
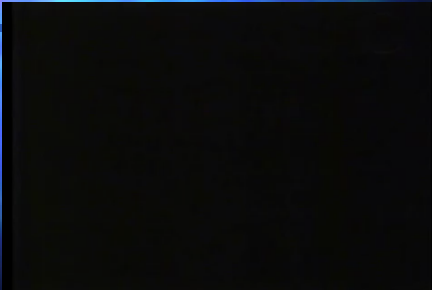


## Lect 4: Buoyancy & Density


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



## 10. Eureka!!! Buoyancy!




## Will it float or sink?



- The largest ship in the world is the *Jahre Viking*, an oil-carrying tanker.
- This super-sized ship is 1,504 feet long and 264 feet wide, longer than 5 football fields laid end-to-end.
- If the Empire State building was laid on its side, the *Jahre Viking* would be longer by 253 feet!
- Crew members use bicycles to get from place to place on the ship.
- 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?

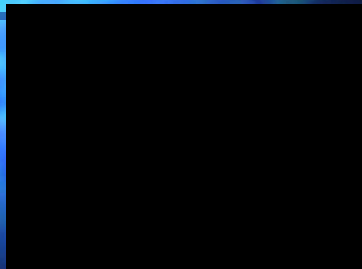
What is your best guess??  
Diet soda will:  
Regular soda will:

## 11. Sink or float?

### Floating Diet Coke Demo



## 12. But, WHY does it sink or float

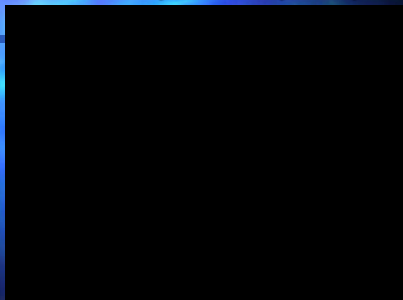


## Will it float or sink?



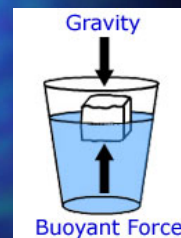
- What did you see?
  - The diet coke floats & the regular sinks.
- Why does the diet float??
  - Regular soda contains 39 grams of sugar.
  - Diet coke contains 100 mg of Nutra-sweet.
  - More "stuff" (matter) is crammed into the same amount of space, or VOLUME, and that increases the MASS.
  - The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

## 13. Density & Buoyancy



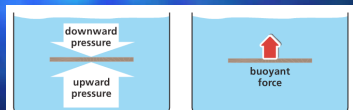
## Buoyant Force

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



## Buoyant Force

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



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.

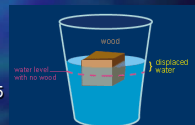
The difference in pressure produces a net upward force on the plank.

## It's Mythbuster's time!

- [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 **equal** to the **weight** 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.



## Floating & Sinking

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



## 14. The Egg Experiment



## 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.

## BrainPop: Buoyancy



Brain POP BUOYANCY April 18, 2010 elaine

## How did you do??

SCORE: 10/10

1. What is the name of the force that keeps you afloat?
  - Buoyancy
  - Electromagnetism
  - Density
2. What is an object's buoyancy if it floats in water?
  - Negative
  - Neutral
  - Positive
3. What is an object's buoyancy if it sinks in water?
  - Negative
  - Neutral
  - Positive
4. If an object neither sinks nor floats in water, what is its buoyancy?
  - Negative
  - Neutral
  - Positive
5. Which one of these has neutral buoyancy?
  - Alum
  - A fish
  - A rock
6. What determines whether an object will float or sink?
  - Its color
  - Its volume, relative to the mass of the liquid it's in
  - Its density, relative to the density of the liquid it's in
7. If you drop a cube in a bucket of water, the amount the water level rises is equal to:
  - The volume of water displaced by the cube
  - The mass of the cube
  - The weight of the water
8. Compared with the molecules within a freshwater lake, the molecules of a heavy lake are:
  - farther apart
  - closer together
  - loosely close together
9. How do you calculate an object's density?
  - Divide its height
  - Divide its weight by its height
  - Divide its mass by its volume
10. Which of these is densest?
  - A sheet of paper
  - A rock
  - A cloud of nitrogen

## Formulas to Remember!

- Density:  $D = m/v$  (mass / volume)

You can also rearrange the formulas as:

- Mass:  $m = D \times V$
- Volume:  $V = m/D$

## Some Problems to do:

1. Find the density of a substance with a mass of 5kg and a volume of 43 m<sup>3</sup>
2. Suppose you have a lead ball with a mass of 454g. What is its volume? (density of lead is: 11.35 g/cm<sup>3</sup>)
3. What is the mass of a 15mL sample of mercury? (density of mercury is: 13.55 g/cm<sup>3</sup>)
4. A block of pine wood has a mass of 120g and a volume of 300 cm<sup>3</sup>. What is the density of wood?

## Answers

1.  $D = M/V$   
 $D = 5 \text{ kg} / 43 \text{ m}^3$  Which equals: 0.12 kg/ m<sup>3</sup>
2. Volume:  $V = M/D$   
 $= 454 \text{ g} / 11.35 \text{ g/cm}^3 = 40 \text{ cm}^3$
3. Mass:  $M = D \times V$   
 $M = 13.55 \text{ g/mL} \times 15 \text{ mL} = 203 \text{ g}$
4.  $D = M/V$   
 $= 120 \text{ g} / 300 \text{ cm}^3 = 0.4 \text{ g/cm}^3$