowing through the battery? Explain.

(b) Which has the *least* current flowing through the battery? Explain.

9. Give at least *two* separate reasons why it's advantageous to wire holiday lights in parallel. (Ask your GSI if you don't know what we mean by "holiday lights.")

10. Are the electrical outlets in your house/room wired in series or in parallel? Explain.

11. In electrostatic systems, a potential difference (i.e., a voltage) always corresponds to an electric field. Is this also true about circuits? Specifically, does the potential difference between the two terminals of the battery correspond to an electric field anywhere? Or do circuits allow us to have "voltages without fields?"