Name:

Period:

LAB 9 - DENSITY AND THE CARTESIAN DIVER

BACKGROUND

We have observed the Cartesian Diver floating at the surface, subsurface floating (neutral buoyancy) and resting on the bottom of the container.

We now look more closely at the volume of water the diver displaces in these three positions. We will also investigate the relationship between the mass and the volume of the diver at each of these positions.

One relationship between an object's mass and its volume is called *density*. Density is expressed as the number of grams in each cubic centimeter (cm^3) of the object.

PROBLEM

How do we determine the density of an object?

What is the density of the diver as it floats or sinks at different positions in a container of water?

HYPOTHESIS

Buoyancy	Mass & Total Volume
independent variable	dependent variable

The predicted relationship between the variables is: (use <, =, >)

Surface floating (positively buoyant):

Subsurface floating (neutrally buoyant):

Sinking (negatively buoyant):

MATERIALS

- Cartesian Diver
  - 2000mL bottle & cap
  - Syringe
- Graduated Cylinder (100mL)
- Triple-Beam Balance
- Beaker (250mL)
- Beaker (600mL or 1000mL)
- Glass rod
- Lead Shot
- Apron & Goggles

PROCEDURE

1. Build your Cartesian Diver, this time using a syringe as the diver. This may take several tries to get it right. Use the 600mL or 1000mL beaker to test if the diver floats prior to putting it in the 2000mL bottle.
    a. Record the plunger level here: _____

2. Record the water level *in the syringe* at each position within the bottle.
    a. When the diver is floating at the top, the water level inside the syringe is: _____

    b. When the diver is subsurface floating the water level is:_____

    c. When the diver is on the bottom the water level is:_____

3. You will now use the above data to re-create the water levels in the dropper, but this time **outside** of the bottle.
    a. Remove the syringe from the bottle
    b. By moving the plunger up and down with the open end either in the water, out of the water, or upside down, you can control the amount of air and water in the plunger.
    c. The goal is to make the diver look just like it did when it was negatively buoyant (water level the same and the plunger at the same level).

4. Measure the mass of the diver. Record your data in table 9-1.
    a. Make sure that there is water in the open space at the top of the syringe.

5. Use the graduated cylinder to measure the volume of water displaced by the diver.
    a. Fill the graduate about 1/2 full of water (enough so that the dropper can be fully submerged w/o touching the bottom).
    b. Record the amount of water in the graduate.
    c. Drop the diver into the graduate and record the change in volume
        i. **Note:** if any part of the diver is still above the water, gently press it down using the glass stirring rod. Do **not** push the rod itself into the water, only the eyedropper.
    d. Record your data in table 9-1

VERIFY YOUR DATA WITH MR. KOERGER BEFORE CONTINUING ON

6. Repeat steps 3 - 5 as needed to duplicate the water level at the subsurface floating position and the surface floating position. Record your mass and volume measurements on table 9-1.

7. Clean up your lab station and record the data on the table of class data. Class data will be available outside my classroom door by the end of the day. It will also be available on the class web site.

DATA

Table 9-1: Mass & Total Volume of Cartesian Diver at different positions.		
Position of Diver	Mass (g)	Volume of water displaced (mL)
Floating		
Subsurface Floating		
Sinking		

SUMMARY

Summary and Challenge Questions must be typed on a separate piece of paper.
You must write in complete sentences or restate the question.

1. **Using a computer,** graph the class data of the mass of the diver and the volume of water displaced by the diver. **Make sure that mass is on the X-Axis**. Mark the set of data for **each buoyancy** with a different color/symbol.
    a. Create a best-fit line for the **subsurface data only**.

2. Examine your graph.
    a. What are the relationships between the mass and the volume of the diver when subsurface floating?
    b. Where are the plotted points for sinking objects? What relationship is suggested by that data?
    c. Where are the plotted points for the floating objects? What relationship is suggested by that data?

CHALLENGE

1. Can you predict the **mass** of **water** (not volume of water) displaced by the diver when it is floating at the surface, subsurface floating, and resting on the bottom? If so, how? If not, why not?