UNIT NINE: Chapter 12 ~ Liquids and Solids

Liquids

- Less common than _____.
    - A substance in the liquid state can exist only within a relatively narrow range of _____ and _____.

Liquids & Kinetic Molecular Theory

- Liquids have _____ and _____ of its container.
- KMT can be applied to liquids considering _____ _____ _____.
- Particles of liquids are in _____ motion.
    - _____ together than those of _____
    - Have _____ KE than particles of gases
    - Attractive forces are _____ between liquid particles than gas particles
    - Liquids are _____

- Particles are not bound together in fixed positions; they have

  _____ and are therefore referred to as _____.

  - A fluid is substance that can _____and therefore take the shape of its container.
  - Most liquids naturally flow _____ because of _____.

Viscosity

- Can be defined as the _____

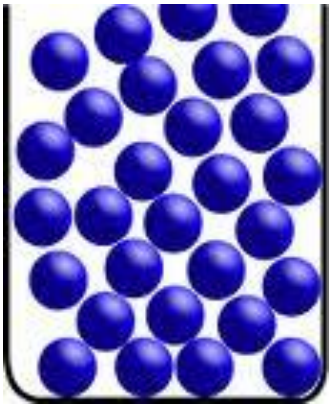
  _____.

  - Due to _____
- _____ property
  - _____ substances have _____ viscosities

Properties of Liquids

- Relatively _____
  - Most substances are _____ of times more dense as _____ than as _____.
  - Most substances are only slightly _____ as _____ than as _____.
  - **Exception:** _____ is less dense when it solidifies.

- Relative _____



  - Liquids are much less compressible than gases because

    _____

    _____.

- Ability to _____

  - Any liquid gradually diffuses throughout any other liquid in which it can dissolve due to the _____

    _____ of particles.

  - Diffusion occurs much _____ in liquids than in gases because liquid particles are much _____ together.

    - _____ between the particles slow movement.
    - If the _____ of the liquids are

      _____, _____ will occur more

      _____.

- _____
  - Can be defined as a _____ that tends to pull adjacent parts of a liquid's surface together, thereby _____ surface area to the smallest possible size.
    - Results from the _____ between the particles of a liquid.
  - Ex. _____ consists of _____ bonds

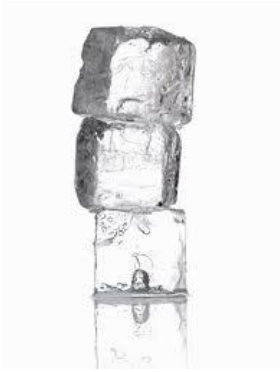
    - _____ forces = _____ surface tension
    - Results in _____.
  - _____**:** the _____ of the surface of a _____ to the surface of a _____**.**

    - Because of capillary action, a liquid will _____ _____ in a narrow tube if a strong attraction exists between the liquid molecules and the molecules that make up the surface of the tube.

- _____ and _____

  - _____: liquid to gaseous state
    - Occurs _____ the boiling point.
  - _____: a form of vaporization; liquid to gaseous state

    - Occurs _____ the boiling point.
- _____



  - When a liquid is _____, the average _____ of the particles _____.
    - If the _____, the particles are pulled into an even more _____ arrangement.
  - _____**:** the physical change of a liquid to a solid by removal of heat

Solids

- Have _____ and _____.
- Have enough kinetic energy (KE) to _____, but not to move out of position.

Solids & Kinetic Molecular Theory

- Particles of solids are more _____ packed than those of _____.
    - The _____ in solids are much more effective in solids than in liquids and gases.
        - Solids are _____ ordered.

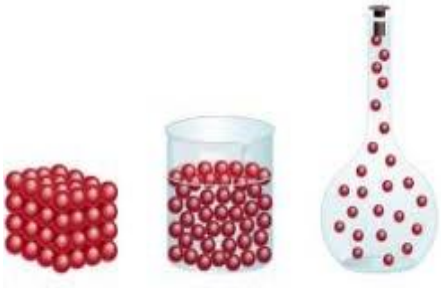
Properties of Solids

- _____ and _____
    - Solids maintain a _____ a container.
    - Volume of solids change _____ with change in temperature or pressure.
        - Because the particles are packed very tightly/closely together with _____.
- _____
    - _____**:** the physical change of a solid to a liquid by the addition of heat

- _____: the temperature at which a solid becomes a liquid
- _____: substances that retain certain liquid properties even at a temperature at which they appear to be solids

- _____ and _____
  - In general, substances are _____ in the solid state.
    - _____ dense than _____
    - _____ dense than _____
  - Particles of solids are so _____ together that they can be considered _____.
    - Very little _____.

- _____
  - Diffusion does occur in solids, _____ it occurs _____ of times slower than in liquids.



Types of Solids

- _____ Solids
    - Most solids are _____ solids, meaning they contain _____ (either single crystals or groups of crystals fused together).
        - _____: a substance in which the particles are arranged in an orderly, geometric, repeating pattern.
    - _____**:** the total three-dimensional arrangement of particles of a crystal
        - _____**:** lattice
    - _____**:** the smallest portion of a crystal lattice that shows the 3D pattern of the entire lattice
    - Types of _____ – classified by scientists according to the shape of the crystals

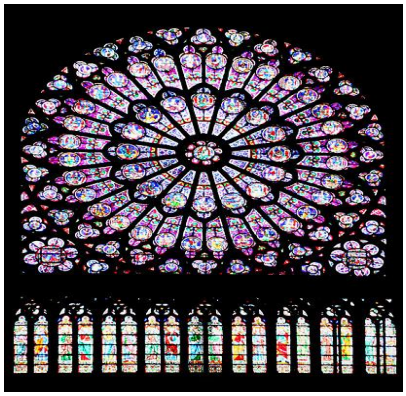
Basic Crystal Structures

- 1. _____ – 3 axes (same length for each and all at 90° angles)
    - ex. Salt, fluorite
- 2. _____– 3 axes (2 are same length, all 90° angles)
    - ex. Tin, zircon
- 3._____– 3 axes (all different lengths, all 90° angles)
    - ex. Sulfur, topaz
- 4. _____– 3 axes (different lengths, 2 have 90° angles)
    - ex. Manganese, gypsum
- 5._____ – 3 axes (all different lengths, all different angles)
    - ex. Turquoise
- 6. _____– 4 axes, 3 in the same plane
    - ex. Graphite, corundum

Types of Solids

- _____ solids
- _____ comes from Greek meaning

  "_____ _____"



- These solids are ones whose particles are arranged _____
    - They do not have _____

      _____.
    - _____ their shape for a long time
        - Flow _____ slowly
    - Ex. Glass and plastic

Changes in State

Freezing and Melting

- _____
    - _____
    - _____ of heat energy
    - _____ in order of the particles

- _____
    - _____
    - _____ of heat energy
    - _____ in order of the particles

Evaporation and Vaporization

- _____
  - _____
  - At temperatures _____
- _____
  - _____
  - At the _____

Condensation

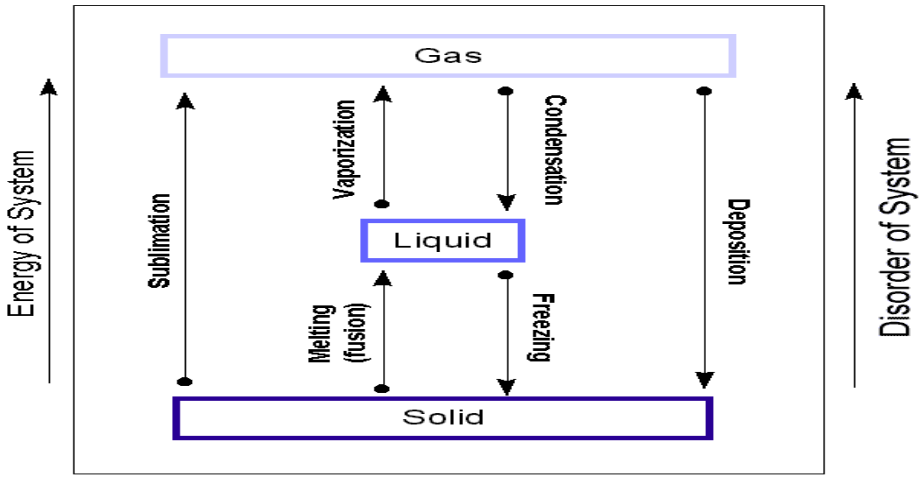
- _____
  - Ex. Water vapor condensing on cold glass

Sublimation and Deposition

- _____
  - _____
    - ❖ _____ going through the _____ state.
      - **Ex.** Ice cubes in freezer shrinking

- _____
    - _____
        - ❖ _____ going through the _____ state.
            - **Ex.** Water vapor → ice

State Change Summary



State Changes and Heat

- Changes in state occur when _____

  _____

  _____.

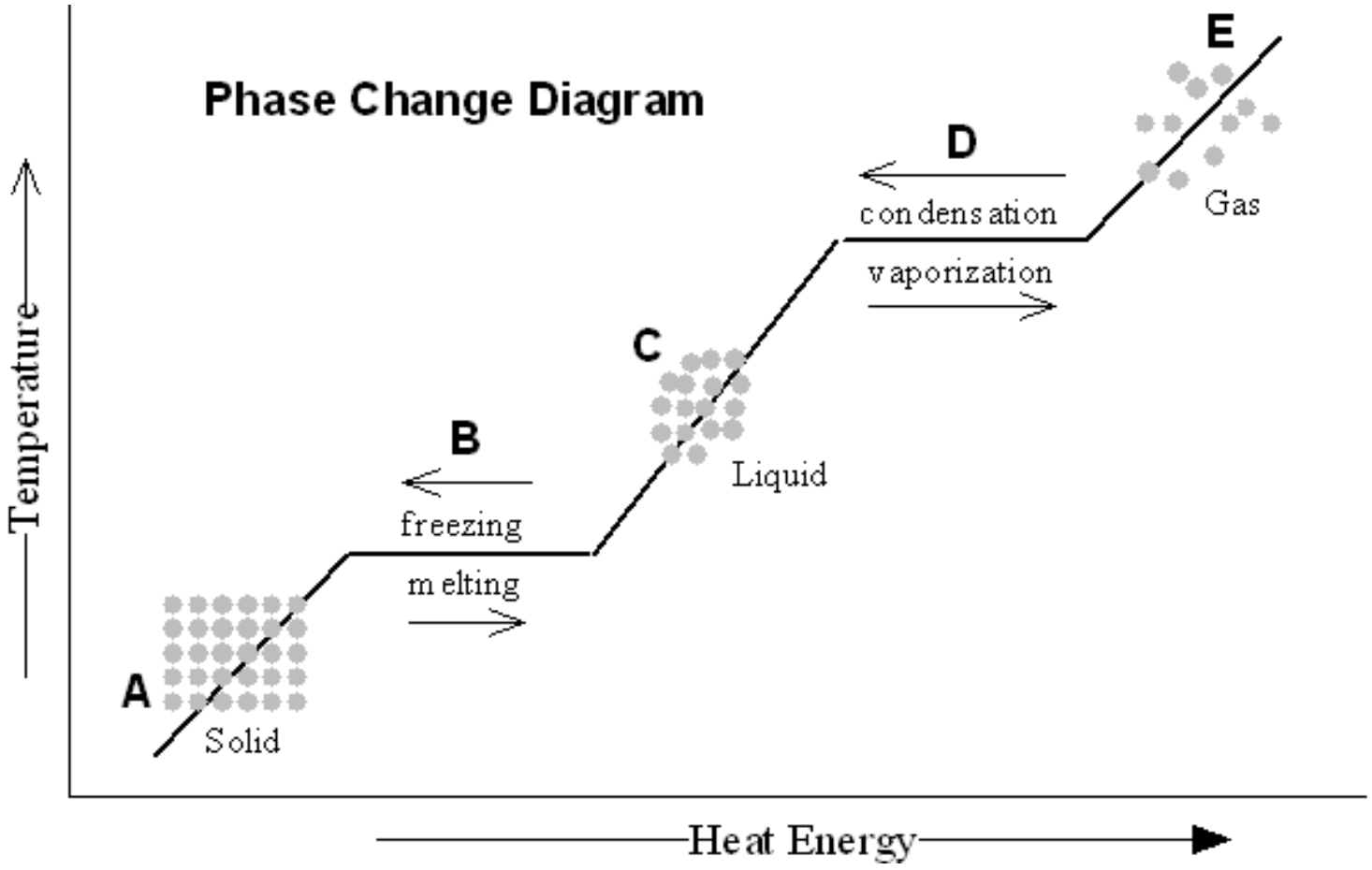
- Melting point and freezing are the _____ temperature.

- Boiling point and condensation point are the _____ temperature.

- Which way the substance goes depends on whether _____

  _____.

Phase Change Diagram



Molar Heat of _____

- The amount of heat energy required _____

  _____.

  - Adding heat energy _____ the _____ of the substance

    and _____ the _____ of the particles.

- _____ is a measure of the _____ between the particles of the solid.
    - ❖ Ex. The heat of fusion for water is 334 kJ/kg.
        - It takes 334 kJ of energy to melt 1 kg of ice _____ changing its temperature.

Molar Heat of _____

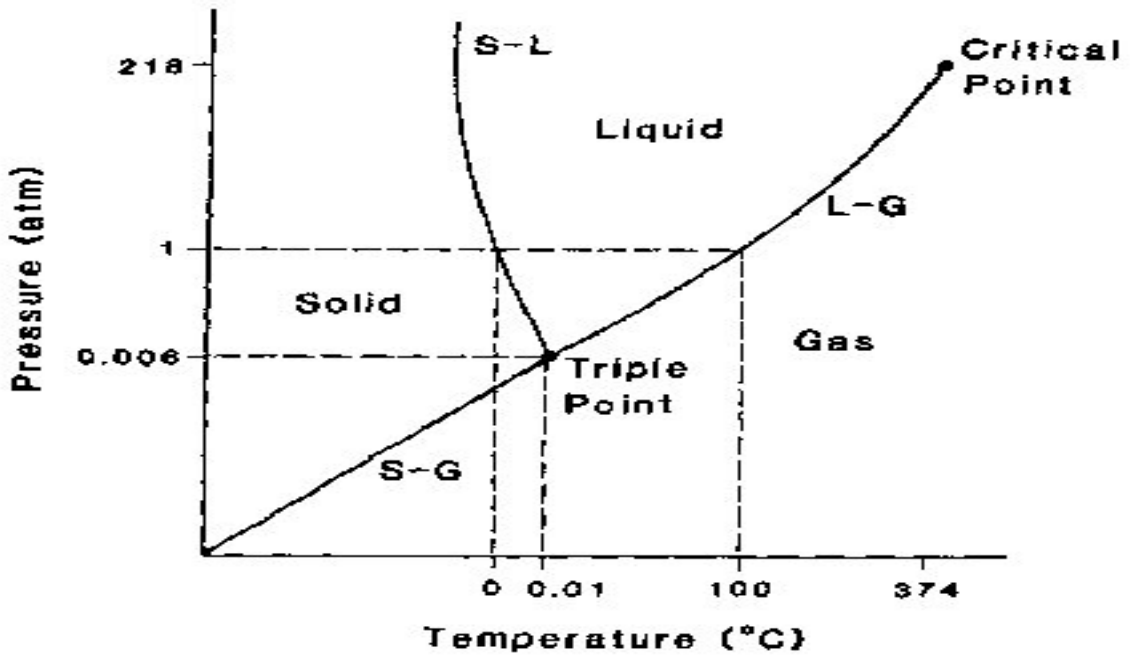
- The amount of heat energy needed _____ _____.
    - _____ is a measure of the _____ between the particles of the liquid.
        - ❖ _____ attraction means _____ energy will be required to overcome it so the molar heat of vaporization will be _____.
    - Heat of vaporization for water is 2260 kJ/kg.

Phase Diagrams

- A graph _____ _____ _____.

- _____: indicates the _____ and _____ conditions at which the solid, liquid, and vapor of the substance can _____ at equilibrium.
- _____: indicates the critical temperature and critical pressure.
- _____ (t_c): the temperature above which a substance _____ exist in the _____ state.
- _____ (p_c): the lowest pressure at which the substance _____ exist as a _____ at the critical temperature

- **Phase Diagrams**



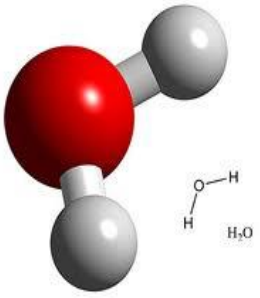
Water

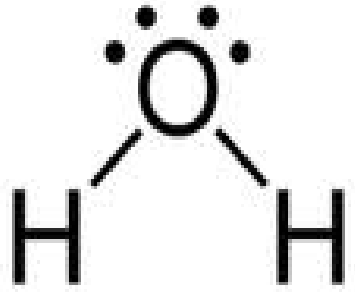
Facts about Water

- Water can exist in _____: solid, liquid, and gas.
- On Earth, water is the _____ liquid
    - Making up about _____ of the Earth's surface
    - Though a significant amount of this water is _____

      _____.
- Water is an _____ of all organisms.
    - _____ of the mass of living things is water.

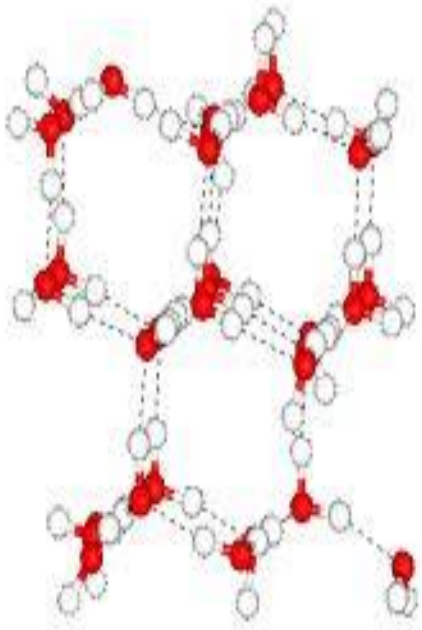
Structure of Water



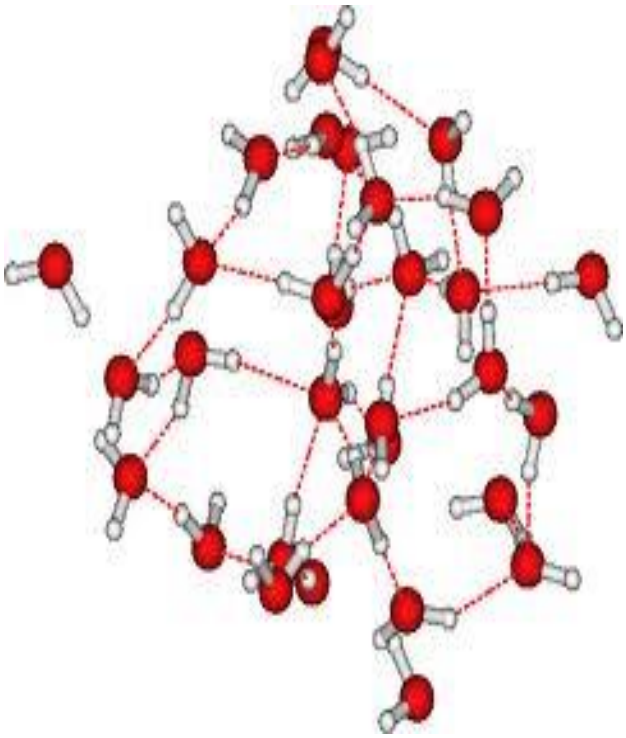


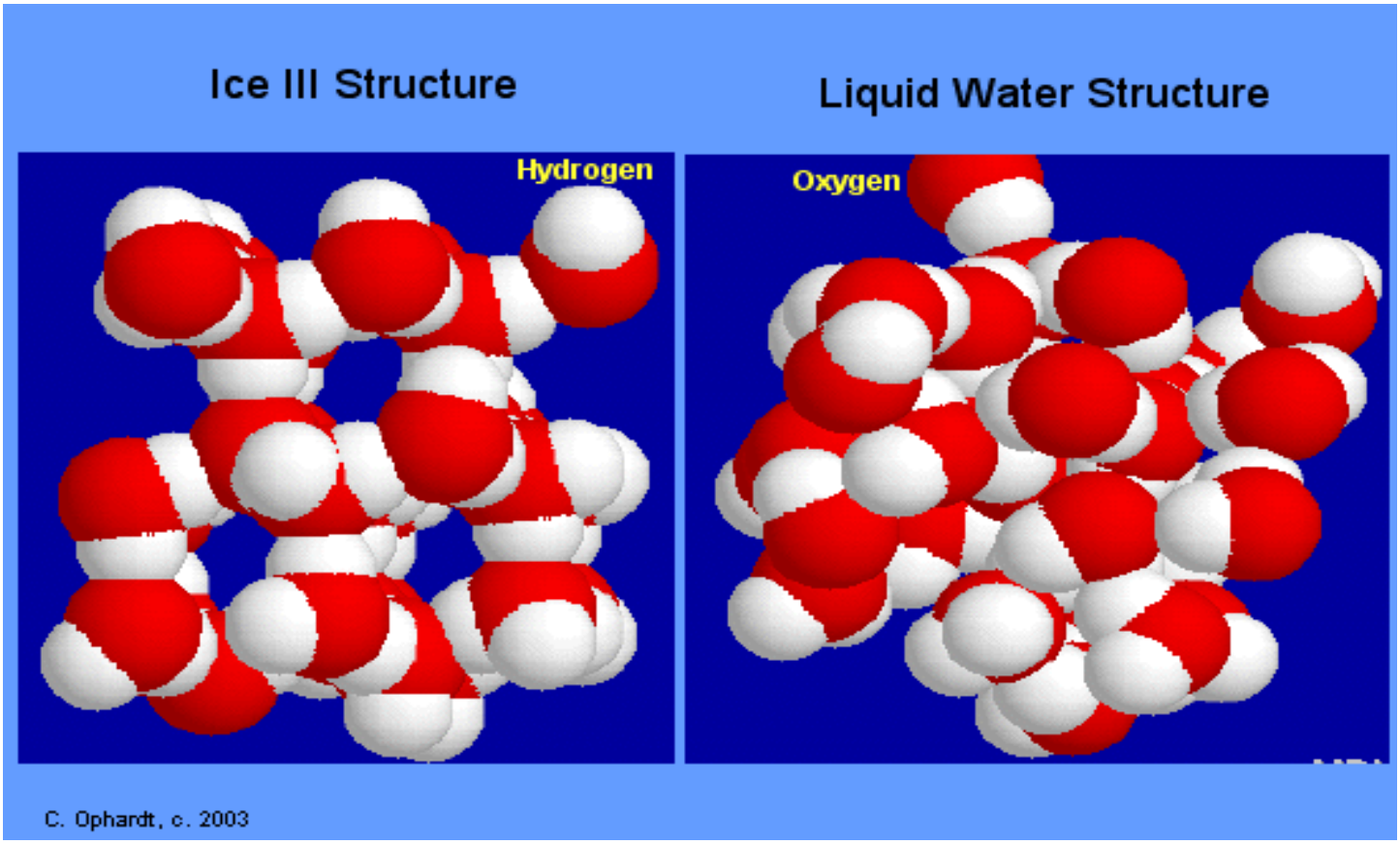
- _____ bond
- _____ structure
- Bond angles are _____
- The molecules in solid or liquid water are linked by _____.
- Usually from _____ molecules per group in liquid water.

- Solid



- Liquid





Ice

- Consists of water molecules in the _____ arrangement.
    - _____ account for the relatively _____ of ice.
- As the ice is heated, the _____ energy of the molecules causes them to move and _____ vigorously.
    - When the melting point is reached, the energy of the molecules is so _____ that the rigid open structure of the ice crystals _____, and ice turns into liquid water.

Liquid Water

- As the temperature is _____, water molecules move _____ apart.
    - _____ KE allows them to _____ molecular attractions.
    - Groups of water molecules _____ enough energy to break into _____ molecules.
    - When the temperature reaches the boiling point (100°C) they _____ the liquid state and become _____.

- Hydrogen bonding between water molecules requires a _____ and therefore water has a relatively _____ compared to other liquids.
- Hydrogen bonds between molecules of liquid water at 0°C are _____ and more _____ than those between molecules of ice at the same temperature.
    - Rigid structure of water has _____.
    - Water molecules are able to _____.
    - Liquid water is _____ than ice.
        - _____ dense at _____.

Physical Properties of Water

- At _____, pure liquid water is
    - _____
    - _____*
    - _____*
    - And _____
        - *any observable odor or taste is caused by _____ such as dissolved minerals, liquids, or gases
- _____**:** expanding in volume as it _____

Chapter 13 ~ Solutions: Types of Mixtures

Mixtures

- _____ : a combination of more than one _____

  _____ .

- _____ : the mixing is the same throughout

  - _____ : two or more substances _____

    spread throughout a _____.

    - ❖ Mixture of substances that has the _____

      _____.

      - **Ex.** Sugar & water

        - ✧ _____: that which dissolves
        - ✧ _____: that which does the dissolving

- _____: the mixing is not the same throughout

  - _____: a mixture of very tiny particles of pure substances that are dispersed in another substance but _____.

- ❖ **Ex.** Gelatin, whipped cream, fog, smoke, blood, paint

- _____: a mixture of _____ liquids in which the liquids are _____ throughout one another; a specific type of _____.
  - ❖ **Ex.** Mayonnaise, cream, butter, lotion
- _____: a mixture that looks _____ when stirred or shaken, but _____ into different layers when _____.

  - ❖ **Ex.** muddy H_2O, Italian dressing, oil & water

- Tyndall Effect
  - Colloids appear _____ because individual particles cannot be seen, but they are _____ _____.
  - The scattering of light by colloidal particles dispersed in a transparent medium is known as the _____.

- ❖ **Ex.** Headlight beams are visible on a foggy night

  - Property that can be used to distinguish between _____

    _____.

Solutes

- _____ vs. _____
  - Substances that dissolve in water are _____ according to whether they yield _____ in solutions.
  - _____: a substance that dissolves in water to give a solution that _____ electric current.
    - ❖ Ionic compounds yield _____ that are _____ making an electric current possible.

- **Ex.** NaCl and _____

- **Ex.** Certain _____ compounds –

  $HCl \rightarrow H_3O^+ + Cl^-$

- _____: a substance that dissolves in water to give a solution that _____an electric current.
  - Neutral solute molecules in a solution _____

    _____ an electric current because _____

    _____

    _____.

The Solution Process

Factors Affecting the Rate of Dissolution

- 1. _____
  - Any solid solute in a liquid solvent dissolves because molecules or ions of the solute are

    _____

    _____.

- Dissolution occurs _____ of the solute.
- In general, the more _____ divided a substance is, the _____ the surface area and the _____ it dissolves.

- 2. _____
  - _____ helps to disperse the solute particles and bring _____ into contact with the solute surface.
  - Similar to _____ (#1)

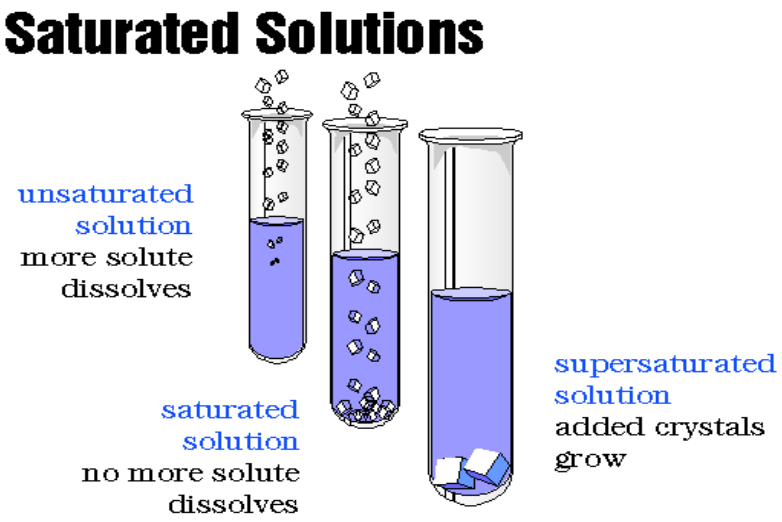
- 3. _____
  - _____ the temperature of the solvent results in the _____ motion of the solvent molecules and the _____ _____.
    - At _____ temperature, the _____ between the solvent molecules and the solute are _____.

Solubility

- _____: capable of being dissolved
- For every solute and solvent combination there is a _____ as to the amount of solute that can _____.
- _____: the physical state in which the opposing processes of dissolution and crystallization of a solute occur _____ _____.

Saturation

- _____: a solution that contains the _____ amount of dissolved solute.
- _____: a solution that contains _____ solute than a saturated solution under the existing conditions.
- _____: a solution that contains _____ dissolved solute than a saturated solution contains under the same conditions.



Solubility Values

- The _____ of a substance is the _____ of that substance required to form a _____ solution with a _____ amount of solvent at a _____ temperature.
    - Varies with _____.
    - For gases, the _____ must also be specified.
- The _____ at which a solid dissolves is _____ to solubility.

Solute-Solvent Interactions

- "_____"
    - Similarities of substances depend on:

        - Type of _____
        - _____
        - Intermolecular _____ between molecules of solute and solvent.

- Dissolving ionic compounds in aqueous solution
    - _____: dissolved in water
    - The attraction between _____ molecules and the _____ is strong enough to draw the ions away from the crystal _____ (solute) and into _____.
        - This process with water as the solvent is called _____.
        - The ions are said to be _____.
    - Some ionic substance form crystals that incorporate water molecules known as _____ .
        - Ex. $CuSO_4 \cdot 5H_2O$
- _____ solvents
    - _____ compounds are _____ generally soluble in _____ solvents.

- The attraction between the ionic solutes and nonpolar solvents is _____ to overcome the intramolecular forces holding the _____ together.

- Liquid solutes and solvents
  - Classified by how they mix:
    - _____: two or more liquids that _____ to dissolve freely into one another
      - They _____ in each other.
    - _____: describes two or more liquids that _____ mix into each other
      - They _____ in each other.

Effects of Temperature and Pressure on Solubility

- Pressure
  - _____ in pressure _____ gas solubilities in _____.
  - Have _____ on the solubilities of liquids or solids in liquid solvents.

- Temperature
    - _____ temperature often _____ the solubility of _____.
    - _____ the temperature usually _____ gas solubility.

Concentration

- The _____ of a solution is a measure of the amount of solute in a given amount of solvent or solution.
- Ways to express the concentrations of solutions:
    - _____

Molarity

- Can be defined as the _____ _____.
    - Must know the molar mass of the _____.

- Examples!
    - 1. What is the molarity of a solution composed of _____ grams of hydrochloric acid, _____, in _____ L of solution?
    - 2. How many moles of potassium iodide, _____, are present in _____ L of a _____ M potassium iodide solution?

- 3. What volume of a _____ M solution of hydrogen bromide, _____, is needed for a reaction that requires _____ grams of hydrogen bromide?

Chapter 14 ~ Compounds in Aqueous Solutions

Dissociation

- The separation of _____ that occurs when an _____ compound dissolves is called _____.
  - **Ex.1:**
  - **Ex.2:**

- **Ex.3:**

- **Ex.4:**

- **Ex.5:**

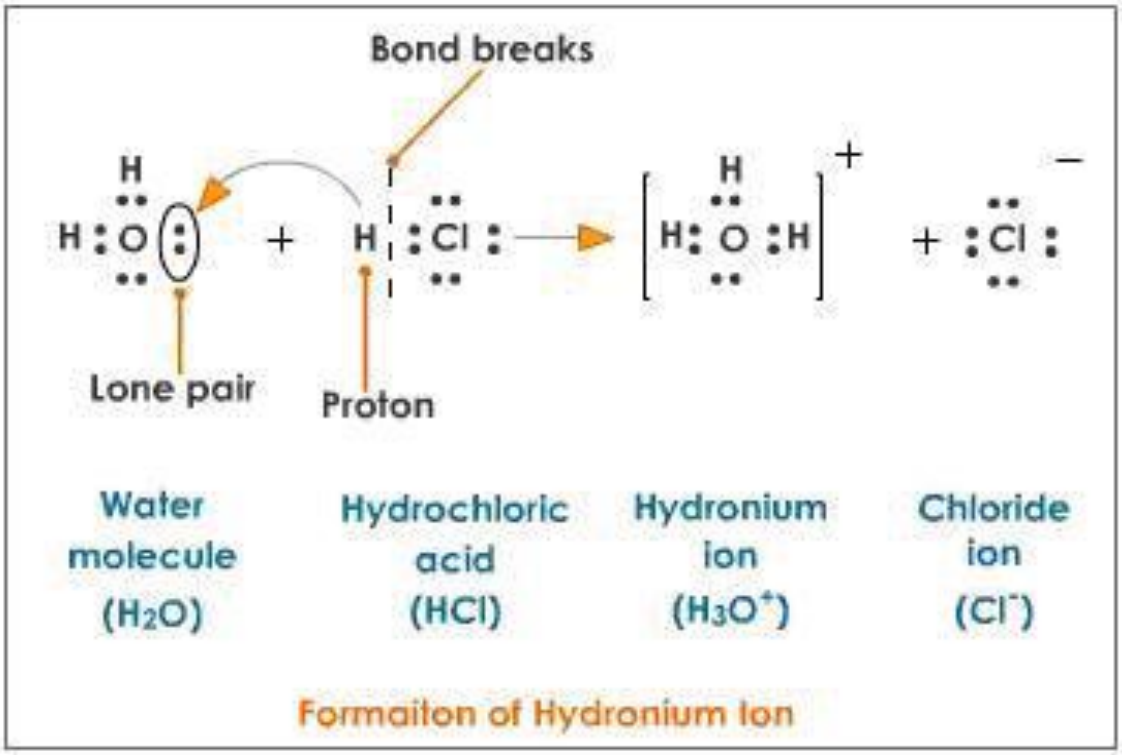
Ionization

- Some _____ compounds can also form _____ in solution.
  - Usually _____ compounds
- Ions are formed from _____ molecules by the action of the _____ in a process called _____.
  - Creation of ions _____.
  - Different than _____.
- The extent to which a _____ ionizes in solution _____ on the _____ of the bonds _____ the molecule

(intramolecular forces) and _____ the solute and solvent (intermolecular forces).

- **Ex.**

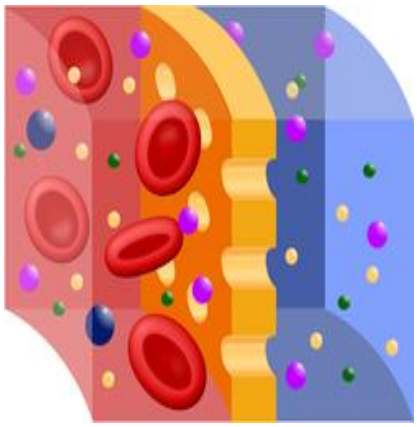
- _____ ion (H_3O^+)
  - H^+ doesn't exist _____
    - A _____ is transferred directly from HCl to a _____ molecule, where it becomes _____ bonded to oxygen.



Strong and Weak Electrolytes

- The _____ with which substances _____ an electric current is _____ to their _____ to form ions in solution.
- _____ electrolytes
    - Any compound of which _____ of the dissolved compound exists as ions in aqueous solution.
        - HCl, HBr, HI, all ionic compounds
    - When strong electrolytes dissolve in water, they yield _____ ions.
- _____ electrolytes
    - A compound of which a relatively _____ of the dissolved compound exists as ions in aqueous solution.
        - **_____ the same as nonelectrolytes where _____ of the dissolved compound exists as ions
        - **Ex.** HF – hydrofluoric acid
- Strength of electrolytes is _____ to the concentration of a solution!

Semipermeable Membranes



- Allow the movement of _____ particles

  while blocking the movement of other particles.

Osmosis

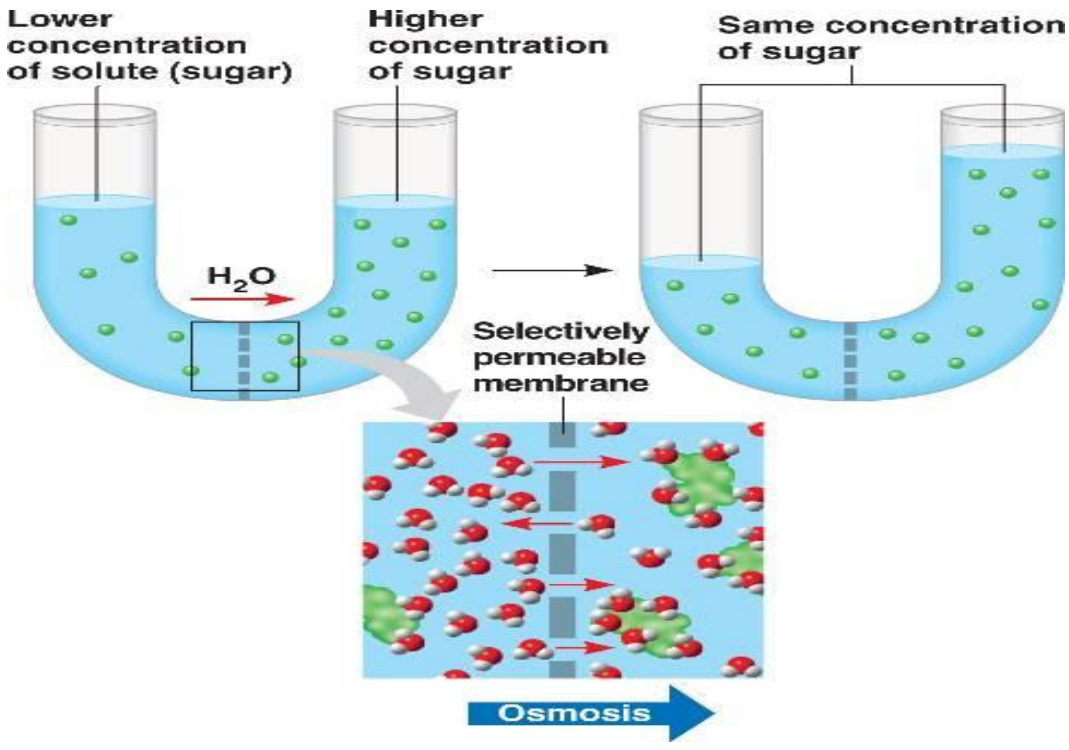
- The _____ of _____ through a semipermeable

  membrane from the side of _____ solute concentration to the side of

  _____ solute concentration.

  - Occurs whenever two solutions of _____ concentrations are

    _____ by a semipermeable membrane.



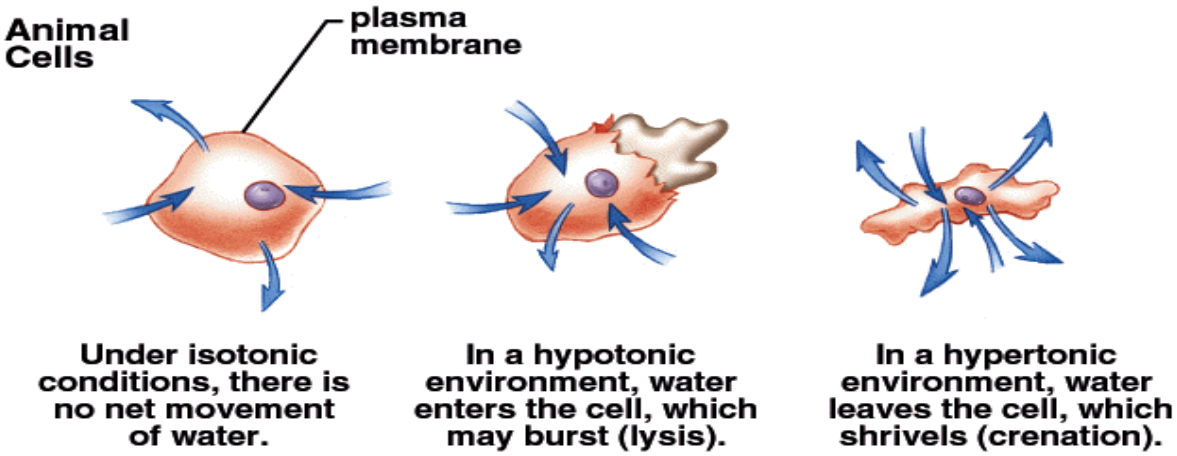
Osmotic Pressure

- The _____ that must be applied to _____ osmosis.
    - _____ on the _____ of solute particles, _____ on the _____ of solute particles.
    - By _____ the concentration of the solution, the osmotic pressure _____ as well.

Osmosis in Our Bodies!

- _____ are semipermeable, so, _____ of osmosis is _____ to cell life.
    - Cells _____ water and _____ when placed in a solution of _____ concentration.
    - Cells _____ water and _____ when placed in a solution of _____ concentration.
    - In _____, cells are _____ from swelling and shrinking by _____ that surround the cells.
        - Blood and lymph are _____ in concentration to the concentration inside the cell.

Osmosis in animal cell



Exam Date: _____

- **Liquids & Solids (Chapter 12)**
  - ✓ Kinetic- Molecular Theory / focus on energy of particles
  - ✓ properties of liquids – density / incompressible / viscosity / surface tension / capillary action
  - ✓ properties of solids – density / incompressible / crystal structures
  - ✓ amorphous solids
  - ✓ changes in state – name of each / define / focus on gain or loss of energy
  - ✓ phase diagram
  - ✓ water chemistry (where / amount /need) / structure / polar / density / ice
- **Solutions (Chapter 13)**
  - ✓ mixtures / types
  - ✓ solutions / types
  - ✓ dissolving process / rates of dissolving
  - ✓ like dissolves like
  - ✓ solubility / saturated / unsaturated / supersaturated
  - ✓ concentration / molarity
- **Ions in Aqueous Solutions (Chapter 14)**
  - ✓ dissociation / ionization
  - ✓ ionic equations for each
  - ✓ electrolytes / nonelectrolytes
  - ✓ semipermeable membrane / osmosis