**Chemistry Concepts**  Name:

**Chapter 10:** States of Matter

10-1: The Kinetic-Molecular Theory of Matter

**Ideal gas** - hypothetical gas that perfectly fits all the assumptions of the

**The Kinetic-Molecular Theory of Gases**

1. Gases consist of large numbers of tiny particles that are far
2. Collisions between gas particles and between particles and container walls are elastic collisions.
   * **Elastic collision** - no net loss of total
3. Gas particles are in continuous, rapid,
4. There are no forces of attraction between gas particles.
5. The temperature of a gas depends on the of the particles of the gas.

* All gases at the same temperature have the same average kinetic energy.
* At the same temperature, lighter gas particles, have than do heavier gas particles.
* Many gases behave nearly ideally if pressure is not very high and temperature is not very low.

**Nature of Gases**

1. Expansion
2. Fluidity
3. Low Density
4. Compressibility
5. Diffusion
6. Effusion

**Real gas** - does not behave completely according to the assumptions of the kinetic-molecular theory.

* The more the molecules of a gas are, the more the gas will deviate from ideal gas behavior.

10-2: Liquids

**Properties of Liquids**

1. **Fluid** - substance that can flow and therefore take the shape
2. Relatively **High Density**
3. Relative **Incompressibility**
4. Ability to **Diffuse**
   * The attractive forces between the particles of a liquid
   * As the temperature of a liquid is increased, diffusion occurs more rapidly.
5. - force that tends to pull adjacent parts of a liquid’s surface together
   * The higher the force of attraction between the particles of a liquid, the higher the surface tension.
6. **Capillary action** - attraction of the surface of a liquid to the
7. **Vaporization** - process by which a liquid or solid changes to a gas
8. **Evaporation** - process by which particles escape from the surface of a and enter the gas state.
9. **Boiling**- change of a liquid to bubbles of vapor that appear throughout the liquid.
10. - physical change of a liquid to a solid by removal of energy as heat

10-3: Solids

1. **Crystalline solids** – most common, *consist of*
2. **Crystal** - substance in which the particles are arranged in an
3. **solid** - particles are arranged randomly.

**Properties of Solids**

1. Definite **Shape** and **Volume**
2. Definite **Melting Point** –
   * Amorphous solids have no definite melting point.
     + example:
   * **Supercooled liquids** –another term for
3. **High Density** – usually most dense state
4. Basically
5. Low rate of **diffusion**

**Crystalline Solids**

* Crystalline solids exist either as single crystals or as groups of crystals fused together.
* **Crystal structure** - three-dimensional arrangement of particles of a crystal

10-4: Change of State

**Changes of State and Equilibrium**

* - any part of a system that has uniform composition and properties.
* **Condensation** - process by which a gas
* **Vapor**- gas in contact with its liquid or solid phase.
* - dynamic condition in which two opposing changes occur at equal rates in a closed system.
* **Equilibrium vapor pressure** - pressure exerted by a vapor in equilibrium with its corresponding liquid at a given temperature
* The equilibrium vapor pressure increases with
  + Increasing the temperature of a liquid increases the average kinetic energy of the liquid’s molecules.
* **Volatile liquids** - liquids that
  + They have relatively weak forces of attraction between their particles.
  + example: ether
* - conversion of a liquid to a vapor within the liquid as well as at its surface.
* **Boiling point** - temperature at which the equilibrium vapor pressure of the liquid equals the atmospheric pressure.
  + The lower the atmospheric pressure is, the lower the
* **Molar enthalpy of vaporization** (*∆Hv*) *-* amount of energy as heat that is needed to vaporize one mole of liquid at the liquid’s
* **Molar enthalpy of fusion** (∆*Hf*) - amount of energy as heat required to melt one mole of solid at the solid’s melting point
* **Sublimation** - change of state from a
* - change of state from a gas directly to a solid

**Phase Diagrams**

* **Phase diagram** - graph of that shows the conditions under which the phases of a substance exist.
* - indicates the temperature and pressure conditions at which the solid, liquid, and vapor of the substance can coexist at equilibrium.
* **Critical point** - indicates the critical
* **Critical temperature** (*tc*) - temperature above which the substance cannot exist in the liquid state.
  + Above this temperature, water cannot be , no matter how much pressure is applied.
* **Critical pressure** (*Pc* ) - lowest pressure at which the substance can exist as a liquid at the critical temperature.

10-5: Water

Physical Properties of Water

* At room temperature, pure liquid water is transparent, odorless,
* The molar enthalpy of fusion of ice is relatively large compared with the molar enthalpy of fusion of other solids.
* Water , because its molecules form an open rigid structure.
  + This lower density explains why ice
* (vaporized water) stores a great deal of energy as heat.

**Sample Problem A**

* How much energy is absorbed when 47.0 g of ice melts at STP?
* How much energy is absorbed when this same mass of liquid water boils?