What has a greater density—diet soda, or regular soda? There are two factors that contribute to the density of an object—its mass and its volume. The relationship between these two extensive properties is called density. Density is defined as the ratio of the mass of an object to its volume:

$$Density = \frac{mass}{volume}$$

Conceptually, density is a measure of how tightly matter is packed. In more dense materials, the particles of matter are very tightly packed, while particles are more loosely packed in less dense materials. In this activity, we will use graduated cylinders and balances to make our measurements.

Preparations
Problem
How do the densities of regular Coke and Diet Coke compare?

Objectives
- Appropriately recording data
- Using significant figures in measurements and calculations
- Experimentally determining the densities of diet and regular soda
- Comparing accuracy and precision of two different experimental strategies

Materials

Diet Coke	2 small beakers
Regular Coke	Balance
50 mL graduated cylinders	Beral pipette

Safety Precautions
Be wary of sharp edges on some of the materials. Wear safety glasses when working with glassware. Dispose of broken glassware in the proper containers.

Roles

Project Manager   _____

- Reads directions, keeps track of time, keeps group on task

Quality Control Manager   _____

- Monitors data collection, checks calculations, checks data quality

Materials Manager   _____

- Gets and returns materials, supervises sharing of materials

Part A:
1. Read through the entire procedure.
2. Put approximately 50 mL of regular Coke in a small beaker.
3. Find the mass of a clean, dry 50 mL graduated cylinder. Record this mass in your data table, using the appropriate amount of precision.
4. Using a beral pipette, add about 5 mL of soda to the cylinder. (Do not spend a lot of time trying to add exactly 5 mL) Precisely record the volume of soda that you actually added.
5. Determine the mass of the graduated cylinder and its contents. Precisely record the mass in your data table.
6. Repeat steps 4 and 5 four additional times, adding about 5 mL each time.
7. Repeat this process, using Diet Coke.

Part B:
1. Record the volume of a Coke can. This is printed directly on the can.
2. Precisely determine the mass of an empty Coke can and record your value. Precisely determine the mass of a full Coke can and record your value in the data table.
3. Repeat steps 1-3 for a can of Diet Coke

Part C:
Record your observations of the cans of Coke and Diet Coke in the bucket of water.

Data and Calculations

Part A Data

Mass of empty cylinder:

Mass of cylinder and regular Coke (g)	Total volume of regular Coke (mL)	Total mass of regular Coke (g)

Mass of cylinder and diet Coke (g)	Total volume of diet Coke (mL)	Total mass of diet Coke (g)

Part B data	Regular Coke	Diet Coke
Mass of empty can (g)		
Mass of full can (g)		
Volume of soda (mL)		

Part C--Observations

Can of regular Coke in water	Can of diet Coke in water

1. Calculate the total mass of soda used for each step in Part A. Record your values in the data tables.
2. Create graphs for the Part A data for both regular and Diet Coke. Use volume as your independent variable. Refer to http://staff.tuhsd.k12.az.us/gfoster/standard/bgraph.htm for guidelines on creating graphs.   Use graph paper. Staple your graphs to the lab handout.
   a. Create a best fit line for your data.
   b. Determine the slope of the best fit lines for both regular Coke and diet Coke. Show your work in the space below.

3. Use the data for part 2 (using the full and empty cans) to find the density of both regular and diet Coke. Show all your work in the space below.

Analyze and Apply

1. Use particle models to compare the density of a solid and a gas of the same substance.

2. What is the purpose of the estimated digit when reporting measurements? Why is that digit uncertain?

3. Compare the densities of soda you determined with the graph and slope method to the full can method.

    a. In the graphs for part A, your best-fit lines should go through the origin. In your own words, explain what this means physically.

    b. Which method do you think is more accurate?   Explain how you arrived at your answer.

    c. Which method do you think is more precise? Justify your answer in two ways.

4. The density of pure water is 1.00 g/cm^3.   Use this information to explain your observations in part C of the experiment.   In your explanation, refer to your calculated densities for regular and diet Coke.

5. How could you improve your results from this experiment?