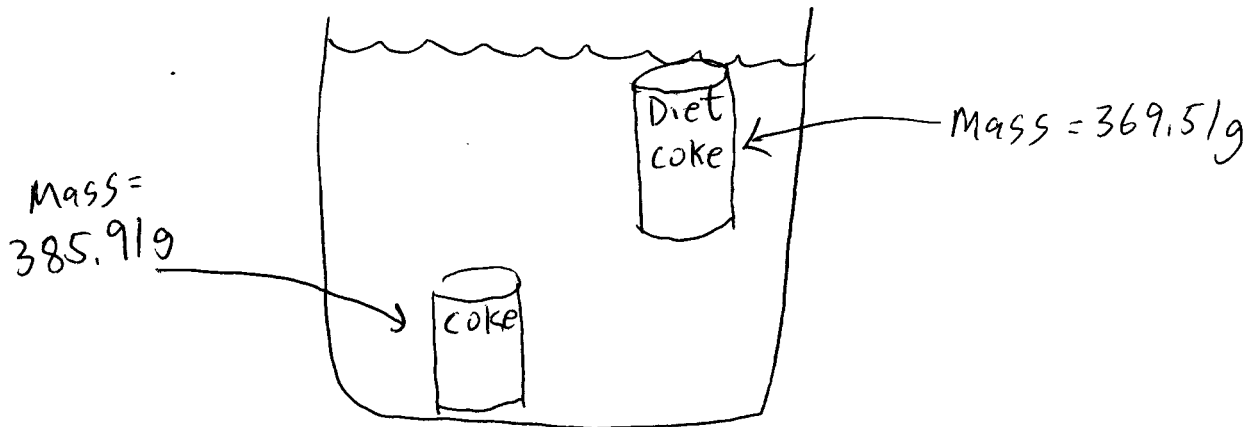# CHEMISTRY LECTURE #2: WHAT IS DENSITY?
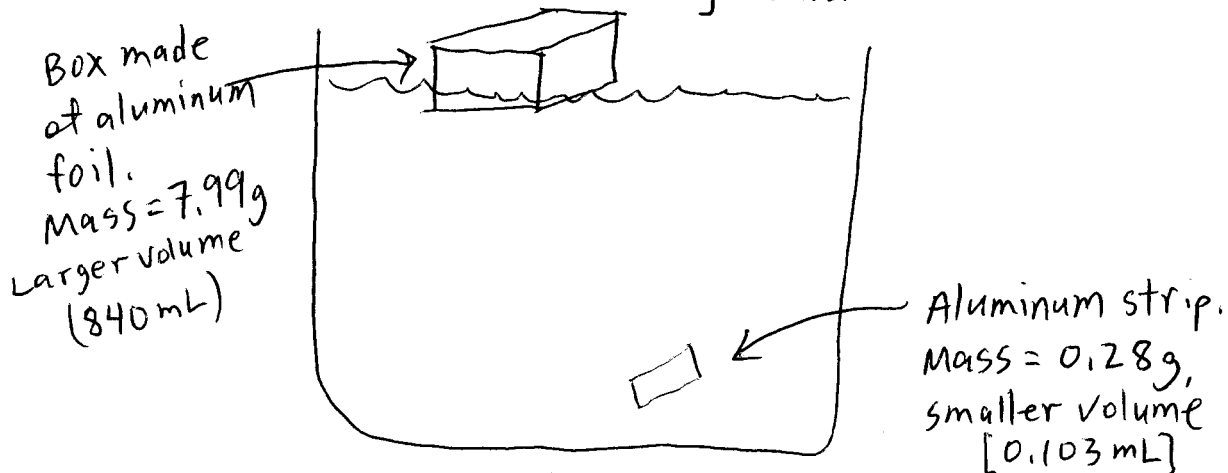
Toss a can of Coke into water and it sinks. Toss a can of Diet Coke into water and it floats. Why does this occur?

Mass = 369.51 g

Mass = 385.91 g

The regular can of Coke has a mass of 385.91 g, while the Diet Coke has a mass of 369.51 g. One can is heavier than the other, so it seems that the mass of the can has something to do with whether it floats or sinks.

If I take a tiny strip of aluminum foil and put it into the water, it sinks. This strip has a mass of 0.28 g.

But if I take two large sheets of aluminum, fold them and turn them into a box, the box floats on the water. The mass of the box is 7.99 g. This aluminum box is heavier than the strip, yet it floats while the lighter strip sinks. So mass is not the sole determinant of whether something floats.

Box made of aluminum foil.
Mass = 7.99 g
Larger volume
(840 mL)

Aluminum strip.
Mass = 0.28 g,
Smaller volume
[0.103 mL]

One obvious difference between the box and the strip is that the box has greater volume - it takes up more space. The box has dimensions of about 14 cm x 12 cm x 5 cm, or a volume of 840 mL. The small strip of aluminum has a volume of 0.103 mL.

So it seems that large masses cause objects to sink, but large volumes cause objects to float. If the mass is large but the volume is small, the object will tend to sink. If the mass is small but the volume is large, the object will float.

It's the ratio of mass to volume that determines whether the object floats. This ratio is the *density* of the object.

$$\text{Density} = \frac{\text{mass}}{\text{Volume}} \quad \text{or} \quad d = m/v$$

Mass is measured in grams (g). Volume is measured in milliliters (mL). Sometimes you see cm^3 used instead of mL. Density is measured in g/mL.

The tiny strip of aluminum has a mass of 0.28 g and a volume of 0.103 mL, so its density is 0.28 g/0.103 mL, or 2.7 g/mL

The box (which contains aluminum and air) has a mass of 7.99 g and a volume of 840 mL, so its density is 7.99 g/840 mL, or 0.0095 g/mL.

The strip of aluminum has a greater density than the box (2.7 g/mL compared to 0.0095 g/mL), which is why it sinks while the box floats.

Objects will float in a fluid if they are less dense than the fluid, and sink if they are more dense than the fluid. Thus, the aluminum strip will sink since its density is 2.7 g/mL, while that of water is 1.00 g/mL. And the aluminum box will float since its density of 0.0095 g/mL is less than 1.00 g/mL.

We can use this property of fluid density to show some interesting things. For example, eggs (with a density of 1.08 g/mL) will sink in regular water (which has a density of 1.00 g/mL), but float in salt water, which has a density 1.20 g/mL

And ice, which has a density of 0.93 g/mL, will float in water, but will sink in rubbing alcohol, which has a density of 0.87 g/mL.

regular water density = 1.00g/mL

egg density = 1.08g/mL

egg density = 1.08g/mL

salt water density = 1.20g/mL

ice density = 0.93g/mL

water density = 1.00g/mL

rubbing alcohol density = 0.87g/mL

ice density = 0.93g/mL