Experiment 1
Does It Make Cents?

OUTCOMES

After completing this experiment, the student should be able to:

- properly use the balances available in the laboratory, obtaining the maximum precision the instrument will allow.
- prepare a data table and graph which properly represents data collected in a simple experiment.
- draw appropriate conclusions based on the results of a simple experiment.

DISCUSSION

In this experiment, you will first measure the masses of several pennies from after 1982. Then you will measure the mass of several different numbers of pennies. You will then prepare a graph by plotting the mass of the pennies against the number of pennies. Finally, you will receive a sample containing a number of pennies that are unknown to you. By measuring their mass and using your graph, you should be able to figure out how many pennies are in your sample.

There are a number of different types of graphs used to represent data and it would be nearly impossible to discuss all of them. The most common type of graph used in chemistry is the line graph, which has numbers on both the vertical and horizontal axes. In preparing this type of graph, the independent variable is placed on the horizontal axis (the *x* axis) and the dependent variable is placed on the vertical axis (the *y* axis). The independent variable is the variable you have experimental control over. The dependent variable is the variable that is affected by changes in the independent variable.

For example, if we were to carry out an experiment to find out how study time affects exam scores, we would say that the exam score is the dependent variable, since we are trying to find how the exam score depends on the amount of time spent studying for the exam. In this case, the vertical axis would be labeled with the exam score and the horizontal axis with time.

In this particular experiment, we are measuring the mass of a group of pennies and comparing it to the total number of pennies. Can you identify which variable is the dependent variable?

Once it has been determined which variable is the dependent variable, decide how the graph paper should be oriented. Always try to graph your data so it fills up as much of the page as possible. Before labeling your axes, determine how many units each division or line on your graph should represent. Also, determine the starting values for the vertical and horizontal axes.

It is not necessary to begin every graph with zero. However, values should always *increase* as you move away from the origin and they should always increase in *equal* steps. Pick starting values and steps which are convenient and easy to work with. Number and mark off the major divisions along each axis. Label each axis with a description and the units, such as "study time (hours)".

Plot the data points onto the graph. The data points will be more visible if you draw a small circle around each dot. Then draw a line through the points that best represent the data. This is often called the best-fit line. The best-fit line does *not* always touch each point, due to errors in measurements. Also, the best-fit line is *not* always straight. In many graphs, the best-fit line is a curve. In virtually all cases, the best-fit line will be a smooth line. We do *not* play dot-to-dot .

Finally, every graph should have a title. The standard format is "*y* axis title vs. *x* axis title." For example, "Exam Score vs. Study Time." Now that we have discussed a few important aspects for this lab, are you ready to begin?

PROCEDURE

1. Obtain instructions for operating the balances available in your laboratory. Measure and record the individual masses of five different pennies from after 1982. Calculate the average mass of the pennies.

2. Gather together 50 pennies from after 1982. Using the same balance, measure and record the masses of 0, 10, 20, 30, 40, and 50 pennies (mass the pennies together).

3. Obtain an unknown vial from the instructor that contains an unknown (to you) number of pennies. **Do not open the vial.** Measure and record the mass of the pennies and the vial together, without counting the number of pennies in the sample. Also, record the sample letter (or number) on the vial. Immediately return the unknown vial to your instructor.

4. Subtract the mass of the vial from the total mass of the vial and pennies together to obtain the mass of just the pennies.

Name_____ Lab Section_____

PRELAB QUESTIONS

1. In a graph of exam score vs. study time (referred to in the discussion), which is the **independent** variable and why?

2. In the post-lab questions, you will be graphing mass of pennies vs. the number of pennies. Identify the dependent and independent variables.

3. Which safety precautions, if any, must be observed during this experiment?

Name_____ Lab Section_____

Partner's Name_____

DATA

Table 1. Individual Masses of Post-1982 Pennies			
Penny #1:		**Penny #4:**	
Penny #2:		**Penny #5:**	
Penny #3:		**Average:**	

Table 2. Masses of Groups of Post-1982 Pennies	
Number of pennies	**Mass**
0	
10	
20	
30	
40	
50	

Table 3. "Unknown" Sample of Post-1982 Pennies	
Unknown sample vial letter (or number)	
Mass of vial and pennies	
Mass of vial (given on vial)	
Mass of pennies	

Name_____ Lab Section_____

Partner's Name_____

POSTLAB QUESTIONS

1. If necessary, review the paragraphs on graphing in the Discussion section. Using the supplied graph paper, prepare a graph in which you plot the mass of different numbers of pennies vs. the number of pennies. Remember to make your graph fill the whole page. Which variable belongs on the horizontal axis? The vertical axis? Draw the best-fit line (or curve). Make sure you title your graph and label the axes.

   (Alternatively, you may use Vernier *Logger Pro* or Microsoft *Excel* to tabulate and graph your data.)

2. Using your graph, locate the mass of the pennies for your unknown sample and use it to estimate the number of pennies in your unknown. Draw dotted lines on your graph to show how you found your answer. How many pennies do you estimate using this method? Since there are only whole pennies in the vial, round your answer to the nearest whole penny. **Do not open the vial!**

3. What is the average mass of your post-1982 pennies (from Table 1)? Using this average, calculate the number of pennies in your unknown vial. Again, round your answer to the nearest whole penny. **Do not open the vial!** How does this compare with the number of pennies you found in question 2?

4. **Using your graph**, estimate the mass of 24 pennies. Draw lines on your graph (using a different color) to show how you found the mass.

5. The masses of 5 individual M&Ms are given below. If you have 2739.4 g of M&Ms, how many M&Ms do you have? Show your setup and round your answer to the nearest M&M.

   0.8965 g
   0.8973 g
   0.7967 g
   0.7998 g
   0.8740 g