Lab 9: Electric current, resistance and voltage in simple circuits

Name:

Group Members:

Date:

TA's Name:

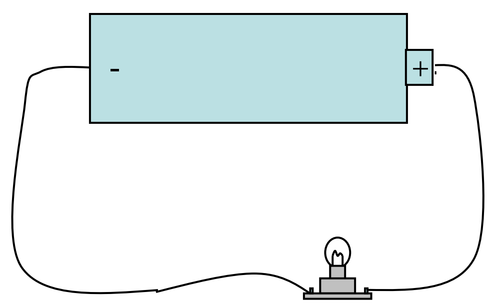
Apparatus: Bulb board with batteries, connecting wires, two identical bulbs and a different bulb, a digital multimeter with leads.

Objectives:

1. To be familiar with the current and voltages across different circuit elements in a series circuit
2. To be familiar with the currents and voltage across circuit elements in a parallel circuit
3. To develop intuition about the electrical power dissipation across a resistor
4. To experimentally obtain Kirchhoff's laws used for circuit analysis

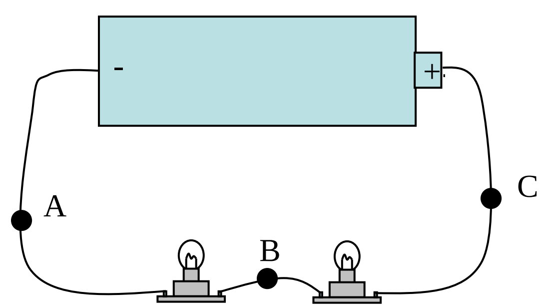
Current (I) is the amount of positive charge flowing across the cross section of the wire (conductor) per second and measured in amperes (A).

Part A: Series circuit



1. Set up the circuit shown with one of two identical bulbs (look for the same type of bulbs; Ex: spherical ones). Then change the circuit to use the other of the two identical bulbs. Is the brightness of the two bulbs about the same?

   Can you conclude that the bulbs are nearly identical?



2. Set up the circuit shown below using the two identical bulbs. This way of connecting bulbs to the battery is called a series connection. Draw arrows on the figure to indicate the direction you believe that the current is flowing in the circuit.

   Are the two bulbs brighter, dimmer, or the same brightness as the one bulb circuit in Question 1?

3. For the two bulb circuit in Question 2, how do the two bulbs compare in brightness to each other?

4. What can you conclude about the current flow at different points in the circuit from your observations of the brightness of the two bulbs in series?

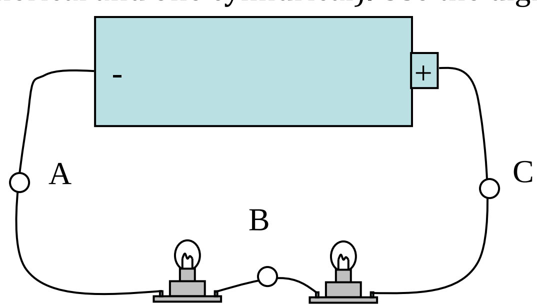
5. If you were to connect an ammeter to measure current in the circuit at points A, B, and C how would the readings compare? (Do not connect ammeter yet) Explain the reasoning for your prediction.

6. A digital multimeter can be used as an ammeter to measure currents. Select the proper terminals to measure currents and choose appropriate range. Remember that an ammeter must be connected in series since it measures the current passing through the meter itself. Ask the TA for help. Then connect the ammeter between the negative terminal of the battery and the bulb and measure current at A. Then measure currents at B and C also.

I_A	I_B	I_C

7. If there are any discrepancies between your prediction and the actual measurements explain what went wrong with your initial reasoning.

8. Now set up the circuit shown below using the two **<u>different</u>** types of light bulbs (for example one spherical and one cylindrical). Use the digital multimeter to measure current.



How do the two bulbs compare in brightness?

9. Measure the current at the three points (A, B, and C).

I_A	I_B	I_C

10. How do the values of the current compare at these three points? Why? Think about the definition of the current to answer this question.

11. Why do you think the bulbs are different in brightness (Just write what you think, no points are deducted here)?

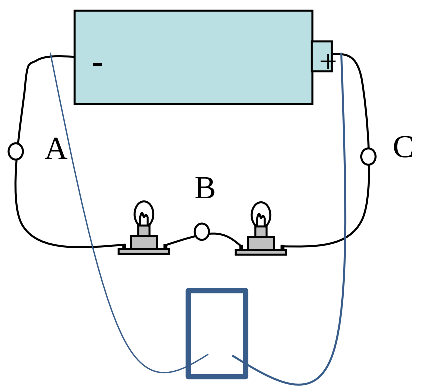
There is a property of circuit elements called resistance, which is the opposition a circuit element offers to the flow of charge through it. Identical bulbs would have identical resistances and different bulbs will have different resistances.

12. Disconnect the bulbs from the circuit and measure the resistance of each bulb using the digital multimeter. Your TA will demonstrate how to use digital multimeter as an ohmmeter that measures resistance. Then measure the total resistance when they are connected together in series. The unit of resistance is Ohms (Ω).

Resistance of Bulb 1	Resistance of Bulb2	Total Resistance when connected in series

13. Based on this new understanding about the resistance of each bulb, how is resistance related to the *brightness of each bulb for the same current* in the series circuit above?

14. The digital multimeter can also be used as a voltmeter which measures the potential difference across a circuit element like a light bulb or a battery. Connect the voltmeter **ACROSS** the battery holder by connecting one lead from the voltmeter to one side of the battery pack and the other lead from the voltmeter to the other side of the battery pack (the voltmeter is in parallel connection to the battery). If you are using the lab power supply, then connect the positive terminal (red) to positive of the multimeter and negative terminal to the negative (common-black) of the multimeter.



Voltmeter

Record the voltmeter reading (remember units)

$\Delta V_{battery}$ = ________________

15. **Predict**: If you connect the voltmeter ACROSS each bulb would you expect

A. the readings to be equal to each other?

B. the readings to be equal to battery or power supply voltage?

C. another result such as ____

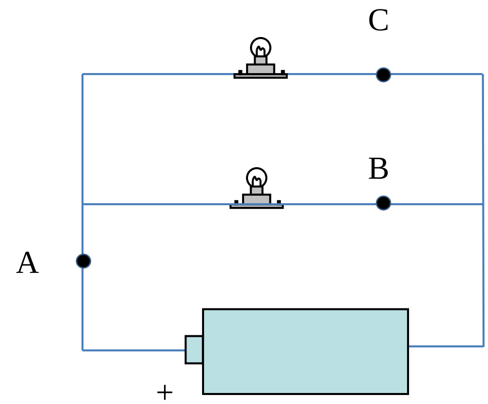
16. Now connect the voltmeter across each of the two bulbs in the circuit and measure voltages across each bulb. Tabulate all results.

ΔV_{B1}	ΔV_{B2}	$\Delta V_{battery}$

17. How do the voltages across the two bulbs compare with each other? Re-draw the circuit showing the current through each element and the voltages across each element obtained from measurements.

18. Based on your measurements of potential differences (voltage) across the bulbs (ΔV_{B1} *and* ΔV_{B2}) and the battery voltage $\Delta V_{Battery}$ write down an equation relating $\Delta V_{B1}, \Delta V_{B2}$ *and* $\Delta V_{Battery}$ for the series circuit. This is the Kirchhoff's loop law applied to the series circuit you studied.

Part B: Parallel circuit



19. If you were to construct the circuit shown (this is called a parallel connection) using two identical bulbs how do you think the bulbs will compare in brightness? Explain.

20. Now set up the circuit and check your prediction regarding brightness of bulbs. What did you find?

21. Prediction: If you were to measure the current at points A, B and C, how do you think the values would compare? Why?

22. Prediction: If you were to measure the potential differences across (what the voltmeter measures) these bulbs how do you think the values will compare to each other and to the potential difference across the battery pack or the power supply? Why?

23. After discussing these predictions with your group members, make the appropriate measurements with your digital multimeter (the ammeter and voltmeter). Make sure you connect the ammeter and voltmeter properly (one is always connected in series and one is always connected in parallel)! Remember units.

I_A	I_B	I_C

ΔV_{B1}	ΔV_{B2}	$\Delta V_{battery}$

24. Re-draw the circuit showing current and voltages across each element obtained from measurements.

25. Based on your current measurements write down an equation relating currents I_A, I_B *and* I_C. This is the Kirchhoff's junction rule applied to a junction in the parallel circuit you studied.

26. You already know the resistance of each bulb and they are the same. Disconnect the power supply or batteries and measure the total resistance of the parallel circuit. Tabulate results.

Resistance of Bulb 1	Resistance of Bulb2	Total Resistance when connected in parallel

You may increase or decrease the total resistance of a circuit by adding resistances to a circuit. Total resistance depends on how you add resistors to the circuit. Fill in the blanks below based on your data from #12 and #26 above.

- Arranging resistances in series ______________________ total resistance in the circuit.
- Arranging resistances in parallel ____________________ total resistance in the circuit.