Today: finish ch 12

12.7 - Boiling point elevation

12.8 - Osmotic pressure

12.4 Factors affecting solubility

Conc units ppm ppb

Boiling point elevation

$\Delta T_b = K_b \times m \times i$

$T_b (\text{sol'n}) = T_b(\text{solvent}) + \Delta T_b$

(LDF)

- Benzene, C_6H_6, has a normal boiling point of 80.1°C. Its K_b value is 2.64 deg/molal. What is the boiling point of a 0.20 molal solution of naphthalene?

  i=1 because like dissolves like and C_6H_6 is nonpolar

  $\Delta T_b = 2.64 \frac{deg}{molal} \times 0.20\,molal \times 1$

  $\Delta T_b = 0.528$

  $T_b = 80.1°C + 0.528° = \boxed{80.63°C}$

- Suppose 7.76g Naphthalene were dissolved in 50.0g C_6H_6 and the solution boiled at 83.3°C. What is the molar mass of Naphthalene?

  $\Delta T_b = 83.3°C - 80.1°C = 3.2\ deg$

  $\Delta T_b = k_b \times m \times i$

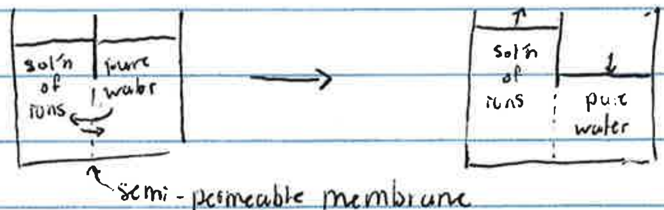
  $3.2 = 2.64 \frac{deg}{molal} \times m \times 1$

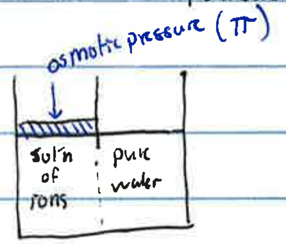
  $1.21\ molal = m = \frac{1.21\ mol\ naph}{kg\ C_6H_6}$

  $\frac{1.21\ mol\ naph}{kg\ C_6H_6} \times 0.05\ kg\ C_6H_6 = 0.0606\ mol\ Naph$

  $\frac{7.76g\ Naph}{0.0606\ mol\ Naph} = \boxed{128\ g/mol\ \text{Naphthalene}}$

Osmotic pressure





the osmotic pressure keeps the levels the same

$$\pi = \underbrace{M}_{\text{molarity}} \times \underbrace{R}_{0.0821\ \frac{L\cdot atm}{mol\cdot K}} \times \underbrace{T}_{\text{temp (K)}} \times i$$

- Sea water is ~6.0 M $\underbrace{NaCl}_{i=2}$. What is its osmotic pressure at 25°C?

$$\pi = \frac{6.0\ mol}{L} \left| \frac{0.0821\ L\cdot atm}{mol\cdot K} \right| 298\ K \left| \ 2 \ = \boxed{294\ atm} \right.$$

- Reverse osmosis ("RO" water) pressure > π
  ↳ purify water for drinking

- Suppose 11.5 mg insulin is dissolved in water to make 5.0 mL solution. The osmotic pressure is 7.14 mmHg. What is the molar mass of insulin? $i = 1$, $T = 298\ K$

$$\pi = M \times R \times T \times i$$

$$\frac{7.14\ mmHg}{} \left| \frac{1\ atm}{760\ mmHg} \right. = 0.00939\ atm$$

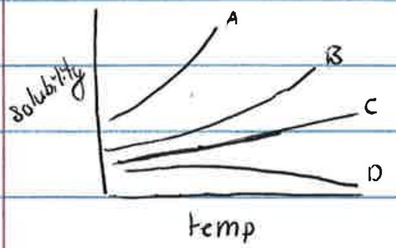
$$\pi = 0.00939\ atm = M \times 0.0821 \frac{L\cdot atm}{mol\cdot K} \times 298\ K \times 1$$

$$3.84\times10^{-4} \frac{mol}{L} = M$$

$$3.84\times10^{-4} \frac{mol}{L} \times 0.005\ L = 1.92\times10^{-6}\ mol \text{ insulin}$$

$$MM = \frac{0.0115\ g}{1.92\times10^{-6}\ mol} = \boxed{5990\ g/mol \text{ insulin}}$$

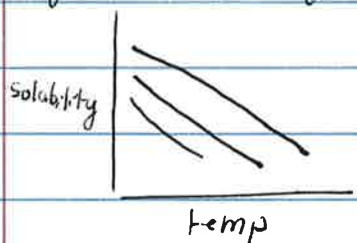
· Solids dissolved in liquids



$A(s) \rightarrow A(aq)$ ΔH + or −
lattice energy ion dipole ΔS = + always

$\Delta G = \Delta H - T\Delta S$
− is spontaneous
$= (?) - (+)(+)$

· gases in liquids (always decrease with ↑ temp)



Henry's law of gas solubility
↳ Solubility = kP_{gas}
Henry's law constant.

12.85. The solubility of H_2S at STP (273K) = 0.195 M

$0.195M = k\ 1\,atm$
$0.195\ \frac{mol}{L \cdot atm}$ at 0°C = k

What is the solubility of H_2S when the P_{H_2S} = 25.5 mmHg

To solve: convert 25.5 mmHg to atm, ~~plud~~ plug into Henry's law equation

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Mass % = $100 \times \frac{m_{solute}}{m_{sol'n}}$

used for very dilute solutions
conc (ppm) = $10^6 \times \frac{m_{solute}}{m_{sol'n}}$
conc (ppb) = $10^9 \times \frac{m_{solute}}{m_{sol'n}}$

for very dilute solutions (m_{solute} < 1% m solvent), $m_{sol'n} \approx m_{solvent}$,
$V_{soln} \approx V_{solvent}$, $d_{sol'n} \approx d_{solvent}$

- What is the molality of a 10 ppm KI sol'n?

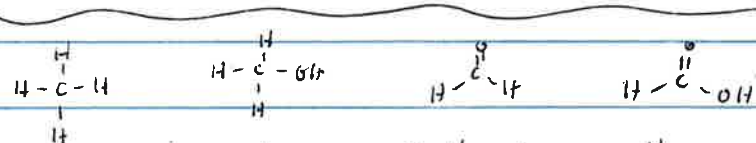
	MM	m	n
KI	166 g/mol	10 g	6.02×10^{-2} mol
H_2O	18.0 g/mol	1×10^{6} g	
Sol'n		1×10^{6} g	

10 ppm: 10 g KI in every 10^6 g Sol'n

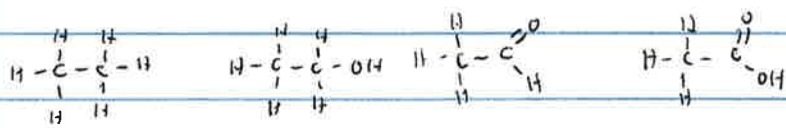
$$\text{molality} = \frac{n_{solute}}{m_{solvent}\,(kg)} = \frac{6.02\times10^{-2}\ \text{mol KI}}{1\times10^{3}\ \text{kg } H_2O} = \boxed{6.02\times10^{-5}\ \text{molal}}$$

$$\text{molarity} \quad \frac{n_{KI}}{V_{sol'n}\,(L)} = \frac{6.02\times10^{-2}\ \text{mol KI}}{1\times10^{3}\ \text{L Sol'n}} = 6.02\times10^{-5}\ M$$

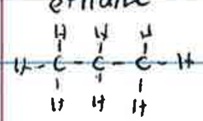
· for very dilute solutions molality and molarity will converge



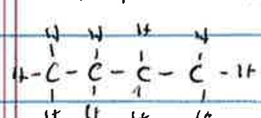
methane methanol methanal methanoic acid (1 carbon)



ethane ethanol ethanal ethanoic acid (2 carbons)



propane propanol propanal propanoic acid (3 carbons)



butane butanol butanal butanoic acid (4 carbons)