Viscosity

- Viscosity is a liquid's thickness, or resistance to flow.
- Flow rate is a measure of a liquid's viscosity. The flow rate of a fluid is measured in ml/s (milliliters per second)
- By measuring the flow rate, we are able to compare the viscosity of different fluids.
- The thicker the fluid, the slower it flows and the more viscous it is.
- Viscosity of fluids is a significant factor in many industries (e.g. car industry- motor oils, food industry- sauces)

Changing Viscosity

- Temperature affects the viscosity of a fluid
  - Increasing the temperature of a fluid will lower its viscosity.
  - Lowering the temperature of a fluid will increase its viscosity

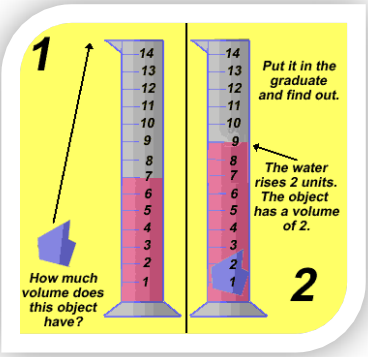
Practical application: to remove bubble gum from a shoe or carpet, lower the temperature, by using an ice cube, to make the bubble gum more viscous, then it will be easier to remove)

Density

- The density of an object is its mass divided by its volume. $D = \frac{m}{v}$

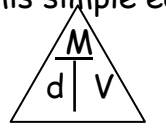
  *Note the difference in units in the formulas of the density of a solid and liquid. solids: d = grams/cubic centimeters liquids: d = grams/milliliters

- If you cannot calculate volume using a formula, 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, (ie. that it displaces)



<u>Density Calculations (Memory Method)</u>

This simple equation will help you figure out how to solve density problems:



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 dV (density x volume). Density times volume will give you mass.

What does density depend on?

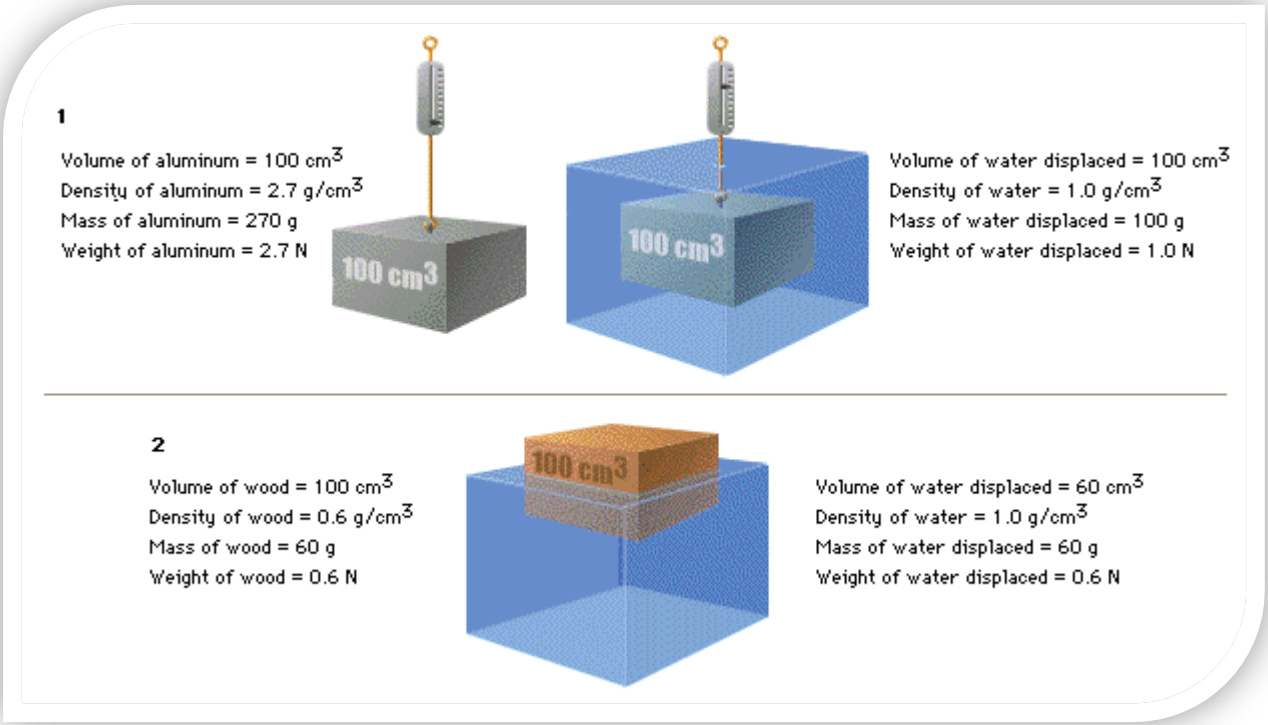
- Density depends on the weight of the individual atoms and molecules making up the object, and how much space there is between them.
- Density also depends on whether the object is solid, filled with airpockets, or something in between.
- Density changes as temperature changes.

A hydrometer is a device that uses buoyancy to measure density

- A liquid can exert a buoyant force making objects (solids, liquids or gases) float
- Density depends, in part, on the concentration of the solution (how much solute is dissolved in a certain solvent); the more concentrated the solution. the more dense it is (think about our saltwater solution vs. freshwater solution)
- Ships can float because they contain large volume of air. The overall density of the ship is less dense than water, so it floats.

Archimedes' Principle

An object that is partly or completely submerged in a fluid will experience a buoyant force equal to the weight of the fluid the object displaces. The buoyant force on an object in a fluid is equal to the weight of the fluid displaced by the object



Pressure

Pressure is the force experienced by an object divided by the area of the surface on which the force acts. The force is acting perpendicular to the surface.

$$P = \frac{F}{A}$$

The unit for pressure is the pascal, Pa. or N/m^2

When we say atmospheric pressure, we're describing the pressure exerted by the weight of the air above us. The air goes up a long way, so even though it has a low density it still exerts a lot of pressure.

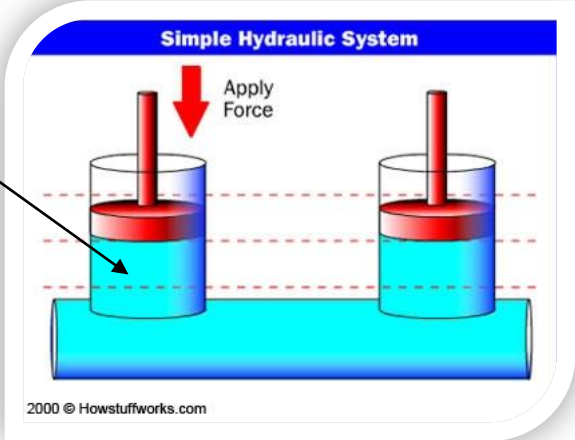
Compressibility

- The ability to decrease the volume when pressure is applied.
- Gases are highly compressible. As pressure increases, the volume of the gas decreases.
- Liquids are nearly incompressible. As the pressure on the liquid increases, the volume remains unchanged. Because the particles in a liquid are already almost as close together as they can get, the volume does not change, and the pressure is exerted everywhere on the container's inner surface (this is fluid pressure)

Pascal's Principle

- Pressure applied to an enclosed fluid is transmitted undiminished to every part of the fluid, as well as to the walls of the container. Pascal's principle can be used to explain how hydraulic systems work. A common example of such a system is the lift used to raise a car off the ground so it can be repaired at a garage.

Force is applied throughout fluid



Hydraulic Systems

Mechanisms that work because of the movement of a liquid, or the force exerted by a liquid within a closed system is called a hydraulic system.

Pneumatic Systems

Mechanisms that work because of the movement of a gas, or the force exerted by a gas within a closed system is called a pneumatic system. The gas must be compressed first in order to apply pressure.