Solubility

1. Adage used to determine if a solvent will dissolve a solute.

"Like Dissolves Like"

This means that polar substances will dissolve polar substances and non-polar substances will dissolve non-polar substances. However, polar and non-polar cannot dissolve each other (think oil and water).

2. Which solvent, water or carbon tetrachloride, would you choose to dissolve each of the following.

To do these problems you need to remember that like dissolves like. SO we will want to stick non polar substances in the non-polar solvent (CCl_4) and the polar/ionic compounds in the polar solvent (H_2O).

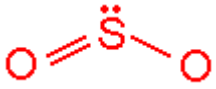
a. KrF_2

Linear → Non-polar → CCl_4

b. SF_2

Bent → polar → H_2O

c. SO_2



Bent → Polar → H_2O

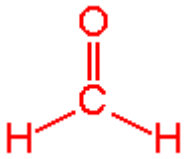
d. CO_2

Linear → Non-polar → CCl_4

e. MgF_2

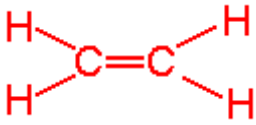
Ionic → H_2O

f. CH_2O



Polar C=O bond, symmetry doesn't cancel → Polar → H_2O

g. CH_2CH_2



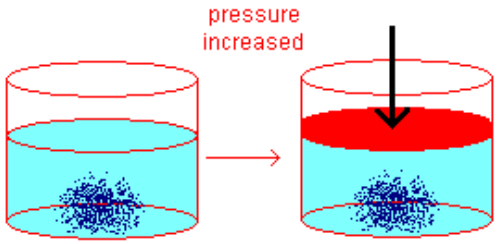
All non polar bonds → Non-polar → CCl_4

3. How does an increase in pressure/temperature affect the solubility of the following in a liquid

a. Solid

An increased pressure has no effect. (The amount of water vapor above the solution that would condense is neglible).

Picture a water solution that is oversaturated with NaCl – oversaturated meaning that a clump of NaCl would exist at the bottom of the container. If I were to press down on the solution with a piston (increasing the pressure) the excess salt would not be more inclined to dissolve.

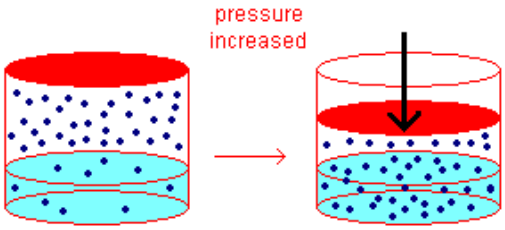


Generally speaking, an increase in temperature will increase the solubility of a solid. Remember that this is general, and *not* true for every ionic compound.

b. Gas

An increase in pressure would Increase the solubility of a gas.

If the area above a is decreased, then there would be less area for the gas to exist and so more particles would have to dissolve.



An increase in temperature would gas the gas to be less soluble. Consider a glass if soda left out on a counter to get warm… it would go flat. The increase in temperature (due to heat flow from the environment) would impart more kinetic energy to the gas particles in the solution… more kinetic energy permits greater evaporation

(i.e. solubility decreases).

4. What is the equation for Henry's Law?

$$P = k_H X \quad \text{or} \quad P = k_H C$$

P = Partial Pressure of gaseous solute above solution.

k_H = Henry's constant (substance specific)

X = Mole fraction of dissolved gas.

C = Concentration of dissolved gas

a. When is it valid?

If the solution is dilute and there is no reaction between the solute and solvent.

b. What relationship does it establish?

The amount of gas dissolved in the solution is directly proportional to the pressure of the gas above the solution.

5. Calculate the solubility of N_2 in water when the partial pressure of of nitrogen above water is 1.10 atm at 0°C.
(k_H = 962 Latm/mol)

This is a Henry's Law question. Because we were given concentration, we will use the formula $P = k_H C$. This question literally boils down to plug and chug.

$$(1.10 \text{ atm}) = \left(962 \frac{\text{L atm}}{\text{mol}}\right)(C)$$

$$\boxed{C = 1.14 \times 10^{-3} \text{ mol/L}}$$