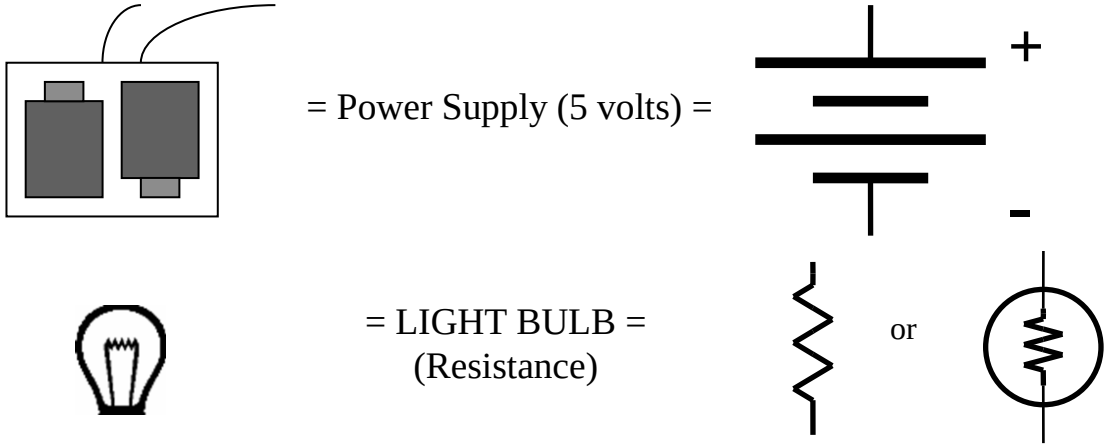
LAB 7 BULBS AND BATTERIES
(SERIES AND PARALLEL CIRCUITS)

Goals:

- **To learn to wire simple circuits using power supply, wires, and bulbs.**
- **To learn to use symbols to draw circuit diagrams.**
- **To study series and parallel circuits.**

Part 1 - Introduction to Electrical Symbols

The key to solving electric circuit problems is understanding the symbols of the devices used, and the functions of the devices. Recognizing resistors, power supply, bulbs, etc. make the calculations (or the conceptual ideas) much easier. The following symbols will be used in this and the next lab experiment:



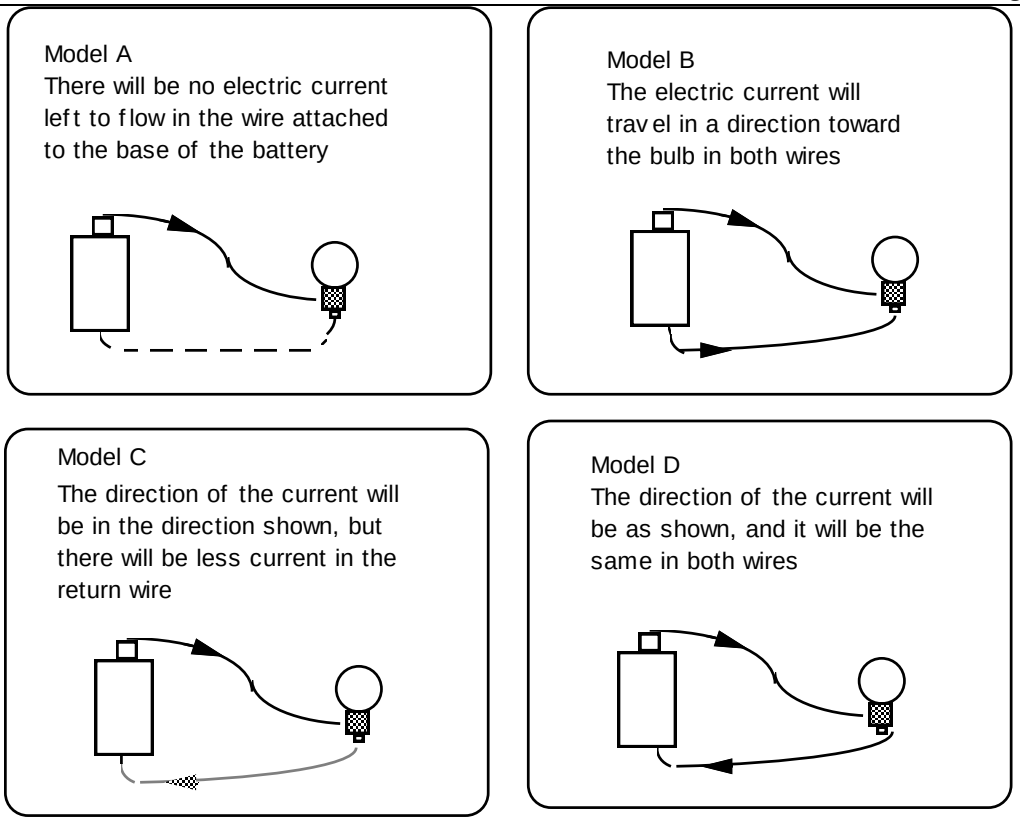
Electrical symbols and elements

It would also be very helpful to look at the online help page for this lab.

Part 2 - Developing a Model for Current Flow

The electrical charge that flows in a circuit is known as the current, with units of Amps = coulombs/second. When we hook a power supply with some wires and some light bulbs, we can form a circuit. Under the right conditions, we will get a current to flow and the bulbs will light up. Depending on how the bulbs are arranged in the circuit, they may be different levels of brightness (assuming all bulbs start out with identical characteristics).

1. Different models. Below are displays with 4 different models for how current could flow in a circuit. Which diagram best describes your view of how current flows in the circuit? Why? Talk it over with your partners. After you have discussed the various ideas with your instructor and the rest of the class, you will be asked to test your model with some bulbs and a power supply.



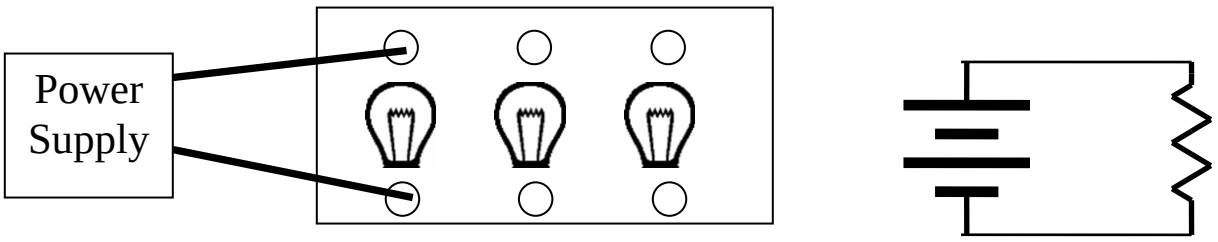
Four alternative models for current flow

Question *Answer on the Data/Question sheet:*
a) Which model did your group pick? What were some of the reasons why you picked that one?
b) What were some of the reasons why you did not choose the other three models?

Part 3 - Circuit Connections and Electrical Diagrams

We will be connecting the 5-volt power supply to the light bulbs in various combinations. The light box has "sockets" for the banana plug wires. In an actual electrical circuit, these wires would be soldered onto circuit boards to make the connections. We want temporary connections, but something easy to connect and disconnect.

1. Connecting one bulb to power supply. Connect a bulb to the power supply as shown in the figure below. An example is shown on the next page:



Bulb connections and electrical circuit diagram

Notice the picture of the setup on the left, and the electrical diagram on the right. The picture is easy to follow when we start doing the wiring, but the electrical circuit on the right is a much more compact way to write the same information. As we get accustomed to the electrical diagrams, they will replace the "pictures".

2. Disconnect the bulb.

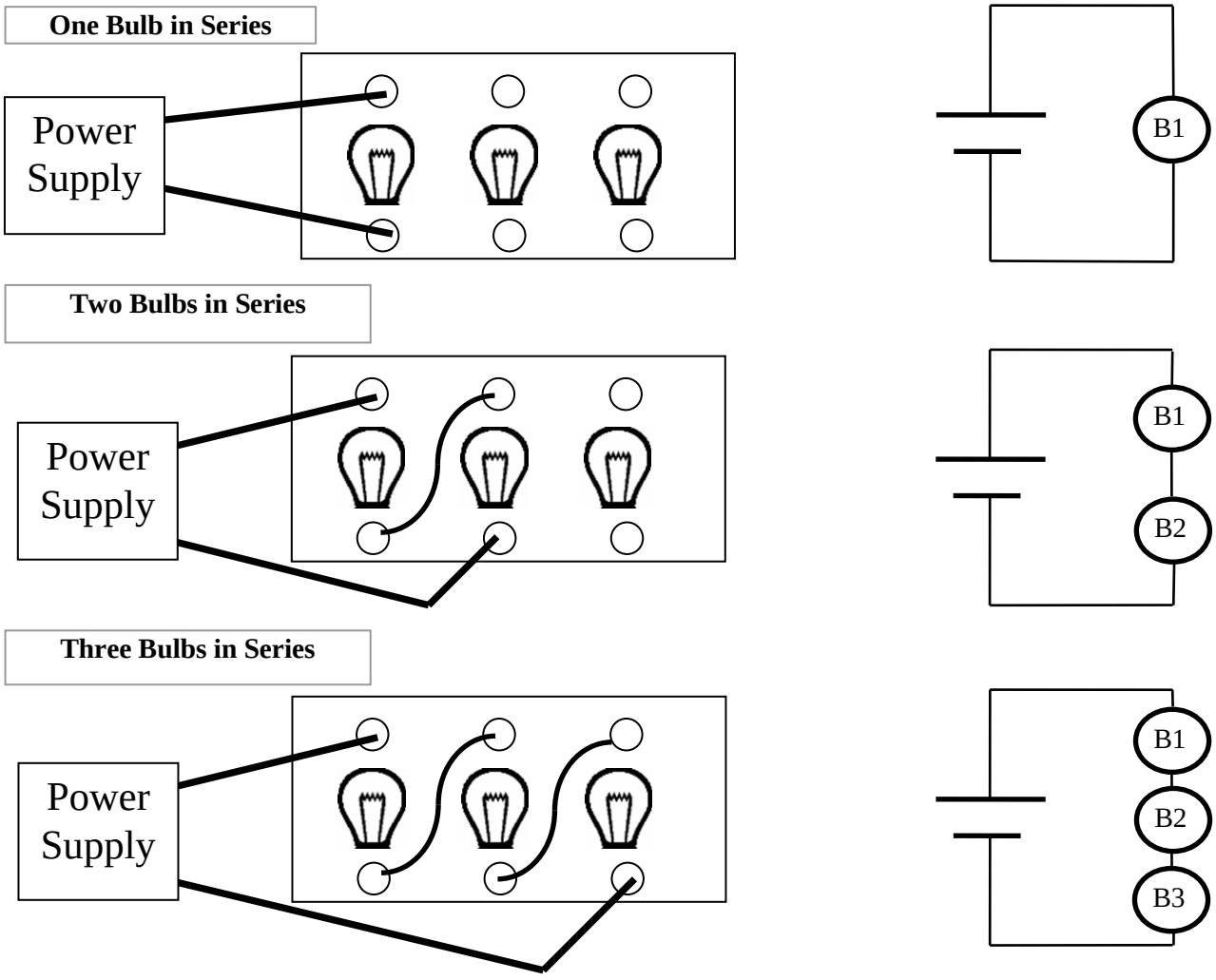
Questions *Answer on the Data/Question sheet.*
a) What happened to the light bulb when you disconnected one wire? Is this what you expected? Does this strengthen your idea of the current model, or does it cause a problem with your model? - Explain.

We will be connecting the power supply to combinations of these bulbs, to see how the circuit configuration affects the brightness of the bulbs. This will help us identify the current model.

Series Circuits

Prediction *Answer this on the Data/Question sheet:*
Look at the circuit diagrams below. Suppose you connected the power supply to one, two, or three bulbs in a series configuration: predict the relative brightness of each of the bulbs in each of the configurations. In which circuit will the bulbs be the brightest, and which the weakest? Will the bulbs be of different brightness within a particular circuit?

3. Circuit connections. Connect the power supply to one bulb. Keep in mind how bright that one bulb appears to be? Now connect it to two bulbs in series, and then three in series (look at the circuit diagrams below).



Bulb configurations and Circuit diagrams for Series circuits

Questions *Answer these on the Data/Question sheet:*
a) When you added a second bulb, or a third bulb, what happened to the brightness of the bulbs? Is this what you expected? What possible explanation do you have for this?

b) Did your observations match your predictions? If not, why not? What does this information do to the model that you proposed (support it or refute it?)

c) With two or three bulbs in the circuit, were the bulbs of relatively equal brightness, or did the brightness drop off in one direction or the other? What does this information do to the model that you proposed (support it or refute it?)

4. Model refinement. Using the information you gathered above, look back to the page with the four models and decide (as a group) which model you want to propose for the current flow in a circuit.

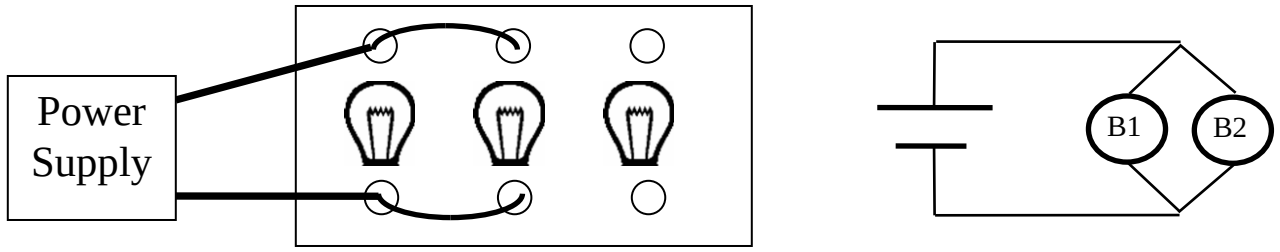
Parallel Circuits

Suppose you connected the bulbs in a parallel configuration instead of series. Parallel circuits have multiple paths for the current to flow.

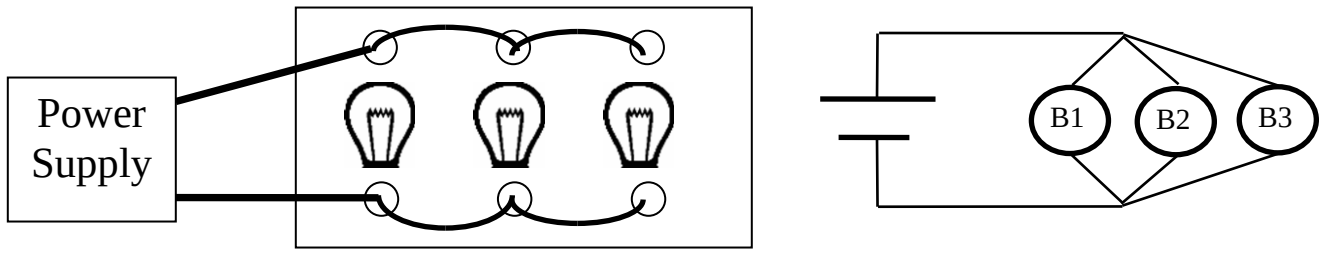
Prediction *Answer this on the Data/Question sheet:*
Look at the diagram below. Suppose you connected the power supply to two or three bulbs in a parallel configuration: predict the relative brightness of each of the bulbs in each of the configurations. In which circuit will the bulbs be the brightest, and which the weakest?

5. Circuit connections. Now connect the bulbs as shown in the circuit diagrams below, and observe the brightness of each individual bulb.

Two Bulbs in Parallel



Three Bulbs in Parallel



Bulb connections and Circuit diagrams for Parallel circuits

Question *Answer this on the Data/Question sheet:*
a) Comparing the circuit when you had two bulbs to three bulbs, what effect did adding the third bulb have on the brightness of the other two? Did you expect this? What explanation could account for this?

b) Did your observations match your predictions? If not, why?

c) In each of the circuits, were all the bulbs of equal brightness, or was there a trend within that circuit?

d) How did the brightness of the three bulbs in parallel compare to the brightness of the three bulbs in series?

e) What sort of current flow model could you come up with for the parallel circuits - based on your observations of the series circuits and the parallel circuits? Since there are different paths, address the issue of potentially different currents in each path. How does that compare to the series with only one path?

f) In comparing the two types of circuits, series and parallel, if a battery is used as the power supply, in which circuit would the battery last longer?

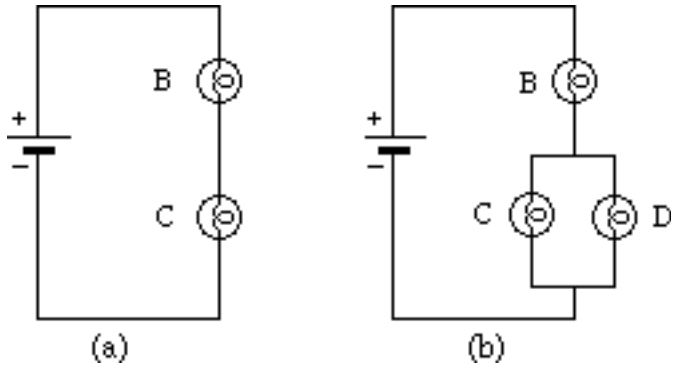
Prediction *Answer on the Data/Question sheet.*
Which circuit could withstand the "loss" of a bulb (burned out) and still continue lighting?

7. Comparing loss of a bulb in series and parallel. Connect two bulbs in series. Gently pull one bulb out of it's socket (to simulate a bulb burning out). Note what happens to the circuit. Now wire them in parallel, and gently pull out one of the bulbs from the socket. Note what happens to the circuit.

Question *Answer on the Data/Question sheet.*
a) What happened to the series circuit when you pulled out the bulb? What happened to the parallel circuit? Can you give an explanation for these effects?

Part 4 - More Complex Series and Parallel Circuits

Prediction *Answer on the Data/Question sheet.*
Consider the circuit, shown in (a) below, consisting of a power supply and two bulbs, B and C, in series. What will happen if you add a third bulb, D, in parallel with bulb C (as shown in (b))? You should be able to answer this question about the relative brightness of B, C, and D based on previous observations. The tough question is: how does the brightness of B change?



Two different circuits with identical bulbs

1. Wiring the circuits. Wire up the circuit shown in (a) above. Note the brightness of the bulbs. Then add another bulb in series with bulb C as shown in (b) above. Note the new brightness of all the bulbs.

Question *Answer on the Data/Question page.*
a) How does the brightness of C and D compare to each other in circuit (b)?

b) How did the brightness of B change when bulb D was added?

c) From your answer in b) ... what do you think the total resistance of the C and D combination is compared to just C?

DATA/QUESTION SHEET - LAB 7 BULBS AND BATTERIES
(SERIES AND PARALLEL CIRCUITS)

Part 2 - Developing a Model for Current Flow

Question *a) Which model did your group pick? What were some of the reasons why you picked that one?*

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b) What were some of the reasons why you did not choose the other three models?

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Part 3 - Circuit Connections and Electrical Diagrams

Questions *a) What happened to the light bulb when you disconnected one wire? Is this what you expected? Does this strengthen your idea of the current model, or does it cause a problem with your model? - Explain.*

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Series Circuits

Prediction *Look at the series circuit figures. Suppose you connected the power supply to one, two, or three bulbs in a series configuration: predict the relative brightness of each of the bulbs in each of the configurations. In which circuit will the bulbs be the brightest, and which the weakest? Will the bulbs be of different brightness within a particular circuit?*

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Questions *a) When you added a second bulb, or a third bulb, what happened to the brightness of the bulbs? Is this what you expected? What possible explanation do you have for this? Could there be more than one explanation?*

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b) Did your observations match your predictions? If not, why? What does this information do to the model that you proposed (support it or refute it?)

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c) With two or three bulbs in the circuit, were the bulbs of relatively equal brightness, or did the brightness drop off in one direction or the other? What does this information do to the model that you proposed (support it or refute it?)

Parallel Circuits

Prediction *Look at the parallel circuit figures. Suppose you connected the power supply to two or three bulbs in a parallel configuration: predict the relative brightness of each of the bulbs in each of the configurations. In which circuit will the bulbs be the brightest, and which the weakest?*

Question *a) Comparing the circuit when you had two bulbs to three bulbs, what effect did adding the third bulb have on the brightness of the other two? Did you expect this? What explanation could account for this?*

b) Did your observations match your predictions? If not, why?

c) In each of the circuits, were all the bulbs of equal brightness, or was there a trend within that circuit?

d) How did the brightness of the three bulbs in parallel compare to the brightness of the three bulbs in series?

e) What sort of current flow model could you come up with for the parallel circuits - based on your observations of the series circuits and the parallel circuits? Since there are different paths, address the issue of potentially different currents in each path. How does that compare to the series with only one path?

f) In comparing the two types of circuits, series and parallel ,if a battery is used as the power supply, in which circuit would the battery last longer?

Prediction *Which circuit could withstand the "loss" of a bulb (burned out) and still continue lighting?*

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7. Comparing loss of a bulb in series and parallel.

Question *a) What happened to the series circuit when you pulled out the bulb? What happened to the parallel circuit? Can you give an explanation for these effects?*

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Part 4 - More Complex Series and Parallel Circuits

Prediction *Consider the series and parallel circuit figure. What will happen if you add a third bulb, D, in parallel with bulb C (as shown in (b))? You should be able to answer this question about the relative brightness of B, C, and D based on previous observations. The tough question is: how does the brightness of B change?*

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1. Wiring the circuits.

Question *a) How does the brightness of C and D compare to each other in circuit (b)?*

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b) How did the brightness of B change when bulb D was added?

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c) From your answer in b) ... what do you think the total resistance of the C and D combination is compared to just C, greater or smaller?

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How do I write up this lab? … What is required for this lab report?

Consult the Rubric for this experiment and the "Lab Report Instructions" document (both found on the Lab Schedule page).

Questions/Suggestions -> Dr. Changgong Zhou czhou@ltu.edu

Portions of this laboratory manual have been adapted from materials originally developed by Priscilla Laws, David Sokoloff and Ronald Thornton for the Tools for Scientific Thinking, RealTime Physics and Workshop Physics curricula. You are free to use (and modify) this laboratory manual only for non-commercial educational uses.

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College Physics 2 Lab
PHY2231

Rubric - Lab 7 Bulbs/Batteries (Series/Parallel) - 80 points

Cover Page (R)	Student Name	1
5 Points	Course-Section-Station	1
	Lab Title / Instructor's Name	1
	Date / Lab partner names	1
	HONOR CODE PLEDGE	1

Introduction (R)	Content/Grammar/Spelling	10
10 Points		

Part 2 – Current Flow Model	Questions (D/Q)	5
5 Points		

Part 3 – Circuit connections …	Series Questions (D/Q)	15
30 Points	Parallel Questions (D/Q)	15

Part 4 – More Complex …	Questions (D/Q)	10
10 Points		

Analysis (R)	Spelling/Grammar	5
20 Points	Analyze the results of this experiment, including a description of how well the observations of brightness illustrated the ideas of series and parallel circuits (use some of your questions/answers on the Data Question sheets as a guide). (See "Lab Report Instructions" file for format details.)	15

Also: points will be taken off for the following as appropriate:

Report turned in late (5 points per school day)
Any units missing (if not printed on data table) (1 pt each)
Report not typed/stapled (5 pts)
Decimal point and sig fig errors (1 pt each)
Presentation (i.e. torn edges on papers (5 pts)
Instructor's signature/stamp missing – 5 points
Data/Question sheets missing – 20 points

Revised – 03/23/2012