DENSITY LAB

Name ______________________

INTRODUCTION:

Density is the word we use to define how tightly packed the molecules are in a certain substance. Some substances, such as stone, have many atoms packed closely together, giving them a high density and making them feel heavy. Other substances, such as foam, have many fewer atoms in the same amount of space, making them feel light. The size of the atoms themselves also affects the measurement of density. For example, atoms of gold, mercury and lead are very large, much larger than aluminum or copper atoms. The larger atoms have more protons and neutrons in their nuclei, adding to the overall mass and density of the element.

Density is a clue that can help mineralogists figure out the identity of a sample. Two minerals might look exactly the same but have different densities. Therefore, all rock and mineral guide books will list the density along with the other properties of the rock or mineral. However, some books prefer to use the term "specific gravity" instead of density. Specific gravity compares the density of the mineral to the density of water. Since the density of water is exactly 1.0, the specific gravity number is always the same as the density number. It doesn't make any practical difference which term you use. Specific gravity is technically more correct, but you still see the word density, too.

Since we will actually be comparing some substances to water, we'll go ahead and switch over to using the term specific gravity. Don't let it throw you! We are still talking about density.

PART 1: Comparing the specific gravity of various substances to the specific gravity of water

<u>You will need</u>:

- a small graduated cylinder (10 ml is best for this first part, but 25 ml is okay. 50 ml will do if you don't have a smaller one.) (Smaller cylinders give you a more accurate measurement.)
- a balance (digital scale)
- a sharp knife or razor blade (and adult supervision)
- a bowl of water
- vegetable oil
- a pipette (eye dropper)
- a metric ruler
- a variety of solid "waterproof" foods, such as potato, apple, pear, banana, cheese, carrot, squash, cucumber, eggplant, broccoli stem, egg white, cantaloupe (You can use non-food items, too, such as foam. Just make sure anything you choose will be able to go into a bowl of water and not disintegrate. That eliminates bread. Also, make sure you will be able to cut the substance safely. Stay away from nuts or other hard items that might make the knife or razor slip onto your finger.)

You don't have to use this entire list. Just choose a handful of items from what you have around the house.

TIP: Try to use apple, if you can, as it will give an interesting result.

<u>What to do</u>:

1) Choose 4-6 solid items that you will test. Use the metric ruler and the knife or razor to cut cubes of each food that are EXACTLY one centimeter on a side. Be patient and try to get your centimeter cubes cut as accurately as possible The more accurate you are, the better your measured results will be.

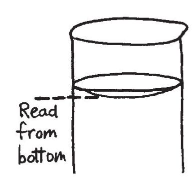
2) Use the balance (set on grams) to record the mass of each cube. Write the name of the substance on the line and then record its mass in grams. (Be sure to keep track of which cube is what, since some of the cubes might look very similar.)

MASSES OF MY CUBES: *(you don't have to use all the lines)*

__________________ = ______ grams   __________________ = ______ grams   _________________ = ______ grams

__________________ = ______ grams   __________________ = ______ grams   _________________ = ______ grams

__________________ = ______ grams   __________________ = ______ grams   _________________ = ______ grams



4) Your cylinder is marked with lines. If you are using a 25 ml or a 50 ml cylinder, those lines will probably represent 1 milliliter (ml). If you are working with another size, figure out what each line represents. Pour water into your cylinder until the top of the water is EXACTLY at 20 ml for the 25 ml size, or 40 ml for the 50 ml size. Use your pipette (eye dropper) to adjust the level of the water until it looks exactly right. (TIP: If you see a slight dip in the surface of the water, this is called the meniscus. Read the level of the water from

the bottom of the meniscus (the low point) not from where the water hits the sides of the cylinder.)

5) Put your cylinder onto the balance and then turn it on. The scale might read "0." This is good. If your scale reads somethign other than 0, try hitting the TARE button if you have one. The TARE button resets the starting point for 0. In effect, the TARE button tells the balance to ignore all that weight that is on it, and just weigh what is coming next. If you don't have a TARE button, just write down the mass it is reading right now so you don't forget. You'll just add one to that number in step 7.

6) Take your pipette/dropper and add water until it looks like you have added exactly one ml to the cylinder. Remember to read from the low point of the water (the meniscus).

7) Look at the number of grams the balance is reading now. Did it go up by exactly 1 gram, or very close to that? If you could be perfectly precise, it would go up by exactly 1.

8) Now try the reverse. Don't look at the cylinder while you are dropping in water. Watch the numbers on the balance. When you've added exactly one gram, stop and look at the water level in the cylinder. Did you add 1 ml?
(Don't throw out that water. Leave it in the cylinder.)

1 ml of water has a mass of 1 gram. What is the density of water? Density is calculated like this:

$$\text{Density} = \frac{\text{grams}}{\text{milliliters}}$$

In this case, we have 1 gram/1 ml. 1 divided by 1 is 1, so **water has a density of 1**.

Water is the standard by which all other substances on earth are judged. If a mineral has a density of 2, that means it has a density twice that of water. A substance with a density of 0.5 has a density half that of water. Everything is compared to water.

Substances sort themselves out according to their densities. Higher densities go down, lower densities go up. This principle works in air, in liquids, and sometimes in solids as well. It is easy to see this principle at work in water. Substances with a density greater than 1.0 will sink, and those with a density less than 1.0 will float. Let's test our food cubes!

9) Let's test the density of another liquid. You will add exactly 1 gram of oil to the cylinder of water. Use the pipette/dropper to add the oil drop by drop, as you watch the numbers go up on the balance. Add exactly 1 gram.

10) Now look at the level of fluid in the balance. The oil will be on top of the water. Did you add exactly 1 ml oil? What does that tell you about the density of the oil? (The fact that it is floating on the water confirms what your numbers are telling you.)

11) The size of your cubes was not chosen at random. One solid cubic centimeter happens to have the same volume as one liquid milliliter. That makes calculating the density of these foods very easy! Using the density formula, Density= g/ml, we can put in "1" as the bottom number. That means we'll be dividing by 1, which means our number won't change. So those measurements we did on the cubes ARE the densities. All we need to do is look at those numbers and see which ones are greater than or less than 1.

12) Pick up a cube, check the number of grams, and then predict whether it will sink or float. Then put it into the bowl of water and see if you are right.

13) Lastly, put one of the sinking cubes into the cylinder. How much do you think it will raise the water level? (Make sure you read the cylinder level before you put the cube in.) Do your results confirm that 1 ml = 1 cc? (cc = cubic centimeter)

<u>EXTENSION QUESTIONS</u>:

1) If you cut a food block in half, will half a block have the same density as the whole block? You might want to test two of your blocks, one that floats and one that sinks. Does a very small piece act the same way as the whole piece did? What would happen of you put a whole apple/potato/zucchini/carrot into a large tub of water? Can you accurately predict whether the whole fruit or vegetable will float or sink?

2) Liquid mercury has a specific gravity of 5.43 g/ml. What would happen if you poured some liquid mercury into water? What would happen if you poured the mercury into a glass of vegetable oil?

2) Copper has a density of 8.9. What would happen if you put a piece of copper into liquid mercury? Titanium has a density of34.5. What would it do in liquid mercury?

PART 2: Calculating the specific gravity of some mineral samples

<u>You will need</u>:
- a small graduated cylinder (25 ml or 50 ml, depending on your sample sizes)
- a balance
- water
- some small minerals or rocks (must fit into your graduated cylinder)
- a calculator

In the last section, our samples were perfect cubes—cubic centimeters that were equal to 1 ml. It was easy to find the density because the number on the bottom of the equation was 1. In this section, we will use things that are not cubic and will need to use the graduated cylinder to help us find their volume, plus a calculator (or your brain) to do the math.

<u>What to do</u>:

1) First, hold your mineral samples and compare how heavy they are. They are probably of different sizes, so comparing densities will be difficult. If you can, try to judge their densities based on their weight and size. Which one would you predict as being the most dense? Which one is the least dense? Take a guess before you measure them. See how good your brain is at estimating density. You might be surprised at how accurate your brain turns out to be!

2) Weigh each of your mineral samples. Keep track of which is which by number them or giving them names if you know what they are (calcite, granite, etc.). Write the name or number on a line and then now many grams it weighs. Include the number to the right of the decimal point, such as "19.45." (You might not need all these lines.)

________________ = ______ grams ________________ = ______ grams ________________ = ______ grams

________________ = ______ grams ________________ = ______ grams ________________ = ______ grams

2) Now choose one of the mineral samples and a graduated cylinder. You want to choose the smallest size cylinder that the sample will fit into. Smaller cylinders always give you a more accurate measure.

3) Fill the cylinder about halfway full with water, but make sure that the water line is exactly at a nice even number such as 20 or 30. Use the dropper to get the water line (the bottom of the meniscus) exactly at the mark.

4) Slide the sample gently down into the cylinder. You don't want water splashing out because you just carefully measure the level of the water. Make sure the sample is completely covered by the water. You will get an incorrect reading if it is sticking up out of the water. The sample will "displace" a volume of water equal to its volume. In other words, the amount that the water rises is the volume of the sample. Record the volume of each sample.

________________ = ______ ml ________________ = ______ ml ________________ = ______ ml

________________ = ______ ml ________________ = ______ ml ________________ = ______ ml

Remember, 1 ml equals 1 cubic centimeter, so this ml measure is also giving us the volume of the sample in centimeters.

5) Finally, calculate the density of each one by dividing the grams by the mls. Density = g/ml

________________ = ______ density ________________ = ______ density ________________ = ______ density

________________ = ______ density ________________ = ______ density ________________ = ______ density

6) Calculate the specific gravity of each sample. This is a no-brainer. The specific gravity of a sample is its density divided by the specific gravity of water, which is 1. Any number divided by 1 stays the same. So the density and the specific gravity are the same. No calculations needed!

7) Compare your results to your original guesses. Did you get any right?