**Buoyancy Lab**

**Observation**

*When placed in liquids some objects sink and some objects float.*

**Question**

*Why do some objects float and some objects sink when placed into a liquid?*

**Background**

Eureka! According to popular legend, in the 3rd. century B.C. the Greek mathematician Archimedes discovered that there was a relationship between the amount of water he displaced when getting into a bathtub and the buoyant force that made him feel lighter in the water.

This discovery lead to the principle named after him (Archimedes principle) which states that:

“An immersed object is buoyed up by a force equal to the weight of the ﬂuid it displaces.”

Why do some objects ﬂoat and others sink? The answer depends partly on the densities of the object itself and the liquid it is placed in. Density is the mass of a material in one unit of volume. The mathematical formula for density is given below.

*Density = Mass/Volume or d=m/v*

**Procedure**

1. Fill 3 graduated cylinders with 80 mL of water. Make sure that you are accurate with your measurements.
2. Using the balance measure the mass of 3 samples; a piece of wood, a marble and a piece of metal. Record the mass in the table provides.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sample | Mass of Sample (g) | Volume of Water | Volume of water and sample (mL) | Volume of sample (mL) | Weight of Solid (N) | Density (g/mL) | Buoyant force (N) |
|  |  |  |  |  |  |  |  |
| Marble |  | 80 mL |  |  |  |  |  |
| Wood |  | 80 mL |  |  |  |  |  |
| Metal |  | 80 mL |  |  |  |  |  |

1. Calculate the volume of the 3 samples. You can do this easily for samples that sink. Measure the volume (mL) of the sample and the water from the graduated cylinder. How can you calculate the volume of objects that don’t sink?

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People often confuse mass and weight. Explain the difference between mass and weight below. We discussed this in class. Which value is constant anywhere in the galaxy and which will change based on the force of gravity?

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1. Calculate the weight of each of the samples. The SI unit for weight is the Newton (N). 1 Newton is equal to the force of gravity acting on 1 kg or 1 x 9.81 m/s2. We can use 10 m/s2 as the force of gravity but be careful we need to convert grams into kilograms first! 1000g = 1kg.

Don’t forget to show your working:

1. Now calculate the density of each sample using the equation given above (density = mass/volume). The SI unit for density is g/mL. Why does this unit make sense as a unit of density?

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Calculate the density for each object. Don’t forget to show your working:

1. What is the density of water? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*You will need to calculate the mass of the sample. To save time you could also look this up online.*

1. What do you notice about the densities of the samples that float compared to the density of water?

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**Buoyant Force**

Some objects that are denser than the liquid they are placed in but they still float. Think about metal ships.

Why do you think that these objects are able to float? Think about their shape.

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The buoyant force acting on an object is what makes it float. This is a force pushing an object up that needs to be greater than the force of gravity pulling an object down. The equation below is used to calculate buoyant force.

*Buoyant force on object = Weight of displaced fluid = Mass of displaced fluid x gravity.*

Notice how this is very similar to the calculation for weight (w=mg). So the calculation for buoyant force could be bf=mg. Where bf = buoyant force, m= mass of displaced fluid, and g= force of gravity (10m/s2).

Can you calculate the buoyant force acting on each sample?

Don’t forget to show your working:

(bf=mg)

**Extra Credit**: Can you explain how the principles studied in this lab might be applied to a hot air balloon?