WORKSHEET: Water and Solutions

1. What is surface tension and what causes it?
2. Explain the following AND how each affects water: polarity, hydrogen bonding, adhesion, cohesion, surfactant, vapor pressure
3. Define (YOUR WORDS) and give a new example of: solute, solvent, solution, colloid, suspension.
4. Give your own explanation of: saturated, unsaturated, supersaturated, oversaturated, solvation, electrolyte, hydrate, efflorescent, hygroscopic, deliquescent, coagulation, Tyndall effect, emulsion, colligative property, like dissolves like
5. You are asked to make a solution as quickly as possible, list and explain four things that you could do to make this happen. What could you do to absolutely be sure it will happen the MOST quickly?
6. Jo-Mama adds 238.4 grams of calcium phosphate to 527.0 grams of ethanol (d = .9712 g/cm^3, t_f = -114.7 ^{o}C). The solution has a density of 1.131 g/cm^3, a molal freezing constant of 2.00 ^{o}C/m, find:

   a. solution molarity b. solution molality c. mass percent of ethanol
   d. mole fraction of solute e. t_b f. t_f

ANSWERS (not totally complete)

1. Surface tension is the "skin" on the top of a liquid. It results from the cohesive forces (attraction between like molecules) that make water molecules, for example, want to hang together. It is caused by the affinity like liquid molecules have for each other It allows leaves to float on top of the water, water striders and other small critters to walk across water, and allows you to fill a cup above the rim.
2. polarity: one end of the water molecule is positive (the hydrogen side); the other negative (the oxygen side) it makes the water molecules line up and the sample expand when freezing, it causes water molecules to be attracted to each other (cohesive force)

   hydrogen bonding: the hydrogen of one water molecule are attracted to the oxygen of other water molecules causes the same things as stated above about polarity AND low vapor pressure (water molecules would rather hang together than escape to the atmosphere), capillary action, etc

   cohesion: like molecules being attracted to each other--same things as above

   adhesion: different molecules being attracted to each other--has water molecules stick to inside of cup, sides of straws, etc

   surfactant: substance that gets in the way of the hydrogen bonding in water (for example) ; soaps and/or detergents will cause a decrease in surface tension because they prevent the hydrogen bonding between neighboring water molecules

   vapor pressure: force per unit area caused by the liquid molecules escaping into the atmosphere, bouncing off of each other, the sides of the container, etc
3. solute: the stuff that is being dissolved--like the sugar or coke particles in Coca-Cola
   solvent: the stuff that is doing the dissolving--like the water portion of Coca-Cola
   solution: the combination of the solute and the solvent--Coke
   colloid: suspension made of little particles--face make up
   suspension: mixture made of a solvent with visible particles that "hang" in it for a while--dust in the air
4. saturated: there is just the right/maximum amount of solute in a solvent
   unsaturated: the solvent could hold more solute
   supersaturated: there is more solute in the solvent than it should be able to hold--but it IS in the solution, not at the bottom of the container

oversaturated: there is too much solute for the solvent to hold it and the excess IS at the bottom of the container

solvation: the process of dissolving; the solvent particles pulling apart the solute particles

electrolyte: a substance that will conduct electricity when dissolved into water--generally must be an ionic substance; it breaks into ions and the ions conduct electricity in water

hydrate: a substance that has water physically attached to another molecule; formulas are written as $\_\_\cdot xH_2O$

efflorescent: a substance that gives off its water to the air

hygroscopic: a substance that takes water in from the air

deliquescent: a substance that takes in so much water from the air that it becomes a liquid

coagulation: the clumping together of particles that had been suspended in a colloid or other suspension

Tyndall effect: the reflecting of light by the tiny particles in a colloid or other suspension

emulsion: a liquid suspended in another liquid, may seem foamy or pudding-like

5. stir or shake it: the added motion adds to the kinetic energy of the particles and allows the solute particles to come into contact with greater numbers of solute particles, thus increasing the rate of solvation

heat the solution: heating the solution makes all of the solvent particles move more quickly, again increasing the number of collisions between solute and solvent particles, increasing the rate of solvation

grind up the solute: making the solute particles smaller means that there is more surface area of solute particles which can come into contact with solvent particles and increases the rate of solvation

decrease the temperature of a gas-liquid solution: this would decrease the kinetic energy of the solution and keep the gas bubbles from escaping the solution which ensures greater solubility of the gas bubbles in the solution

increase the pressure on a gas-liquid solution: this causes the bubbles to shrink and allows more of them to be contained within the solution; increasing the solubility

--If you want to make a solid-liquid solution as quickly as possible, heat the solvent, grind up the solute and shake the solution as you are making it

6. 238.4 g $Ca_3(PO_4)_2$

Ca: (40.08)3 = 120.24
P: (30.97)2 = 61.94
O: (16.00) 8 = 128.00
310.18 g/mole

527.0 g C_2H_5OH

C: (12.01)2 = 24.02
H: (1.01)6 = 6.06
O: 16.00 = 16.00
46.08 g/mole

$\frac{238.4\text{ g} \mid \text{mole}}{\mid 310.18\text{ g}} = .7686 \text{ moles } Ca_3(PO_4)_2$

$\frac{527.0\text{ g} \mid \text{mole}}{\mid 46.08\text{ g}} = 11.44 \text{ moles } C_2H_5OH$

$\frac{527.0\text{ g} \mid \text{cm}^3}{\mid .9712\text{ g}} = 542.6 \text{ ml}$

$V_{sol'n} = \frac{m}{d} = \frac{(238.4 + 527.0)\text{ g} \mid \text{cm}^3}{\mid 1.131\text{ g}} = \frac{765.4}{1.131} = 676.7 \text{ cm}^3$

a. $M = \frac{n_{solute}}{L_{sol'n}} = \frac{.7686 \text{ moles} \mid 1000 \text{ ml}}{676.7 \text{ ml} \mid \text{L}} = 1.136 \text{ mole/L} = 1.136\ M$

b. $m = \frac{n_{solute}}{kg_{solvent}} = \frac{.7686 \text{ moles} \mid 1000 \text{ g}}{527.0 \text{ g} \mid 1 \text{ kg}} = 1.458 \text{ mole/kg} = 1.458\ m$

c. mass % ethanol = $\frac{mass_{ethanol}}{mass_{sol'n}} \times 100\ \% = \frac{527.0\text{ g}}{(527.0 + 238.4)\text{g}} \times 100\% = \frac{527.0\text{ g}}{765.4\text{ g}} \times 100\% =$ 68.85 % solvent

d. $X_{solute} = \frac{n_{solute}}{n_{sol'n}} = \frac{.7686 \text{ moles}}{(.7686 + 11.44)\text{ moles}} = \frac{.7686 \text{ moles}}{12.0286 \text{ moles}} = .06296$

e. $\Delta t_b = k_b \cdot m = \frac{1.19\ ^oC}{m} \Big| \ 1.458\ m = 1.74\ ^oC$

$t_b = t_b^o + \Delta t_b = 78.5\ ^oC + 1.74\ ^oC = 80.24\ ^oC = 80.2\ ^oC$

f. $\Delta t_f = k_f \cdot m = \frac{2.00\ ^oC}{m} \Big| \ 1.458\ m = 2.96\ ^oC$

$t_f = t_f^o - \Delta t_f = -114.7\ ^oC - 2.96\ ^oC = -117.66\ ^oC = -117.7\ ^oC$