General Chemistry with Doc M!

Today Jan 18 — Colligative properties
Last day for lab sales

Thursday Jan 19 — Lab @ 8/11 am
Quiz (10 min)
mattson.creighton.edu to find CHM206 site

Friday Jan 20 — Lab reports due by beginning of class
start Chp 13 kinetics
HW Quiz #1 at end of class

Sunday Jan 22 — Review session 5-6:30 pm
Hitchcock 108

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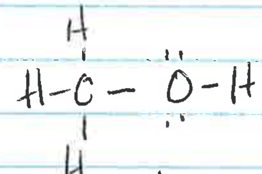
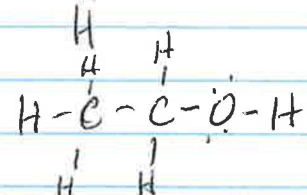
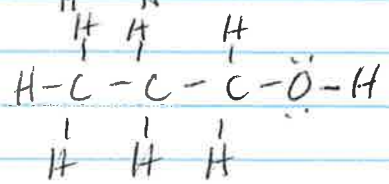
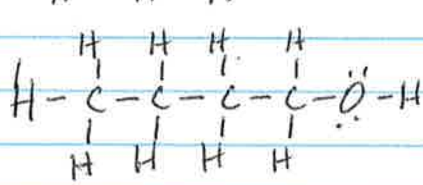
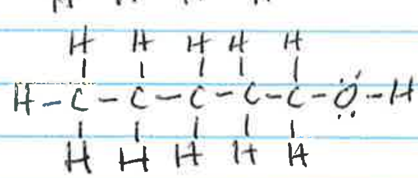
solubility in water ~~colligative properties~~

methanol  miscible

ethanol  miscible

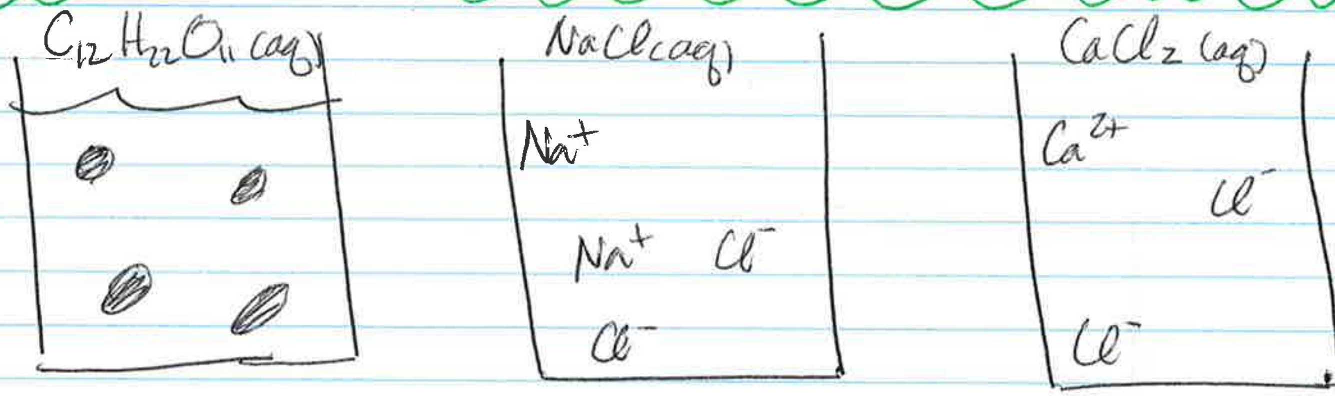
1-propanol  miscible

1-butanol  73g/L

1-pentanol  22 g/L

Colligative properties

* property of a sol'n that depends on amount of particles
* vapor pressure lowering
* freezing pt lowering
* boiling pt increasing
* osmotic ~~pres~~ pressure



1 mol sugar
$\Rightarrow$ 1 mol particles

$i = 1$

1 mol NaCl
$\Rightarrow$ 1 mol Na^+
+ 1 mol Cl^-
2 mol particles

$i = 2$

1 mol $CaCl_2$
$\Rightarrow$ 1 mol Ca^{2+}
+ 2 mol Cl^-
3 mol particles

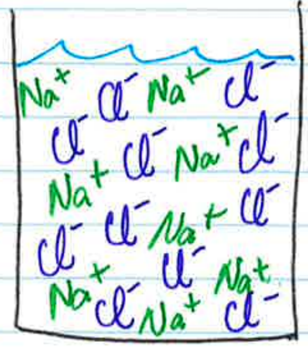
$i = 3$

$K_3PO_4(aq) \Rightarrow 3K^+ + PO_4^{3-}$

$i = 4$
↳ van't Hoff factor

Concentrated sol'n

$i \leq 2$



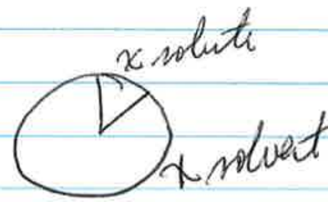
due to interactions between Na^+ and Cl^-

dilute sol'ns

$i = 2$

Vapor Pressure Lowering

$$P^{25°C}_{sol'n} = \chi_{solvent} * P^{25°C}_{solvent}$$



Dissolve 30.0 g $C_{12}H_{22}O_{11}$ (MM = 342 g/mol) in 50.0 g H_2O
$P^\circ_{H_2O}$ = 23.8 mmHg what is $P_{sol'n}$?

$$\chi_{H_2O} = \frac{n_{H_2O}}{n_{H_2O} + n_{sugar}} = \frac{2.78\ mol}{2.78\ mol + 0.0877\ mol} = 0.969$$

$$P_{sol'n} = 0.969 * 23.8\ mmHg$$
$$= 23.1\ mmHg$$

For electrolytes

$$P_{sol'n} = \frac{n_{H_2O}}{n_{H_2O} + \underbrace{n_{NaCl} * i}_{\text{mole particles}}}$$

Freezing pt lowering

$$\Delta T_f = K_f * m * i$$

m → molality

K_f → property of each solvent
deg/molal → C° or K

$K_f(H_2O) = 1.86$ deg/molal

MM = 58.5 g/mol
30 g NaCl → 0.513 mol NaCl
+100 g H_2O

$$m = \frac{n \text{ solute}}{m \text{ solvent (kg)}} = \frac{0.513 \text{ mol NaCl}}{0.100 \text{ kg } H_2O} = 5.13 m$$

$$\Delta T_f = \frac{1.86 \text{ deg}}{\text{molal}} * 5.13 \text{ molal} * 2$$
$$= 19.1 \text{ degrees}$$

T_f (soln) = $-19.1°C$

Example
Urea is a non-volatile, non electrolyte ($i=1$)
If 43.2 g urea is dissolved in 500 g H_2O the freezing pt drops by 2.67 degrees. What is MM urea?

$$\Delta T_f = K_f * m * i = \frac{1.86 \text{ deg}}{\text{molal}} * m * 1 = 2.67$$

$$m = \frac{1.435 \text{ mol urea}}{\text{kg } H_2O}$$

$n_{urea} = \frac{1.435 \text{ mol urea}}{\text{kg } H_2O} \times 0.500 \text{ kg } H_2O = 0.718 \text{ mol urea}$

$MM_{urea} = \frac{m_{urea}}{n_{urea}} = \frac{43.2 \text{ g urea}}{0.718 \text{ mol urea}} = 60.2 \text{ g/mol urea}$

definitions

non-volatile vs volatile
no vapor pressure (solid) — with vapor pressure (liquid)

non electrolyte vs electrolyte
covalent-molecular — ionic
$i=1$ — $i=2,3,$ etc

Boiling pt elevation

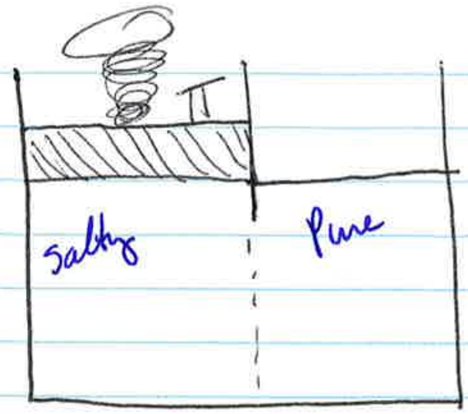
$\Delta T_b = K_b * m * i$

m = molality

K_b → property of each solvent, deg/molal

$K_b(H_2O) = .51$ deg/molal

Osmotic pressure



$\frac{PV}{V} = \frac{nRT}{V}$ molality

$P = M\,RT$

$$\Pi = M * R * T * i$$

Π → (atm) R → 0.0821 $\frac{L\,atm}{mol\,K}$

Suppose 2.41 g unknown non-electrolyte ($i = 1$) is 0.100 L sol'n at 300 K and Π = 3.85 atm. What is MM_{unk}?

$\pi = MRTi$

$3.85\,atm = M * \frac{0.0821\ L\,atm}{mol\,K} * 300\,K * 1$

$M_{unknown} = 0.156\ mol/L$

$n_{unknown} = 0.156\,mol/L \times 0.100\ L$

$= 0.0156\ mol$

$MM_{unk} = \frac{M_{unk}}{n_{unk}} = \frac{2.41\,g}{0.0156\,mol} = 154\ g/mol$

For very dilute sol'n

	MM	m	n
solute		small	
solvent		$m_{solvent} \approx m_{sol'n}$	
sol'n			

Given a 15 ppm sol'n of 15g solute + 10^6 g solution

$\Rightarrow 10^6$ g solvent