Mix and Flow of Matter

Section 3.0 –The Particle Model of Matter can explain the properties of gases and liquids.

3.1 Viscosity and the Effects of Temperature

Fluids can flow. How quickly they can flow is called flow rate. A substance's resistance to flow (how thick or thin it is), or viscosity, affects flow rate. The ***internal resistance*** or friction between the particles of the substance determines the viscosity of that substance.

Ketchup

More Viscous

Soda pop

Less Viscous

The **more friction** - the **more viscous** (thicker) a substance is.
The higher the viscosity of a substance, the slower it flows.

The Effect of Temperature on Viscosity

Temperature has an effect on the viscosity of a substance.

When thick syrup is poured over hot pancakes, the syrup becomes thinner and runs over the sides of the pancakes.

When thick oil is added to the engine of a car, the oil thins out when the engine heats up.

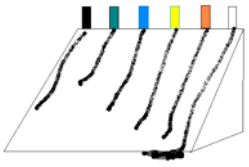
Olive oil is very thin (almost watery). To make it a little thicker it can be placed in the fridge, where it's viscosity can be increased.

Asphalt (road paving) materials are heated up (making them less viscous) so they can be poured easily before it hardens.

Viscosity can be easily measured using the **ramp method.**

Pour different liquids down a ramp and time how long it takes for each of them to get to the bottom.

The one that is the slowest will be the most viscous.



Reminder:

Increasing temperature lowers viscosity (makes it thinner)
Decreasing temperature increases viscosity (making it thicker)

3.2 Density of Fluids

Density is the amount of matter in a given volume. Every substance has a different density, because each substance is made up of different particles. The density of a substance depends on the particles it is made up of. When we talk about density, it's usually mass density we're referring to. The mass density of an object is simply its mass divided by its volume.
Density depends on whether the object is solid, filled with air pockets, or something in between. Substances that have a higher density than the density of the substance it is placed in will sink; substances that have a lower density than the density of the substance it is placed in will float.

Calculating Density
Density is the mass of a substance divided by its volume, which changes as temperature changes.
This is shown in the following equation form:

Density (d) = mass (m) / volume (V)

Density Calculations (Memory Method)
This simple equation will help you figure out how to solve density problems:

$$\frac{M}{dV}$$

Simply cover up whichever value you need to calculate and the other two are shown in their proper placement, be it to multiply or to divide.
For example: cover up the M. This leaves you with d/V (ignore the fact that it is in the denominator). Density times volume will give you mass.
You can also check it out by way of the units: (g / cm^3) x cm^3 cancels out the volume unit leaving grams, the desired unit for mass.

solids: d = grams/cubic centimeters (cm3)
liquids: d = grams/milliliters (mL)

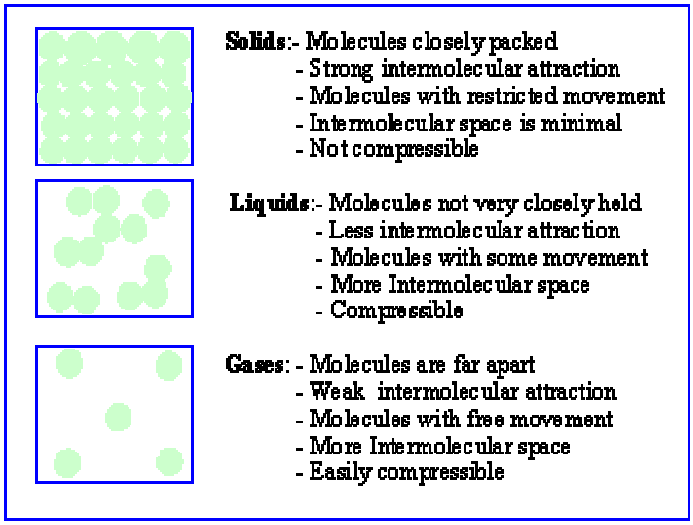
(**Figure 3-4** *Densities of some common substances at 20°* - **SIA p. 43**)

One way to determine the volume of an irregular object is to measure its mass in air and then in water, subtract the second measurement from the first, and divide by the density of water.
Another way to determine the volume of an irregularly shaped object is to submerge the object in a full container of water. The volume of the object equals the volume of water that overflows.
Ships can float because they contain large volume of air. The overall density of the ship is less dense than water, so it floats.

3.3 Density, Temperature and Buoyancy

Viscosity changes with temperature.

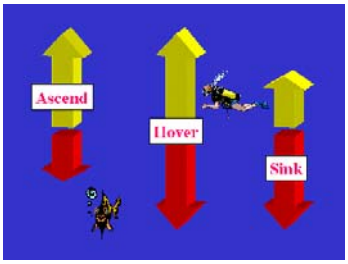
Density does not change as long as the temperature remains the same.
The particle model of matter states that for every substance, the number of particles in a given volume, remain constant, if the temperature is kept constant. As energy is added, the particles move more quickly and further apart, thus increasing the substance's volume. When this happens, the density of the substance (which is the mass to volume ratio) decreases because the mass remains constant, but the volume increases. One substance can have different densities, depending on the state it is in.



Changing Density by Changing Concentration

Objects that are less dense than 1g/ml float in water. The **Dead Sea** is one of the saltiest bodies of water on the Earth. When salt is added to water, there are more particles in a given volume, which increases the density of the water, allowing denser objects to float in the saltwater.

Buoyancy is the tendency of a substance to float. Buoyant objects take up space in a fluid. pushing some of the fluid away or displacing it, causing them to float, because the fluid pushes back against the force of gravity.



When an object is in a liquid, the force of gravity pulls it down. The liquid itself has a force that acts against the force of gravity. This **buoyant force** pushes objects upward. Objects that are denser than water will ***sink*** (**negative buoyancy**); objects that are less dense than water will ***float*** (**positive buoyancy**); objects with the same density as water will ***hover*** (or, be **suspended** - ***(neutral buoyancy)***, neither sinking nor floating.)

Measurement of Buoyancy

Force is a push or a pull on an object, and is measured in Newtons (N).
The upward force of a fluid on an object is called its buoyant force, which is also measured in Newtons.

Calculation of Buoyant Force

Buoyant Force = Weight in Air - Weight in Liquid

Applications of Buoyancy

Buoyancy has important applications in transportation.

Ships are designed to float in all types of water, regardless of the density of the water.

This is possible because of the **Plimsoll Line** - which shows how heavily a ship can be loaded in different water conditions.

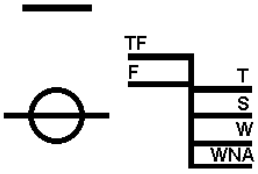


Figure 3.11
(**sia** p.51)

The marks on the left indicate fresh water - while the marks on the right are for saltwater.

Hot Air Balloons –

As the air inside the balloon is heated, it becomes less dense than the surrounding air. The buoyant force of the air will push the hot air balloon upwards, until the buoyant force equals the force of gravity.