Density and Buoyancy

8. All objects experience a buoyant force when immersed in a fluid. As a basis for understanding this concept:
   a. *Students know* density is mass per unit volume.
   b. *Students know* how to calculate the density of substances (regular and irregular solids and liquids) from measurements of mass and volume.
   c. *Students know* the buoyant force on an object in a fluid is an upward force equal to the weight of the fluid the object has displaced.
   d. *Students know* how to predict whether an object will float or sink.

Notes

Read the following section highlights. Then, in your own words, write the highlights in your ScienceLog.

- A fluid is any material that flows and that takes the shape of its container.
- Pressure is force exerted on a given area.
- Moving particles of matter create pressure by colliding with one another and with the walls of their container.
- Fluids exert pressure equally in all directions.
- The pressure caused by the weight of Earth's atmosphere is called atmospheric pressure.
- Fluid pressure increases as depth increases.
- Fluids flow from areas of high pressure to areas of low pressure.
- Pascal's principle states that a change in pressure at any point in an enclosed fluid will be transmitted equally to all parts of the fluid.
- Hydraulic devices transmit changes of pressure through liquids.
- All fluids exert an upward force called buoyant force.
- Buoyant force is caused by differences in fluid pressure.
- Archimedes' principle states that the buoyant force on an object is equal to the weight of the fluid displaced by the object.
- Any object that is more dense than the surrounding fluid will sink; any object that is less dense than the surrounding fluid will float.
- Bernoulli's principle states that fluid pressure decreases as the speed of a moving fluid increases.
- Wings are often shaped to allow airplanes to take advantage of decreased pressure in moving air in order to achieve flight.
- Lift is an upward force that acts against gravity.
- Lift on an airplane is determined by wing size and thrust (the forward force produced by the engine).
- Drag opposes motion through fluids.
- The density (mass per unit volume) of a substance is always the same at a given pressure and temperature regardless of the size of the sample of the substance.

1. Definitions:

________________the amount of matter in a given space; mass per unit volume

______________the amount of matter that something is made of; its value does NOT change with the object's location in the universe

________________the amount of space that something occupies or the amount of space that something contains

________________________the upward force that fluids exert on all matter; buoyant force opposes gravitational force

<u>2 examples: </u>rubber ducky in the tub floats, an aircraft carrier floats

*An object in a fluid will sink if it has a weight greater than the weight of the fluid it displaced. An object will sink if its weight is greater than the buoyant force acting on it. An object floats ONLY when it displaces a volume of liquid that has a weight equal to the object's weight

________________the amount of force exerted on a given area

atmospheric pressure: the pressure caused by the weight of earth's atmosphere

_________________________________this states that a change in pressure at any point of an enclosed fluid is transmitted equally to all parts of that fluid

_________________________________that the buoyant force on an object in a fluid is an upward force equal to the weight of the volume of fluid that the object displaces

_________________________________as the speed of a moving fluid increases, its pressure decreases

Density

Calculate density, and identify substances using a density chart.

Density is a measure of the amount of mass in a certain volume. This physical property is often used to identify and classify substances. It is usually expressed in grams per cubic centimeters, or g/cm^3. The chart on the right lists the densities of some common materials.

Densities of Substances

Substance	Density (g/cm^3)
Gold	19.3
Mercury	13.5
Lead	11.4
Iron	7.87
Aluminum	3.7
Bone	1.7–2.0
Gasoline	0.66–0.69
Air (dry)	0.00119

EQUATION: $\text{density} = \frac{\text{mass}}{\text{volume}}$

$$D = \frac{m}{V}$$

SAMPLE PROBLEM: What is the density of a billiard ball that has a volume of $100\ cm^3$ and a mass of 250 g?

$$D = \frac{250\ g}{100\ cm^3}$$

$$D = 2.5\ g/cm^3$$

Your Turn!

1. A loaf of bread has a volume of $2270\ cm^3$ and a mass of 454 g. What is the density of the bread?

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2. A liter of water has a mass of 1000 g. What is the density of water? (Hint: $1\ mL = 1\ cm^3$)

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3. A block of wood has a density of $0.6\ g/cm^3$ and a volume of $1.2\ cm^3$. What is the mass of the block of wood? Be careful!

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4. Use the data below to calculate the density of each unknown substance. Then use the density chart above to determine the identity of each substance.

	Mass (g)	Volume (cm^3)	Density (g/cm^3)	Substance
Example:	4725	350	4725 ÷ 350 = 13.5	mercury
a.	171	15	________	________
b.	148	40	________	________
c.	475	250	________	________
d.	680	1000	________	________