DENSITY READING

One of the ways a scientist identifies a substance is by calculating its density. Density is defined as the amount of matter (mass) in a given unit of volume. This means that the property of density tells how tightly matter is packed in a substance. You have probably heard of the famous riddle, "Which weighs more, a pound of feathers or a pound of lead?" At first many people say, a pound of lead. But the answer is that they weigh the same (one pound each). This riddle illustrates the physical property of matter called density. The density of lead is much greater than the density of feathers. A pound of lead would be a small cube, while a pound of feathers would be in a much larger box. Another way of saying this is that lead has more matter packed in a smaller space than the feathers have. Answer the following: if a liter of water has a mass of one kilogram, and a liter of mercury has a mass of 13.6 kilograms, which is more dense? Why?

The idea of density can be expressed in mathematical terms. The formula for density is: density = mass divided by volume (d = m/v). So, density is found by dividing mass of an object by its volume. The units for density are usually grams per cubic centimeter (g/cm^3) or grams per milliliter (g/mL). For example, the mass of an object is 30 grams and its volume is 15 cubic centimeters. We find the density of the object by dividing 15 into 30. The density would be recorded as 2 grams per cubic centimeters or 2 g/cm^3. Find the density for the following:

Object	***Mass***	***Volume***	***Density***
Object A	***20 g***	***4 mL***	
Object B	***120 g***	***6 mL***	
Object C	***49 g***	***7 cm^3***	

The density of any particular substance is always the same, regardless of the size of the object being measured. Because of this, density is used to identify substances. For example, gold has density of 19.32 g/cm^3, copper has a density of 8.9 g/cm^3, and water has a density of 1 g/mL. So, how can this be used? An example can be seen with the two metals, silver and polished aluminum. They both look alike and have many common properties, so how can we tell them both apart? We measure their densities by first finding their mass and volumes and plugging them into our formula for density and then comparing our answer to the known densities of the metals. Aluminum has a density of 2.7 g/cm^3 and silver has a much heavier density.

You can also use density to determine the amount of gold found in a piece of jewelry. Gold alone is too soft to use in the making of jewelry so it is often mixed with copper to make it stronger. This mixture is called an alloy. The gold alloy is not worth as much as pure gold. To determine how much copper is in the gold alloy, you must first find the mass of the jewelry. Then, measure the volume of the jewelry using the water displacement method due to its irregular shape. When the mass is divided by volume, density can be determined. If a piece of jewelry is 50% copper and 50% gold, its density would be 12.22 g/cm^3. If its density is less than this, it would have more copper in it than gold and the value would be lower. If its density is more than this, it would have more gold in it than copper and the value would be higher. How can this be applied to ore being mined?

The densities of liquid can show how much matter is dissolved in them. For example, the liquid in a car battery is a mixture of water and sulfuric acid. The density of this liquid is about 1.3 g/mL. When a car battery is in good condition, the liquid is at its highest density. As the battery ages and loses its ability to produce electricity, the density of the water drops. The condition of the battery can be determined by measuring the liquid's density. The higher the density, the better the battery's condition.

Service stations have a tube with a float in it called a hydrometer. This device measures the density of the battery liquid. There is a rubber bulb on one end of the tube that the attendant squeezes to draw battery liquid into the device and the float floats in the liquid. In a more dense liquid, more of the float remains above the surface. The float rides deeper in less dense liquids. Marks on the float tell what the liquid's density is. Some hydrometers are marked with words that describe the condition of the battery. Low density would suggest a bad battery. Hydrometers can also be used to determine the densities of other liquids such as milk sugar, alcohol, or pollutants in water.

Another use of density can be found in the sports gym. An athletic trainer can determine the percentage of body fat in an athlete's body. The mass of the athlete is first determined on a scale. He or she is then immersed in a tub of water to determine their volume. The density of the athlete is calculated. If the percent of the body fat is too high, the trainer will recommend a diet and exercise program.

Densities also show which objects will float in various liquids. The rule is objects of lower density will float on liquids of higher density. For example, most dry wood is less dense than water, since it has many air pockets. A block of dry wood will, therefore, float in water. If the wood becomes water soaked, the air in the wood is replaced with water. The wood then becomes more dense than water and will sink.

Density applies to all forms of matter. Seawater is more dense than fresh water. Cold air is more dense than warm air. Mercury, a liquid, is more dense than steel a hard, tough, solid. As you can see, density is an important physical property of matter.

Answer the questions below in your journal in complete sentences.

1. Copy the data table and complete it.
2. Which object has the most density – A, B, or C?
3. Define density.
4. What does density tell us?
5. Which is more dense, a pound of rice or a pound of cement? Explain your answer.
6. What is the mathematical formula for density?
7. How is density used to identify substances?
8. Will a two liter bottle of coke have a different density than a one liter bottle of coke? Explain your answer.
9. If a jeweler was trying to sell you a bracelet that he said was an alloy of 50% copper and 50% gold, how could you be sure that this was correct?
10. How is density used to determine if your car battery is good?
11. If you had an object with a density of 1.12 g/cm^3, would it sink or float in a container of salt water that has a density of 1.35 g/mL?
12. Would the same object as above sink or float in a container of fresh water with a density of 1.0 g/mL?
13. Which is more dense – air that is 90 degrees or air that is 40 degrees?