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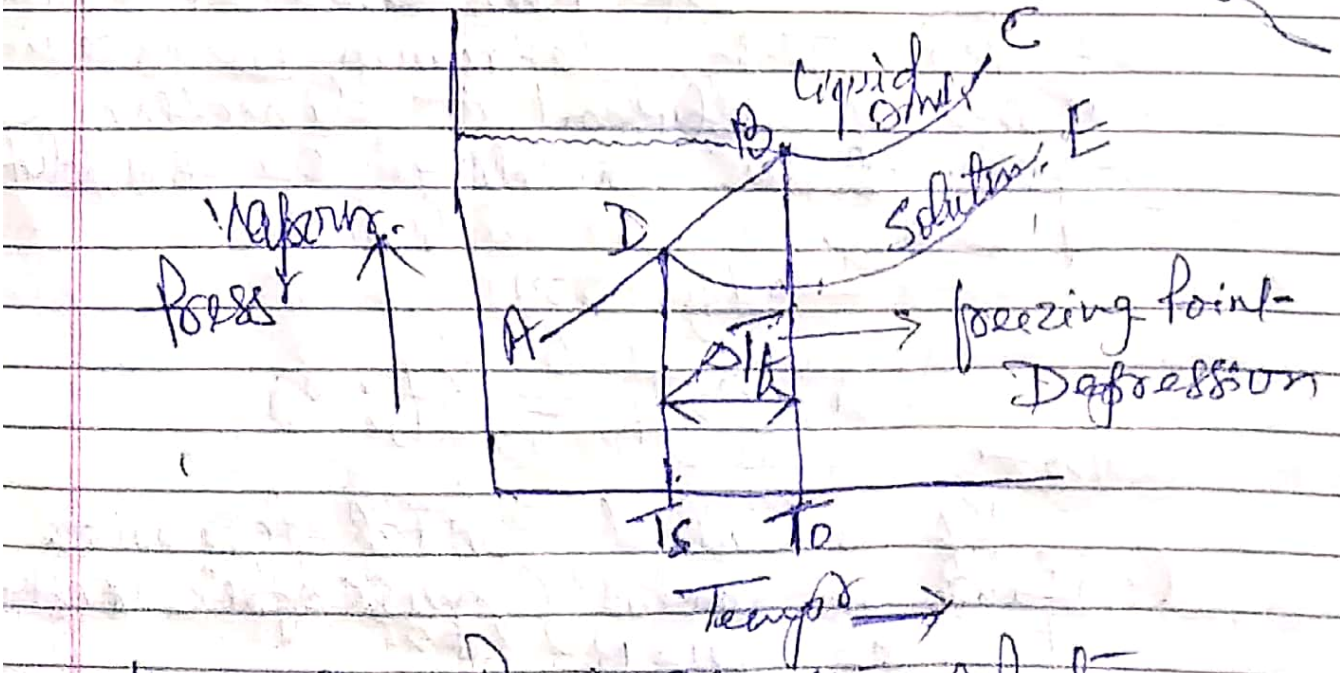
Deg-I(H) - Solution
Topics - Depression of freezing Point.

Freezing-Point :— It is the temperature at which liquid & the solid phase of the substance co-exists.

Solid $\rightleftharpoons$ Liquid

At this Temp. both liquid & solid solvent have same Vapours Press.

When a non-volatile solute is dissolved in a solvent, the V.P of the solution is decreased. From figure BC gives the V.P of pure solvent. The curve DE gives



the vapours press of the solution.

The curve AB corresponds to the vapour pressure of solid at different temperature.

T_0 = freezing point of pure solvent

T_s = " " " " solution

When a solution is cooled, usually the pure solvent separate out as a solid. Here Freezing $T_0 > T_s$

addition of non-volatile solute depressed the freezing point.

$$\Delta T_f = T_0 - T_s$$

ΔT_f = depression in f.p.

Expression for depression in freezing point.

It has been experimentally found that depression in freezing point of solution is directly proportional to molality of the solute.

$$\Delta T_f \propto m.$$

$$\therefore \Delta T_f = K_f \cdot m$$

K_f is called molal depression constant or molal cryoscopic constant.

If $m = 1$

$$\Delta T_f = K_f$$

Then molal depression Constant is defined as the depression in freezing-point for one molal-solution (solution containing one gm-mole of solute dissolved in 1000 gm of a solvent.

K_f for some solvent

Solvent	freezing-Point (K)	K_f (K kgm^{-1})
Water	273.0	1.86
Ethanol	155.7	1.99
Benzene	278.6	5.12
Ether (Diethyl eth)	156.9	1.75
Cyclohexane	279.5	20.0
Acetic acid	290.0	3.90
Nitro-benzene	278.7	7.00

Determination of Molar Mass of solute.

To calculate the molar mass of an unknown non-volatile compound by a known mass of it is dissolved in a known mass of ~~it is dissolved in~~ solvent & Depression in its f.pt-

W_B = Wt of solute, M_B = molar mass of solute
W_A = Wt of solvent

Molality of the solution

$$m = \frac{W_B \times 1000}{M_B \times W_A}$$

$$\Delta T_f = \frac{K_f \times W_B \times 1000}{W_A \times M_B}$$

$$\therefore M_B = \frac{1000 \times K_f \times W_B}{\Delta T_f \times W_A}$$

K_f-value also Calculated thermodynamically as,

$$K_f = \frac{RT_0^2}{1000 \times L_f}$$

T_0 = freezing point of solvent

L_f = latent heat of fusion (Joules/gm)

Numerical Problem:—

Qustn — 45 gm of ethylene glycol ($C_2H_6O_2$) is mixed with 600 gm of water. Calculate f.pt of solution.

$K_f(H_2O) = 1.86$

Solve — $\Delta T_f = \frac{1000 \times K_f \times W_B}{M_B \times W_A}$

$$= \frac{1000 \times 1.86 \times 45}{62 \times 600}$$

$$= 2.25\,K$$

freezing point of aqueous solution $= 273.15 - 2.25$

$= 270.90\,K$