CH 13 States of Matter

I. Gases

A. Kinetic Molecular Theory of Gases - describes behavior of gases in terms of particle motion

1. gases contain relatively few very small particles and mainly empty space

2. particles in constant motion

a. move in straight lines until they collide with something

b. collisions are elastic - sum of speeds before equals sum of speeds after

3. KE = ½ mv2 = average temp

B. Behavior

1. low density

2. no definite shape or volume (compressible)

3. fluid - can flow

4. diffuses - slowly spreads out to fill its container

5. effuses - escapes from small openings in container

6. Gram's Law - rate of diffusion/effusion for gas is inversely proportional to square root of molar mass

rate A = ex) p 388 #1

rate B

C. Gas Pressure - force per unit area

1. caused by particle collisions with side of container or object

2. air pressure - due to weight of air in atmosphere above you

a. greatest at lower elevations

b. measured with barometer

c. standard pressure at sea level and zero Celsius

1) 1 atm (atmosphere)

2) 101.3 kPa (kilopascals)

3) 760 torr or millibars of mercury

3. Dalton's Law of Partial Pressure - total pressure of sample equals sum pf pressures of all gases in sample

a. Pt = P1 + P2 +….

II. Forces of Attraction - pull particles closer together causing increased MP and BP

A. Intermolecular forces - forces of attraction between molecules

1. dispersion forces - attraction between non[polar molecules

a. cause - temporary shift in electron cloud as molecules get close creating partial positive and negative areas temporarily

b. strength - weakest type

2. dipole - dipole forces - attraction between permanently charges areas of polar molecules

a. caused by unequal sharing of bond electrons in polar bonds

b. dipole - charged area of molecule

1) negative near atom with bond electrons closer

2) positive near atom with bond electrons farther away

c. strength - middle level

3. hydrogen bonds - not actually bonds

a. cause - strongest type of polarity - when nitrogen, oxygen, or fluorine bond with hydrogen

1) smallest most electronegative atoms

b. strength - strongest

c. causes water to hive much higher MP and BP than molecules of similar mass

III. Liquids and Solids

A. Liquids - definite volume, but no definite shape

1. more dense than gas phase at same temp and pressure

2. not very compressible

3. fluids

4. diffusion slower than gases

5. have viscosity - measurable resistance to flow

a. stronger intermolecular forces - more viscosity

1) larger molecules - more intermolecular forces

b. colder - more time for intermolecular forces to pull - higher viscosity

6. surface tension - energy required to increase surface area of break through surface

a. stronger intermolecular forces - more surface tension

b. soaps block intermolecular forces - decrease surface tension

7. capillary action - liquid being drawn into tiny spaces

a. caused by adhesion - molecules want to stick to other types of molecules

B. Solids - definite shape and volume

1. particles only vibrate, do not change location

2. most dense phase of a substance, except water

3. crystalline solids - arranged into repeating 3D structures

a. unit cell - smallest piece of a crystal

1. simple cubic - particles at corners of cube

2. body centered cubic - particles at corners and one in middle of cube

3. face centered cubic - particles at corners and middle of each side ( like one in dice)

4. Types of solids

a. atomic solids - made of cold noble gases

1) very low MP

2) soft

3) poor conductors

b. molecular solids - held together by intermolecular forces

1) low MP, most not solid at room temp

2) somewhat soft

3) poor conductors

c. metallic solids - held together by metallic bonds

1) MP varies - most high

2) malleable

3) good conductors

d. ionic solids - held together by ionic bonds

1) high MP

2) hard

3) poor conductors

e. covalent network solids

1) highest MP

2) very hard

3) poor conductors

f. amorphous solids - don't form crystals

1) no definite MP - behave solid and liquid at same time

IV. Phase Changes

A. When adding energy - hot to cold from heat source

1. temp remains constant during phase change

2. solid to liquid - melting

a. stronger intermolecular forces, higher MP

3. Liquid to gas - vaporization - 2 types

a. evaporation - vaporization at surface of liquid only

1) happens at any temp.

2) higher temp - faster evaporation

3) more vapor in air/container - causes more vapor pressure - partial pressure due to additional gas molecules

ex) humidity

1) slows rate of evaporation

b. boiling - vaporization throughout liquid (gas bubbles)

1) happens when liquid temp equals vapor pressure

4. sublimation - solid turns directly into gas

a. happens more at lower pressures

B. Releasing energy

1. particles slow down enough for intermolecular forces to pull particles into different phase

a. condensation - gas to liquid

b. deposition - gas directly to solid

c. freezing - liquid to solid

C. Phase diagrams - graph showing effect of temp. and pres. on phase

1. higher temp. - more likely gas phase

2. higher pres. - more likely solid phase

3. triple point - temp and pres where all 3 phases exist at same time

4. critical point - only gas exists beyond this temp.