Chapter 11 HW pp. 494 - 501:Set 1- 8, 10, 12, 16, 19, 20; Set 2- 36, 40, 48, 52, 54, 56;
        Set 3- 74, 75, 78, 82, 85, 93, 96; Set 4- 110, 118, 125, 126, 133, 137, 140.
Intermolecular Attractive Forces and Liquids and Solids
    A. _____ Attractive Forces
        1.   Johannes _____
            a.   Tried to explain why something condenses. As the molecules
                    _____down in a gas being _____something must
                    _____these molecules together to change _____.
                    _____forces. The higher the temperature at which the gas
                    condenses the stronger the intermolecular forces. There are two
                    basic types
            b.   _____ _____forces (_____interaction or
                    _____ _____forces) {Named for Fritz London}
                    (1)   This type exists between _____ molecules. The _____
                            the molecule (number of electrons) the _____ the
                            attraction.   This is the _____ van der Waals force.
                            This can also be viewed as a momentary dipole. Since the
                            electrons are constantly moving about the molecule, it is
                            logical to assume at a particular time most of the electrons
                            will be clustered about _____ end of a molecule thus
                            creating a _____ _____ distribution of
                            charge or a dipole. This creates attractive forces between
                            two molecules, momentarily.
            c.   _____- _____attractive force.
                    (1)   This only exists between _____ (polar molecules
                            with two distinct regions of opposite charge). This is a
                            _____force than dispersion. The slightly positive end of a
                            molecule is attracted to the slightly negative end of another.
                    (2)   A special type of Dipole - Dipole attraction is a
                            _____bond. This is the _____type of
                            dipole - dipole attraction since the hydrogen only has one
                            valence electron and its proton is easily exposed. This
                            exposed proton attracts other negatively charged regions of
                            other dipoles. This has 5% of the strength of a covalent
                            bond. It is _____a true chemical bond but is important in
                            determining properties.

    B.   Liquids - _____common phase of matter in universe because liquid phase
            of any substance can exist only within a _____range of
            _____and _____.
            1.   General description - _____shape, _____volume
            2.   KMT description (Review this in chapter 5, page 197)
                    a.   consists of _____
                    b.   substance is a liquid because of the _____and
                            _____of particles not the _____of
                            particles

      c.   particles are in _____motion

      d.   particles are _____together and lower in _____and _____than gas particles thus the attractive forces must be _____than gas and limits motion

      e.   kinetic energy is _____enough so the particles are not bound together as in solids.

3.   Properties

      a.   _____- ability to flow since particle are not bound about a fixed   position, the E_K overcomes attractive forces.

      b.   _____- attractive forces are strong enough to hold particles together on one surface

      c.   _____- 1000 times greater than corresponding gas; particles are more closely packed due to attractive forces.

      d.   _____- particles are closely packed and can evenly distribute pressure in all directions

      e.   _____- Definition - when one substance is added to another so that, after mixing, only one phase is observed, the substance has been dissolved. Liquid is the most common dissolving agent. Why ? Motion of particles and attractive forces they exert on solute.

      f.   _____- any liquid will gradually diffuse throughout any other liquid in which it can be dissolved. Due to constant random motion of particles. Occurs slower than gases since forward moving particles of closely packed liquid will soon strike another particle, changing its path and attractive forces impede movement. Increases with temperature since avg. E_K increases thus the particles are moving faster.

      g.   _____- common to all liquids to different degrees; attractive forces tend to pull adjacent parts of liquid's surface together, thus making the surface less penetrable by solid bodies; acts to minimize free surface area - as a result, liquid droplets tend to be spherical shape which is the least possible surface area.

      h.   _____- tendency for liquid to rise up a narrow tube resulting from the attractive forces between particles and glass

      i.   _____ - process by which a liquid or solid changes to a gas is vaporization; process by which particles escape from the surface of a non-boiling liquid and enter into gaseous phase is evaporation. Some particles are moving faster than other particles and can escape spontaneously into gaseous phase. This lowers the liquid's E_K and allows it to absorb energy from the surroundings

thus giving more particles enough energy to escape. This is a continuous process until all liquid is evaporated. No noticeable temperature change. (Good short answer question)

-This also causes vapor pressure in a closed system. Equilibrium is reached when as many particles are going to vapor as are returning to liquid. This is continuous thus dynamic. Rate are equal not particles. When equilibrium is reached the vapor pressure is called the _____ _____. Vapor pressure is directly related to intermolecular attractive forces. Substances with strong IM forces have _____vapor pressures; weak IM forces have _____vapor pressures. Why? (another good short answer)

j. _____- When bubbles appear throughout liquid ; this occurs when the equilibrium vapor pressure equals the atmospheric pressure. The temp at which this occurs is called the boiling point. The temperature at which the vapor pressure of a solid equals the vapor pressure of the corresponding liquid is melting point. Depends on IM forces - weak IM forces (non polar, low molar mass) - low boiling point and melting point ; strong IM forces (polar) - high boiling and melting points. If a solid has a high enough vapor pressure the solid will sublime - turn to gas with out passing through the liquid phase (iodine). How does boiling differ from evaporation? _____ _____. A liquid with a very low boiling point and evaporates readily at room temp is said to be volatile, high vapor pressures.
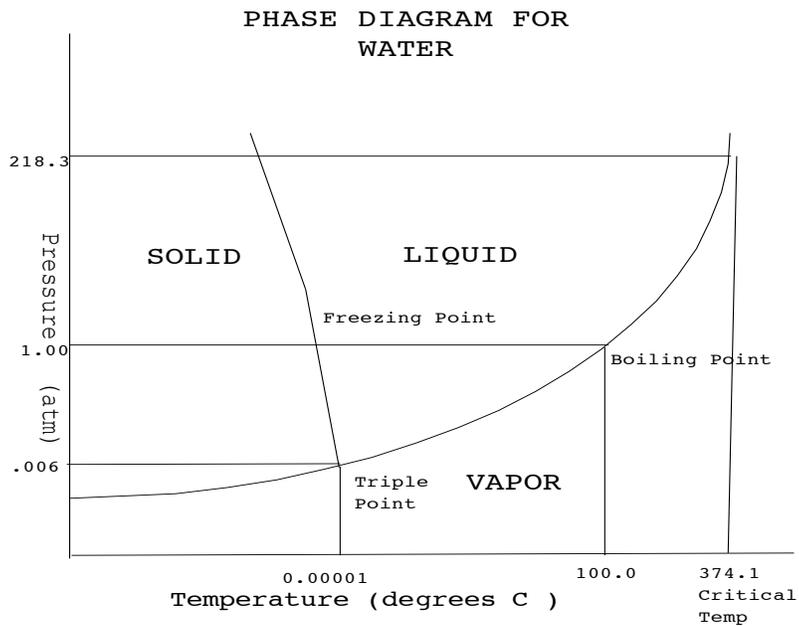
k. _____&_____- Condensation is vapor to liquid while liquefaction is gas to liquid. Cooling gas / vapor slows the particles until the IM forces ca take hold. Compression helps since van der Waals forces are effective for short distances. Associated terms - _____ (T_c) - temp above which no amount of pressure can liquefy gas. Indication of strength of IM forces. (Table 11.7) critical pressure (P_c) - minimum pressure needed to liquefy gas at T_c .

l. _____- As liquid is cooled E_K is small enough for IM forces to hold particle about a fixed point with an orderly arrangement (solid). All liquids freeze. Wax freezes at room temp

m. _____-_____equilibrium - In a closed system we have liquid + energy ====> vapor and then
vapor ====> liquid + energy
once equilibrium is reached (rates are equal) we have
liquid + energy <====> vapor

If this equilibrium is disturbed by a stress, the equilibrium will shift to relieve that stress and form a new equilibrium at a new rate – called_____.

n. _____- A diagram used to show the relationships between solids, liquids and gases. It is a graph of temperature vs. pressure that indicates the conditions under which gaseous, liquid or solid phase of a substance exists. The negative slope of solid - liquid line means if pressure drops ice melts at a higher temperature. As temp drops below triple point, the temp of sublimation decreases with decreasing pressure. This is how food is

PHASE DIAGRAM FOR
WATER

218.3

Pressure   (atm)

SOLID   LIQUID

Freezing Point

1.00   Boiling Point

.006

Triple   VAPOR
Point

0.00001   100.0   374.1
Temperature (degrees C)   Critical
                                  Temp

freeze - dried.. vaporize ice and lower press after freezing.

o. Most common liquid - _____.
Why does ice float? _____? Why ? Water's bond angle is 105^0, this creates openings in crystal. Water has strong hydrogen bonds - strong IM forces - high boiling point - low vapor pressure and high critical temp. Water is most dense at 4^0C; as ice melts particles are closest at 4^0C then move apart and break hydrogen bonds

C. Solids
1. General definition - _____shape, _____volume
2. KMT description
   a. Consists of particles (ions, atoms, molecules)
   b. Avg. kinetic energy is _____than gas and liquid particles thus _____motion; particles move back and forth about fixed position.

     c.   More _____packed than gases or liquids thus IM forces are more important ; dipole-dipole, dispersion interaction, hydrogen bonds; hold solid particles in place.

     d.   Much more orderly since held in place and therefore very low _____.

3.   Particle model of a solid

     a.   description in terms of the arrangement and motion of the solid particles and the attractive forces between them.

     b.   two types of solids

          1)   _____solid - most common - consists of crystal, particles are arranged in an orderly geometric repeating pattern.

          2)   _____solids - super cooled liquids; from Greek a(_____) + Morphe(_____); particles arranged randomly

4.   Properties

     a.   _____- crystalline solids are geometrically regular; amorphous solids do maintain a definite shape (temporary), but no geometry and can have any shape.

     b.   _____- since particles are very closely packed, strong IM forces; all surfaces are free

     c.   _____- particles are held in fixed position; some amorph do flow very slowly - very viscous

     d.   _____- temp where a solid becomes a liquid; E_k of particles overcome IM forces; amorphous solids have no definite m.p.(this is why they are called super cooled liquids - retain certain   liquid properties at temperatures which appear to be solid

     e.   _____- particles are tightly packed

     f.   _____- particles are as close as they are going to get at normal conditions (FYI- Discover article - Element Smith pounds elements closer together than normal. Older article)

     g.   _____- particles are still in motion - at surface some can migrate to other solids; rate is a million times slower than in liquids.

5.   Closer look at crystalline solids

     a.   classified by _____and shape -Done by X-ray crystallography , as X-ray passes through crystal it gives a distinct pattern similar to light passing through a prism as in spectroscope lab.

     b.   _____structure is the total 3-D arrangement of particles

     c.   _____is the smallest portion of a crystal lattice that shows the pattern (simplest repeating pattern).

     e.   _____ basic shapes

NAME	Axes	Angles between axes
	all equal axes	all 90º
	2 equal	all 90º
	all equal	all not 90º
	all unequal	all 90º
	all unequal	2 = 90º, 1 not
	all unequal	no 90º
	3 equal	1 = 90º, 3 = 60º

      f.   central shapes may contain different type of unit cells for example : simple cubic - each particle has _____ immediate neighbors and contains _____ atom; face-centered - each particle has _____ immediate neighbors and contains _____ atoms; body centered - each particle has _____ immediate neighbors and contains _____ atoms.

      g.   Forces that keep crystals together (4 basic types of crystals)

          1)   _____ Crystal -contains ions, Group1 or 2 w/Group16 or 17, strong binding (+) (-) attraction results in hard & brittle, high melting points and good insulators.

          2)   _____ (Network) Crystals - contains single atoms covalently bonded to neighbor, very large # of atoms e.g. diamonds (C_x), quartz (SiO_2)$_x$, carbide (SiC)$_x$ where x = indefinite chains; giant or macromolecules; hard & brittle, high melting points, nonconductors or semiconductors.

          3)   _____ Crystals - positive ions of metal surrounded by a cloud of valence electrons donated by metal atoms and belonging to the crystal as a whole, binding force is between (+) ions and electrons; electrons are free to migrate through crystal lattice thus high electrical conductivity; m.p. vary

          4)   _____ Crystals - covalently bonded molecules held together by IM forces between molecules; non polar molec.= dispersion interaction; polar molec. = dipole-dipole and dispersion; low melting points, easily vaporized, soft and good insulators

6.   More about Morphs

      a.   amorphous forms of _____ alloys prepared by rapid cooling of thin films of metals- atoms do not have time to arrange themselves - resulting in "_____" , strong flexible more resistant to corrosion than crystals of same composition.

    b.   _____- crystals of different solids with same structural shape

    c.   _____- crystals of same substance with 2 or more shapes

7.   Nothing's Perfect

    a.   _____or _____either within unit cell structure (ions missing others in place) or extra layer.

    b.   Some defects are on purpose and helpful

        1)   man made defects - crystals are "_____" ; used to make _____...Si & Ge can be made to conduct electricity, if As is added - extra electron available to move across crystal. If Ga is added - short an electron and electrons fill "hole."

    c.   Other impurities

        1)   If water is in crystal that is if ions are chemically bonded to water (_____ions) & then crystallize - _____crystal or _____. To remove water - heat , lower pressure , then they become _____. $CuSO_4$ $\cdot\ 5H_2O$

        2)   some substances absorb water from air - _____

        3)   some absorb enough to dissolve - _____

8.   What the heck is a _____crystal ?

    a.   crystalline solid very orderly, liquid very unorderly - random in all three dimensions; solid _____crystalline order in only one or two _____at melting point form liquid crystals. (smectic - retain 2 orders ; nemetic - retains 1 order)

D.   Energy involved in Phase Changes

1.   Substancs boil and melt at constant temps. This is due to energy needed for phase change to occur. IM forces are overcome.

2.   Energy required to melt one gram of a substance at its melting point is called the _____ (ΔH_f) ($H_2O = 334$ J / g)

3.   Energy required to vaporize 1 g of a substance at its boiling point is called the _____of _____ (ΔH_v) ($H_2O = 2260$ J / g)

4.   Also involved is the _____heat (amount of heat needed to raise 1 g of a substance 1 C^0 .) since substance needs to reach its m.p. or b.p. (C_p)

        $H_2O_{(l)} =$ _____J / g C^0 $H_2O_{(s)} =$ _____J / g C^0

                $H_2O_{(v)} =$ _____J / g C^0

5.   Formula $q = mC_p (\Delta T)$ not needed just catch the fever !

        q = Heat (J)   m = mass (g) ΔT = change in temp (C^0)

                C_p = specific heat