Chemistry – the study of matter

1-28-09

Matter

- Matter – Anything that has mass and takes up space
- Matter is described by its characteristics or properties

Physical Properties of Matter

- Physical Property - A characteristic of matter than can be observed or measured without changing the identity of matter. Determined by the use of senses
- Color – what color it is
- Odor - smell
- Luster - how shiny an object is
- Malleability - the ability of an object to be beaten into thin sheets (aluminum)
- Ductility - the ability of an object to be made into thin wires (copper)

Physical properties continued…..

- Conductivity - the ability of a substance to conduct electricity or heat
- Hardness – how easily a substance can be scratched
- Boiling Point – when a substance changes from a liquid to a gas
- Density
- Solubility – the ability of a substance to be dissolved in another

Describe the physical properties of the following using the new vocabulary words

- A. Your table
- B. A banana
- C. A piece of aluminum foil

Chemical Properties of matter

- Chemical Property of matter – a characteristic of matter that you have to test to be able to see.
- Flammability – the ability to burn
- Reactivity with oxygen – reacts with oxygen ex: iron reacts with oxygen and produces rust
- Reactivity with water – reacts with water ex: sodium

What are the chemical properties of the following?

- 1. a piece of paper burning
- 2. heating gold
- 3. car rusting

Elements, Compounds and Mixtures

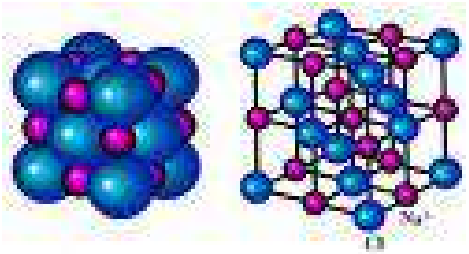
- Atoms – smallest whole unit of matter. Basic particle from which elements are made.
- Elements – pure substances that cannot be broken down further. Made of only 1 type of atom
- Compounds – 2 + elements that are chemically combined in a set ratio. They have different properties than the original elements. Not easily separated.
- Mixtures – 2+ elements or compounds physically combined. The constituents keep their original properties. Easily separated

Types of Solids

The structure of a solid can be either:

Crystalline – made of crystals that are arranged in a regular repeating pattern

Ex: salt, diamond, quartz



or

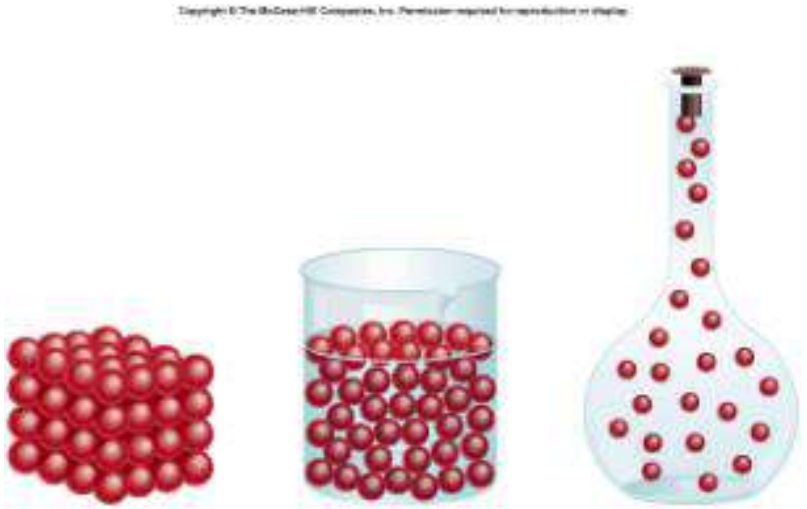
Amorphous – made up of particles that are not in a regular repeating pattern.

Ex: glass, plastics, wax

States of Matter

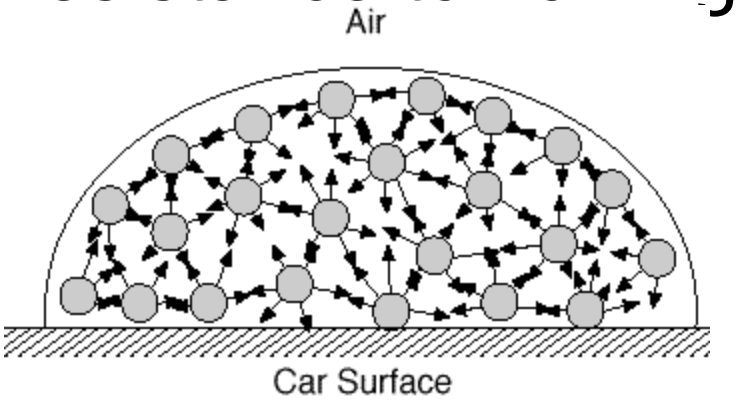
- Solids – Definite shape and definite volume, particles held tightly together & vibrate
- Liquids – No definite shape but definite volume, takes shape of container, and particles move and slide past one another
- Gases – No definite shape and no definite volume, particles excited and move about, will expand to fit container

- Plasmas – ionized gas (containing free ions and electrons)



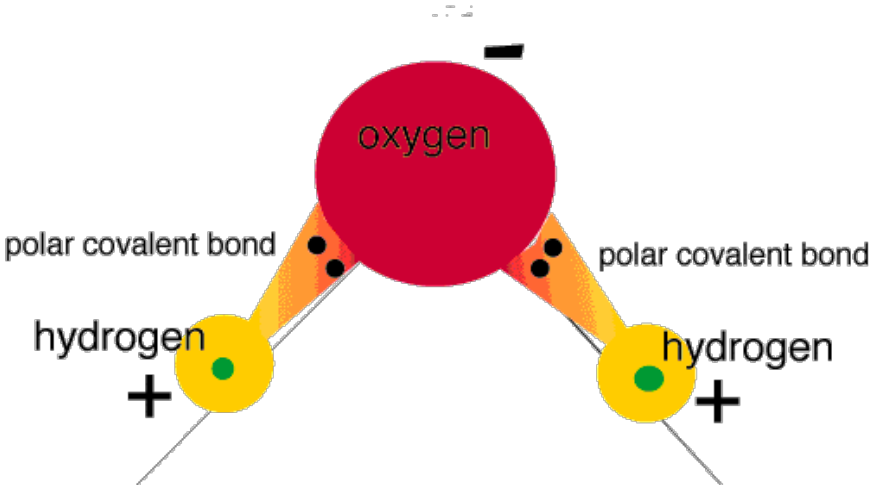
Properties of a liquid

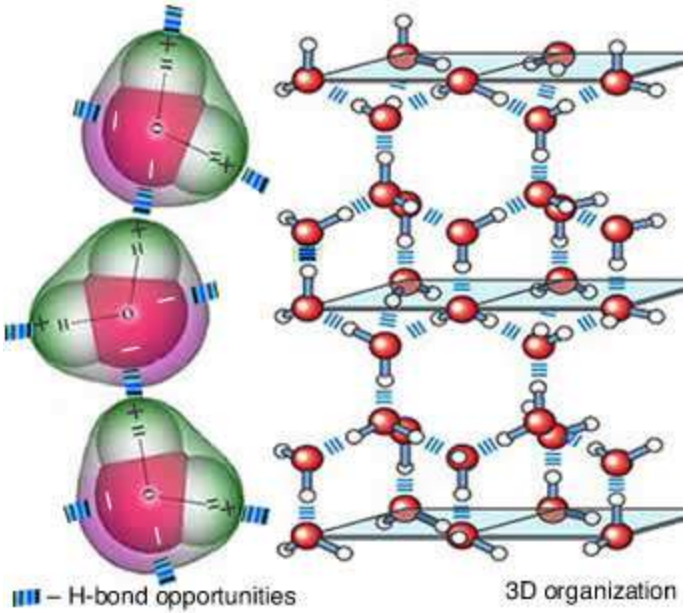
- Surface Tension – The result of the inward pull of molecules that brings the molecules on the surface together
- Viscosity – a liquid's resistance to flowing

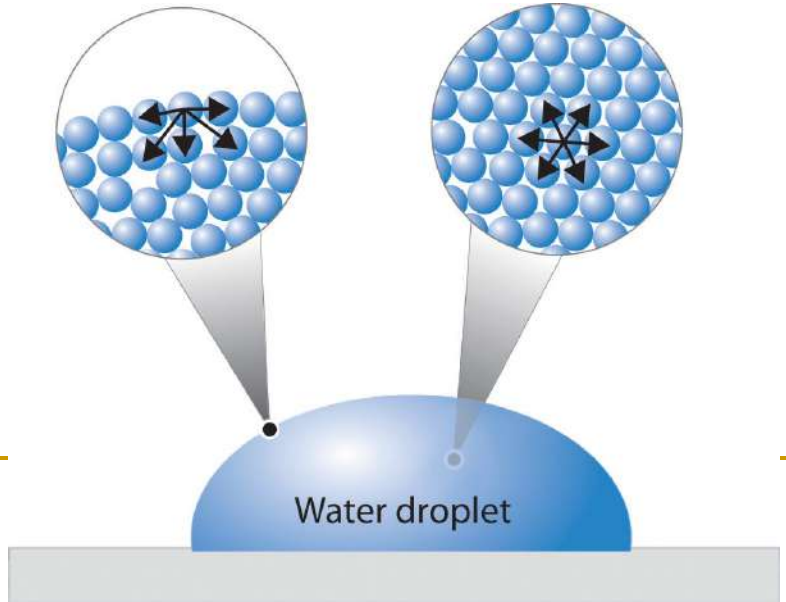


Molecules inside a water drop are attracted in all directions. Drops on the surface are attracted to the sides and inward.

Water is polar!



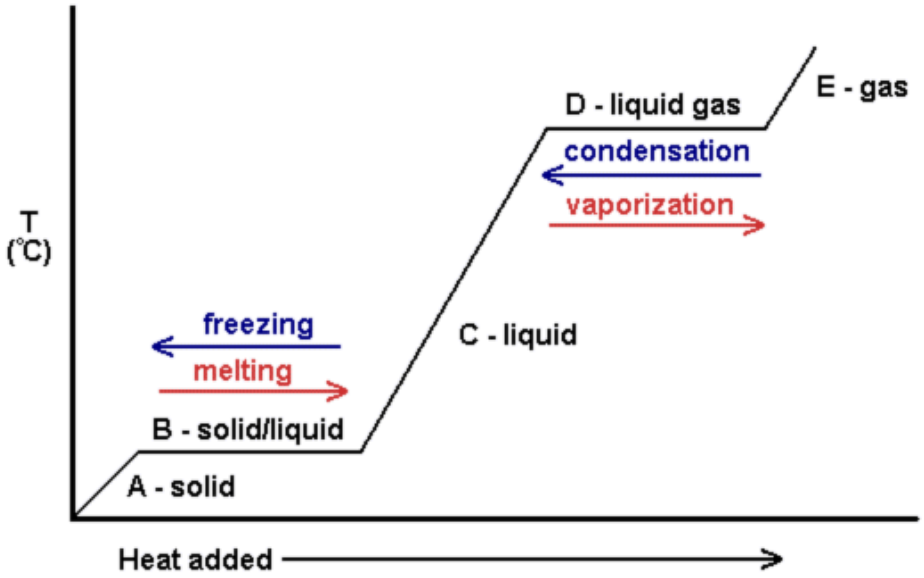




Questions

- What are some examples of solids, liquids and gases?
- Can you think of an example that does not fit the definition of a solid liquid or gas?
- What is the most common state of matter in the universe?

Phase Change Diagram



- Heat of fusion – the amount of heat needed to cause a change in state from a solid to a liquid → 334 kJ/kg for water
- Heat of vaporization – the amount of heat needed to cause a change in state from a liquid to a gas
  → 2260 kJ/kg for water

Phase changes

- Endothermic Processes (heat taken in)
- Solid → Liquid : Melting
- Liquid → Gas : Vaporization
- Solid → Gas : Sublimation

- Exothermic Processes (heat going out)
- Gas → Liquid : Condensation
- Liquid → Solid : Freezing
- Gas →Solid : Deposition

Phase Changes

- Phase changes are about changing the energy of matter, either adding it or taking it away.
- Temperature is really a measurement of the kinetic energy of molecules

Specific Heat

- The amount of heat (energy) required to raise the temperature of 1 gram of a substance by 1 degree Celsius.
- Energy = $Q = (m)(T_f - T_i)(cp)$
- where Q is the energy in joules
  m is the mass in grams
- T is the change in the temperature

Gas Laws - Questions

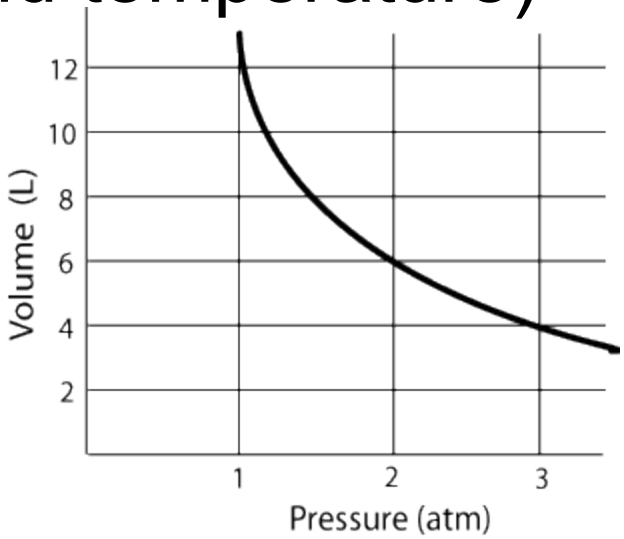
- What happens to a gas when it is cooled down? Warmed up? Examples?
- What happens to a gas when pressure is exerted on it? Examples?

Gas Laws

- Gases exert pressure
- When a gas molecule collides with the wall of a container, it exerts a force on the container. It is the force of collision and the number of collisions with the walls of a container that cause gas pressure
- Ex: Think deflated and inflated basketball

Boyles Law

- Increasing the pressure on a gas will decrease it's volume
- Boyle's Law $P_1V_1 = P_2V_2$ (at a constant mass and temperature)



Gas pressure in force per unit area

- Pressure is measured in mm of mercury (Hg), standard atmospheric pressure (atm) or pounds per square inch (psi)
- At sea level we have 760mm Hg of pressure, or 1 atm, or 14.7 psi

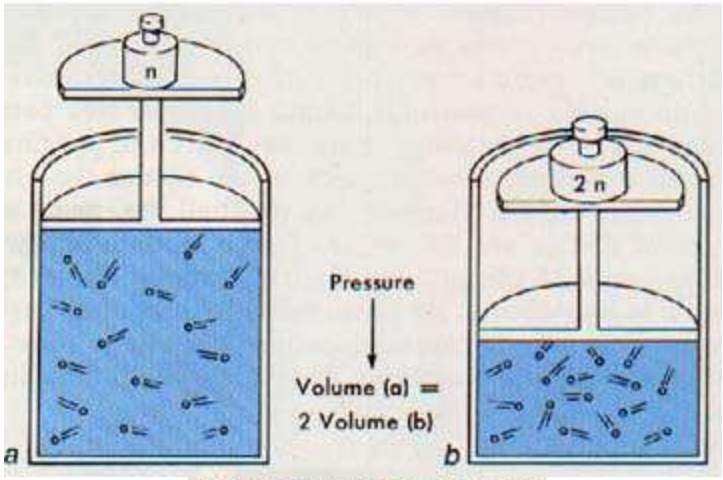


FIGURE 15-2. If the volume of a gas is halved, the number of collisions with the walls of the container doubles. Thus, the pressure in container (b) is twice that of container (a).

Boyle's Law practice

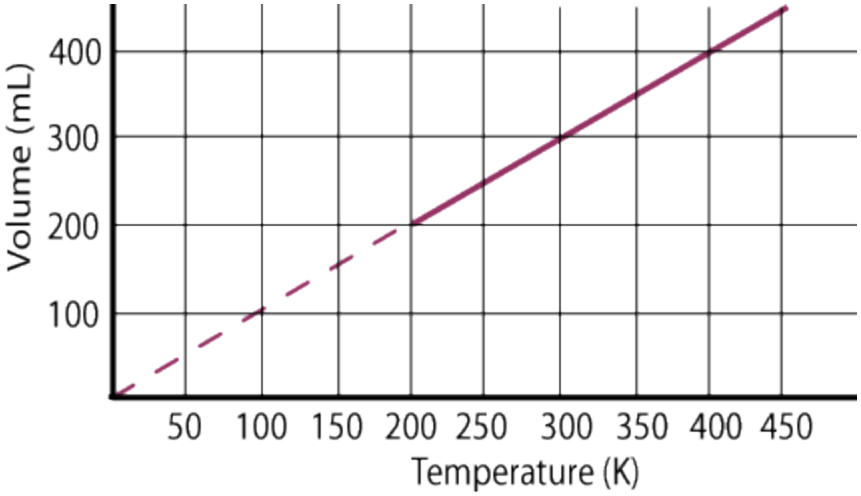
- A gas has a volume of 5L at a 760 mm Hg pressure. What is the new volume of gas if the pressure was increased to 800mm Hg?
- P1V1 = P2V2
- Solve for V2 = $\frac{P1V1}{P2}$

$$= \frac{5L \times 760mm\ Hg}{800mm\ Hg} = 4.75L$$

Charles Law

- A gas will increase in volume with an increase in temperature, because of an increase in kinetic energy of molecules
- Ex: Hot air balloon
- $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

- Temperature is in Kelvin.
- $-273C^o = 0K$



Charles Law Practice

- A gas is at a temperature of 273 K and has a volume of 3L. The gas is being cooled down to a temperature of 173K. What is the new volume of the gas?
- $\frac{V1}{T1} = \frac{V2}{T2}$

$$V2 = \frac{V1 \times T2}{T1}$$

$$= \frac{3L \times 173K}{273\ K} = 1.90L$$