Lect 4:
Buoyancy & Density

1. What is buoyancy?
2. What is the relationship between density & buoyancy?

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10. Eureka!!! Buoyancy!
Take Notes on your lecture notes.

Will it float or sink?

ν The largest ship in the world is the *Jahre Viking*, an oil-carrying tanker.

ν This super-sized ship is 1,504 feet long and 264 feet wide, longer than 5 football fields laid end-to-end.

ν If the Empire State building was laid on its side, the *Jahre Viking* would be longer by 253 feet!

ν Crew members use bicycles to get from place to place on the ship.

ν The *Jahre Viking* is largely constructed of steel, so how can a big, heavy ship like this actually float?

Will it float or sink?

• Let's look at something we're more familiar with….Soda!
• Write down 2 *similarities* between these two cans.
• Write down 2 *differences*.
• Predict what happens when I place a can of regular coke and a can of diet coke into regular tap water.
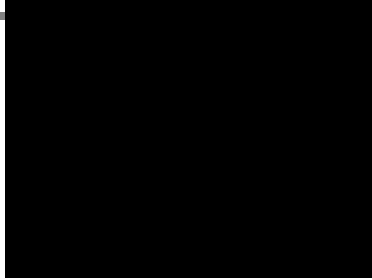

Will it float or sink?

What is your best guess??
Diet soda will:
Regular soda will:

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11. Sink or float?

Floating Diet Coke Demo

12. But, WHY does is sink or float

Will it float or sink?

- **What did you see?**
  - **The diet coke floats & the regular sinks.**
- **Why does the diet float??**
  - **Regular soda contains 39 grams of sugar.**
  - **Diet coke contains 100 mg of Nutra-sweet.**
  - **More "stuff" (matter) is crammed into the same amount of space, or VOLUME, and that increases the MASS.**
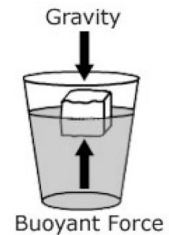 - **The relationship of Mass to Volume is Density.**

## 13. Density & Buoyancy
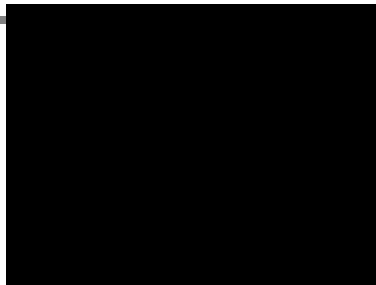
Buoyant Force

- ν Why do ice cubes float in water?
- ν Even though gravity forces an ice cube down, water exerts an upward force on the ice.
- ν This upward force is called **buoyancy**.
- ν All objects submersed a fluid, whether it be a liquid or **gas**, experience this buoyant force.

Gravity

Buoyant Force

Buoyant Force

- ν **The buoyant force exists because of _pressure_ differences in fluids.**
- ν **In any fluid, the greater the depth, the greater the pressure.**
- ν **In this picture, a thin plank of wood has been pushed underwater.**

downward pressure
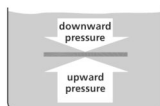
upward pressure

The pressure on the bottom of the plank is greater than the pressure on the top of the plank because the bottom of the plank is deeper.
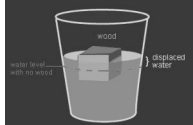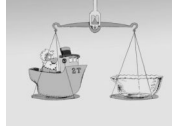
buoyant force

The difference in pressure produces a net upward force on the plank.

It's Mythbuster's time!
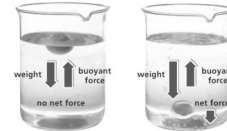
- ν Mythbuster's: Let's Talk Buoyancy

Archimedes' Principle

- More than 2000 years ago, a Greek scientist named Archimedes created a law about buoyancy.
- The Archimedes' Principle states that the buoyant force on an object in a fluid is <u>equal</u> to the <u>weight</u> of the displaced fluid
  - *Example*: Suppose a block displaces 250 mL of water.
  - 250 mL of water weighs about 2.5 N.
  - According to the principle, the buoyant force (pushing upwards) on the block is 2.5 N.

wood

water level with no wood

displaced water

Floating & Sinking

- ν An object will float in a fluid if the buoyant force is <u>equal</u> or <u>greater</u> than the object's weight.
  - ν A cork floats because the weight is less than the buoyant force.
- ν An object <u>sinks</u> if the object's weight is greater than the buoyant force.
  - ν A marble sinks because its weight is more than the buoyant force.

weight buoyant force no net force

weight buoyant force net force

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14. The Egg Experiment

BrainPop: Buoyancy
<u>click here</u>

BUOYANCY

How did you do??

April 18, 2010
elaine

SCORE: 10/10

Formulas to Remember!

ν Density: D= m/v   (mass / volume)

You can also rearrange the formulas as:
ν Mass: m= D x V
ν Volume: V = m/D

Some Problems to do in class or at home:

- 1. Find the density of a substance with a mass of 5kg and a volume of 43 m^3

- 2. Suppose you have a lead ball with a mass of 454g. What is its volume? (density of lead is: 11.35 g/cm^3)

- 3. What is the mass of a 15mL sample of mercury? (density of mercury is: 13.55 g/cm^3)

- 4. A block of pine wood has a mass of 120g and a volume of 300 cm^3. What is the density of wood?

Answers

- 1. D= M/V
  D = 5 kg / 43 m^3 Which equals: 0.12 kg/ m^3

- 2. Volume: V = M/D
  = 454 g / 11.35 g/cm^3 = 40 cm^3

- 3. Mass: M = D x V
  M =13.55 g/mL x 15 mL   = 203 g

- 4. D= M/V
  = 120g / 300 cm^3 = 0.4 g/cm^3

The Magic Ice Cube

- Trial 1: Ice Cube in water
- Trial 2: Watch as I place a second ice cube in another beaker.
- Describe what happened & write a possible explanation.

The Magic Ice Cube

Explanation:
- This ice cube was placed in a beaker of rubbing alcohol.
- Rubbing alcohol is less dense than water.
- The Ice Cube sank because it was more dense than the alcohol.
- The ice cube's weight was more than the weight of the water it displaced.