

Therefore, $\frac{p_0 - p}{p_0} = \frac{n_2}{n_1}$

or, $\frac{\Delta P}{p_0} = \frac{n_2}{n_1}$

or, $\Delta P = \frac{p_0 n_2}{n_1}$ — (III)

Also here $n_1 = \frac{w_1 M_2}{M_1}$, $n_2 = \frac{w_2}{M_2}$

So, we can write $\Delta P = p_0 \frac{w_2}{M_2} \times \frac{M_1}{w_1}$ — (IV)

For a particular solvent at a given temp.

We write, p_0 and M_1 is a constant quantities.

Hence, $\Delta P \propto \frac{w_2}{M_2 \cdot w_1}$ — (V)

or, Also from, $\Delta T_f \propto \frac{w_2}{M_2 \cdot w_1}$

or, $\Delta T_f = K \cdot \frac{w_2}{M_2 \cdot w_1}$ — (VI)

Where K is a proportionally constant known as F.P. Constant.

if $\frac{w_2}{M_2} = 1 \text{ mol}$, $w_1 = 1 \text{ g}$.

So, $\Delta T_f = K$ — (VIIa)

Thus, the F.P. Constant is

depression in F.P. observed by dissolving 1 mol of a solute in 1 g of a solvent.

Generally, the mass of solvent is taken as 1 g or 1 kg.

Thus, when, $\frac{w_2}{M_2} = 1 \text{ mole}$, $w_1 = 1000$.

$\Delta T_f = K \cdot \frac{1}{1000} = K_f$ — (VIIb)

So, that $K = 1000 K_f$

Hence, from the eq. $\Delta T_f = \frac{1000 K_f \times w_2}{M_2 \cdot w_1}$ — (VIIc)

Hence the constant K_f is called molar freezing point depression constant or cryoscopic constant.

When $\frac{w_2}{M_2} = 1 \text{ mol}$ and $w_1 = 1000 \text{ g}$
from eq (VIIc),

(i) Nature of Solute and Solvent \rightarrow Like dissolve like is the general rule for the solubility.

Polar solutes are highly soluble in polar solvent (H_2O) and non-polar solutes are insoluble in water.
eg glucose, and sugar, are soluble in water, while I_2 is insoluble.

(ii) Temperature (T) \rightarrow Solubility of solid solute \propto Temp with increasing Temperature solubility of solid solute increases.

(iii) Pressure (P) \rightarrow No effect, because solid is incompressible.

Factors affecting the solubility of a gas in a liquid \rightarrow

(i) Nature of Solute and Solvent \rightarrow non-polar gases like H_2 , O_2 & N_2 dissolve in H_2O in small amount while CO_2 , HCl , NH_3 are highly soluble in water because they are polar in nature. O_2 , CO_2 , N_2 are more soluble in C_2H_5OH than H_2O .

(ii) Effect of Temp \rightarrow

gas + liquid \rightleftharpoons solution + Heat
For Exothermic ΔH solubility of gas in liquid decreases with increasing Temp.

For Endothermic ΔH .

gas + solvent + Heat \rightleftharpoons solution
solubility increases with increasing Temp.

(iii) Effect of Pressure \rightarrow with increasing pressure solubility of gas in liquid increases i.e. $P \propto$ solubility.

This fact can be explained on the basis of Henry's law -
Henry's law \rightarrow The solubility of a gas dissolved in given volume of liquid at constant Temp (T) is directly proportional to pressure of the solution in equilibrium. i.e. $m \propto P_g$ \Rightarrow $m = K_H P_g$

where K_H is a constant, which is called Henry's constant.
 K_H - value depends upon the nature of the gas.

Condition for Henry's law \rightarrow (i) The pressure of gas is not too high. (ii) Temperature is not too low. (iii) The gas is not highly soluble and does not enter into chemical reaction. (iv) The gas does not dissociate.

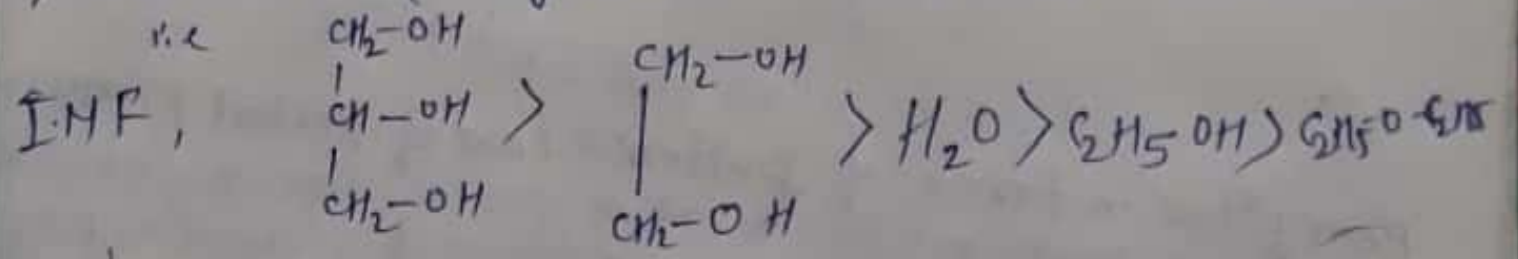
Applications of Henry's Law \rightarrow

(i) In the production of carbonated beverage \rightarrow To increase the solubility of CO_2 in soft drink and soda water the bottle is sealed under high pressure.

(ii) In scuba diving or In deep sea diving \rightarrow N_2 is more soluble than He in blood, the pressure is more in deep sea than the surface of earth. So, deep sea divers use oxygen diluted with less soluble He as a breathing gas to minimise the painful effect.

(iii) In the function of lungs \rightarrow (iv) At high altitudes:-
 Vapour pressure (V.P) \rightarrow The pressure exerted by the vapour molecules at the upper surface of liquid in equilibrium is called V.P. \checkmark Factors on which the V.P depends \rightarrow

(i) Intermolecular force:- $V.P \propto \frac{1}{\text{Intermolecular force}}$
 Larger the Intermolecular force of attraction between the liquid molecule lower will be the V.P and vice-versa.
 eg Intermolecular force glycerol $>$ ethylene glycol $>$ H_2O $>$ C_2H_5OH
 $>$ $C_2H_5-O-C_2H_5$ (Diethyl ether).



So, V.P glycerol $<$ Ethylene glycol $<$ Water $<$ ethyl alcohol $<$ Diethyl ether.

(2) Temperature (T) $\rightarrow V.P \propto$ Temp of liquid
 With increasing Temperature (Temp) Kinetic energy of the molecule increases. Velocity of molecule increases.