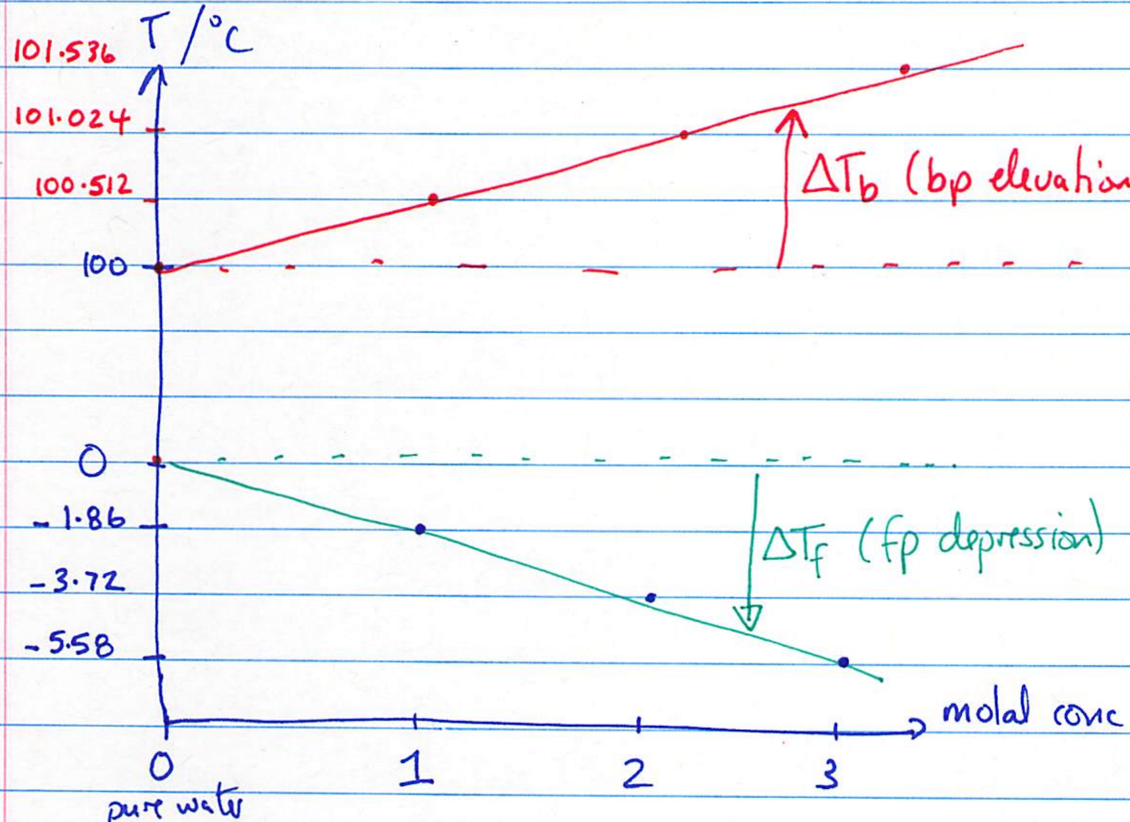
consider H_2O



2/11/19

for H_2O: $\Delta T_b = m \times 0.512\,^{\circ}C/m$

$\Delta T_f = m \times 1.86\,^{\circ}C/m$

in general, for all solvents: $\Delta T_b = m \times K_b$ (bp elevation constant)

$\Delta T_f = m \times K_f$ (fp depression constant)

ex: what's fp of 1.7m CH_2O dissolved in benzene?

(normal fp) $T_f^{\circ} = 5.5\,^{\circ}C$, $K_f = 5.12\,^{\circ}C/m$. Find: T_f ?

Do it! $\Delta T_f = K_f \cdot m = 5.12\,^{\circ}C/\cancel{m} \cdot 1.7\cancel{m} = 8.\underline{7}04\,^{\circ}C$ (depressed by this amount)

$T_f = T_f^{\circ} - \Delta T_f = 5.5\,^{\circ}C - 8.\underline{7}04\,^{\circ}C = -3.2\,^{\circ}C$

TABLE 13.8 Freezing Point Depression and Boiling Point Elevation Constants for Several Liquid Solvents

Solvent	Normal Freezing Point (°C)	K_f (°C/*m*)	Normal Boiling Point (°C)	K_b (°C/*m*)
Benzene (C_6H_6)	5.5	5.12	80.1	2.53
Carbon tetrachloride (CCl_4)	−22.9	29.9	76.7	5.03
Chloroform ($CHCl_3$)	−63.5	4.70	61.2	3.63
Ethanol (C_2H_5OH)	−114.1	1.99	78.3	1.22
Diethyl ether ($C_4H_{10}O$)	−116.3	1.79	34.6	2.02
Water (H_2O)	0.00	1.86	100.0	0.512

What's molar mass of a solute if 5.0g is added to 125g H_2O, causing its bp to become 100.43°C ?

$$\mathcal{M} = \frac{\#g \text{ solute}}{\#mol \text{ solute}}$$ ← ?

$$\Delta T_b = 100.43° - 100°C = 0.43°C$$ (exact)

look-up: 0.512 °C/m

bp elevation: $\Delta T_b = K_b \times m$ ⇒ $m = \frac{\Delta T_b}{K_b} = \frac{0.43°C}{0.512 °C/m}$

⇒ $m = 0.8398 m$ (mol/kg) means: $\frac{0.8398 \text{ mol solute}}{1 \text{ kg } H_2O}$

#mol solute??

$$125 g H_2O \text{ (solvent)} \times \frac{kg}{10^3 g} \times \frac{0.8398 \text{ mol solute}}{1 \text{ kg } H_2O} = 0.105 \text{ mol solute}$$

$$\mathcal{M} = \frac{\#g}{\#mol} = \frac{5.0g}{0.105 mol} = 48 \text{ g/mol}$$

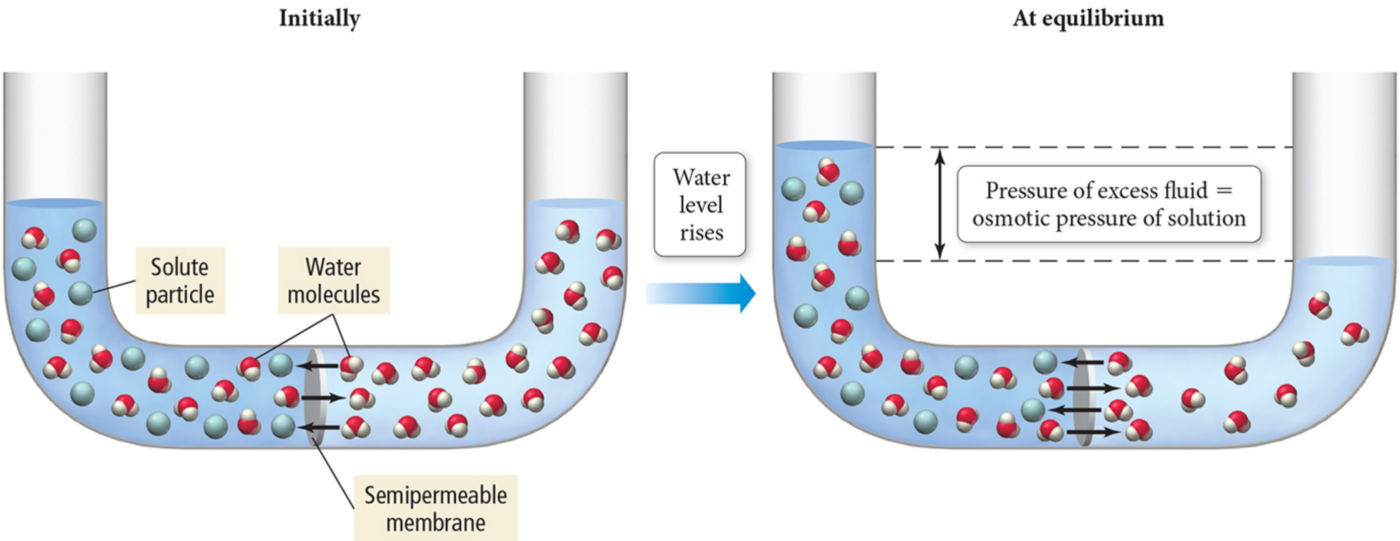
Osmotic pressure

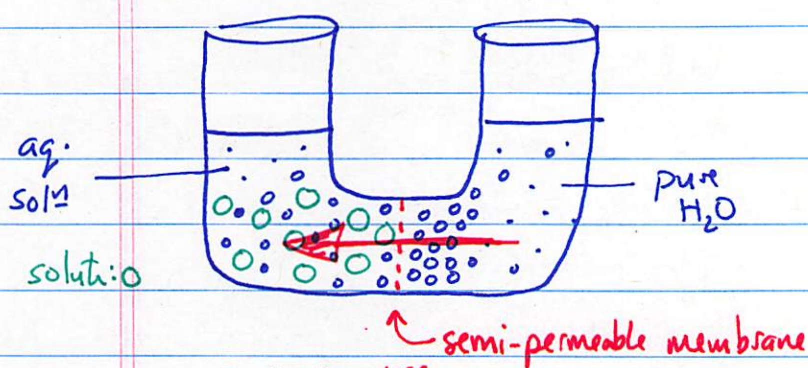
net flow of molecules from high conc → low conc

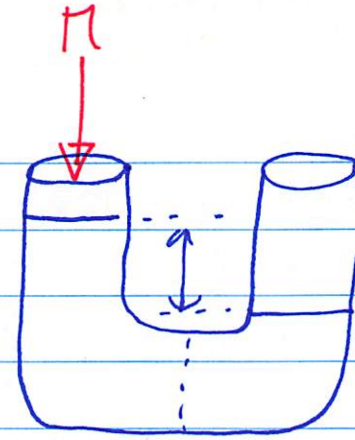
Osmosis = Diffusion of small, solvent molecules (H_2O) through a semi-permeable membrane.

membrane w/ small holes

Osmosis and Osmotic Pressure





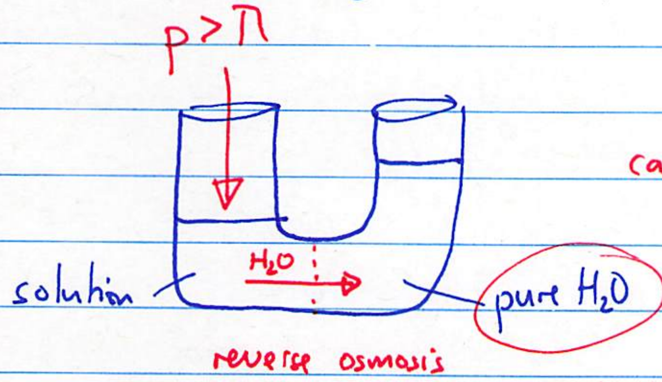


[Solute]↑ $\xrightarrow{\text{diff.}}$ [Solute]↓ ✗

$[H_2O]\downarrow \xleftarrow{\text{diff.}} [H_2O]\uparrow$ ✓

OSMOSIS

If we apply the osmotic pressure, Π ~ can stop osmosis + if we apply $p > \Pi$, can reverse osmosis!



can make pure water from (say) sea water! - If we apply $p > \Pi$.

$$\Pi = M \cdot R \cdot T$$

- M — molar conc of solution
- R — gas constant
- T — temp/K

22 + 273.15 = 295.15

ex: Osmotic pressure of tree-sap, M = 0.75 M @ 22°C

$$\Pi = 0.75 \frac{\text{mol}}{\text{L}} \times 0.08206 \frac{\text{atm}\cdot\text{L}}{\text{mol}\cdot\text{K}} \times 295\text{K} = 18 \text{ atm}$$

Ex 13-10 (using Π to find M_B) p604.