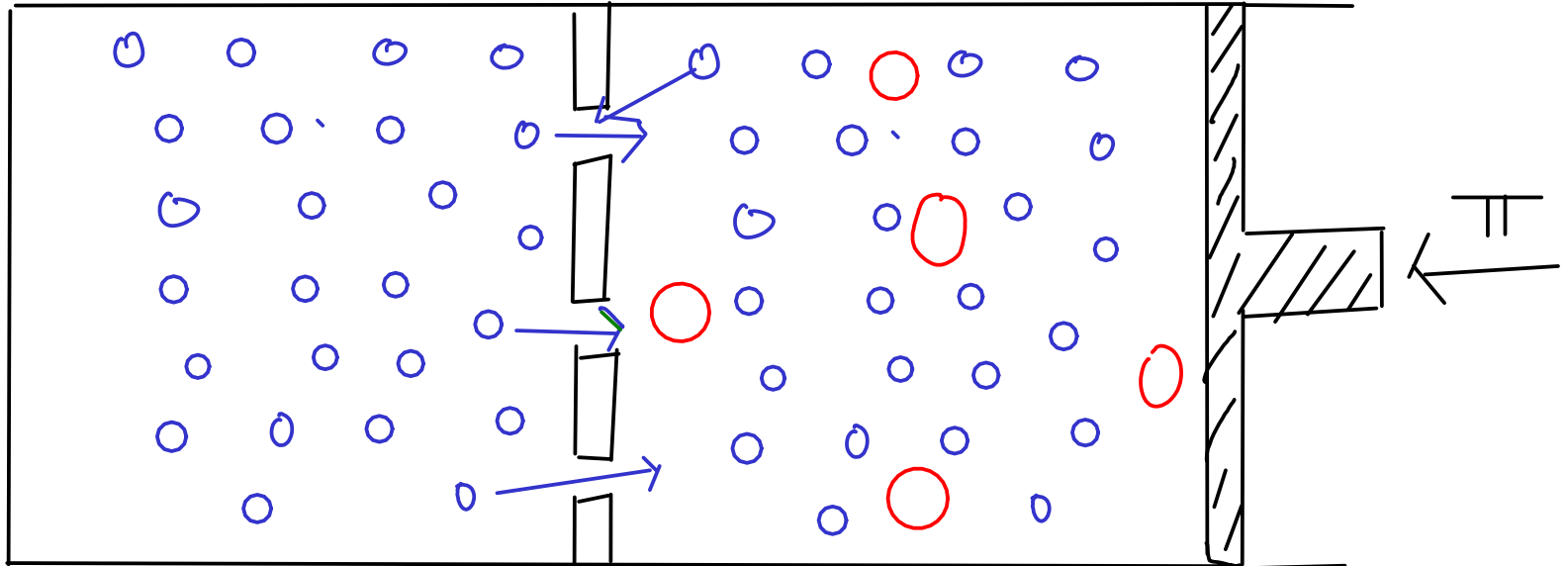# OSMOTIC PRESSURE

permits flow of solvent, but not solute particles

- OSMOSIS: the flow of solvent molecules through a SEMIPERMEABLE membrane to equalize concentration of solute on each side of the membrane.

The rate of solvent migration towards the RIGHT is greater than that towards the LEFT.

If you apply enough pressure to the piston, osmosis will not occur. This pressure is called the OSMOTIC PRESSURE
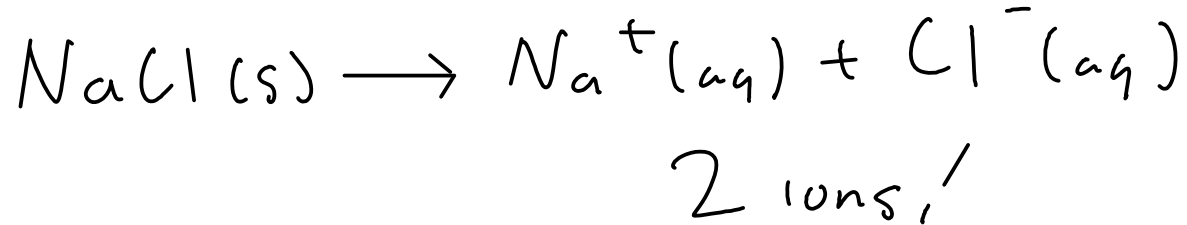
$$\Pi = M \times R \times T$$

temperature

ideal gas constant

molar concentration of solute

IONIC COMPOUNDS and colligative properties

- Ionic compounds DISSOCIATE in water into their component ions. Each ion formed can act as a solute and influence the colligative properties!

$$NaCl\,(s) \longrightarrow Na^+\,(aq) + Cl^-\,(aq)$$

$$2 \text{ ions}!$$

... so the concentration of IONS here is TWICE the nominal NaCl concentration.

$$CaCl_2\,(s) \longrightarrow Ca^{2+}\,(aq) + 2\,Cl^-\,(aq)$$

$$3 \text{ ions}!$$
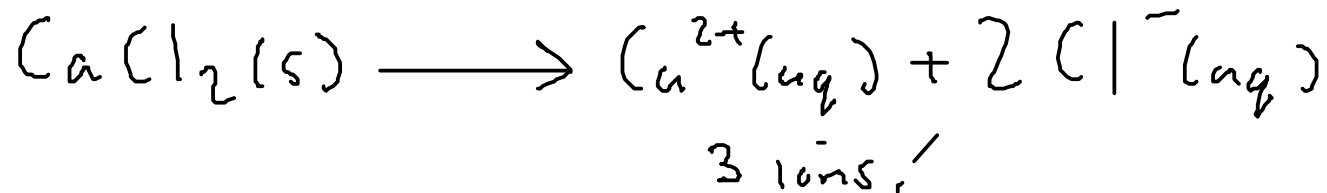
... so the concentration of IONS here is THREE TIMES the nominal calcium chloride concentration.

- Ions interact with each other in solution, so unless an ionic solution is DILUTE, the effective concentrations of ions in solution will be less than expected. A more advanced theory (Debye-Huckel) covers this, but we'll assume that our solutions are dilute enough so that we can use the concentration of the ions in solution to determine the colligative properties!

If you are at an altitude high enough for the boiling point of water to be 95.00 C, what amount of sodium chloride would you need to add to 1.000 kg of water to raise the boiling point to 100.00 C?

$$K_b = 0.512 \; ^\circ C/m \qquad NaCl: 58.443 \; g/mol$$

$$\Delta T_b = K_b \times C_m$$

$$\qquad \qquad \qquad \qquad \sqsubset 0.512 \; ^\circ C/m$$

$$100 \, ^\circ C - 95 \, ^\circ C = 5.00 \, ^\circ C$$

$$C_m = \frac{moles \; ions}{kg \; water}$$

Find Cm (molal concentration of ions)

$$C_m = \frac{\Delta T_b}{K_b} = \frac{5.00 \, ^\circ C}{0.512 \, ^\circ C/m} = 9.765625 \; m \; ions$$

Find moles IONS

$$1.000 \; kg \times \frac{9.765625 \; mol \; ions}{kg \; water} = 9.765625 \; mol \; ions$$

$$NaCl \rightarrow Na^+ + Cl^-$$

$$mol \; NaCl = 2 \; mol \; ions$$

Each mole of NaCl generates two moles of ions! Now we can find the moles of NaCl required

$$9.765625 \; mol \; ions \times \frac{mol \; NaCl}{2 \; mol \; ions} = 4.8828125 \; mol \; NaCl$$

Convert to mass NaCl (use formula weight)

$$4.8828125 \; mol \; NaCl \times \frac{58.443 \; g \; NaCl}{mol \; NaCl} = \boxed{285 g \; NaCl}$$

EXTERNAL FACTORS AFFECTING SOLUBILITY

- There are a few external factors that affect the solubility. (By external, we mean other than the chemical identity of the solute and solvent).

① TEMPERATURE

-For gases dissolved in liquids, the solubility DECREASES as the temperature INCREASES

- This is why THERMAL POLLUTION is bad! Hot water holds less oxygen than cooler water.

- For solids dissolved in liquids, solubility USUALLY increases with temperature. This is not true for ALL solid/liquid solutions.

② PRESSURE

- For gases dissolved in liquids, solubility INCREASES when the partial pressure of the solute gas over the solution INCREASES.

- Consider soft drinks. They go flat after opening because the pressure of carbon dioxide over the liquid goes down.

- No significant pressure effects for solid/liquid solutions.

What is the freezing point of a 10.0% (by mass) aqueous glucose solution

GLUCOSE: $C_6H_{12}O_6$ $K_{F,H_2O} = 1.858\ ^\circ C/m\ (p500)$

$$\Delta T_F = K_F * C_m \quad \Big| \quad C_m = \frac{mol\ C_6H_{12}O_6}{kg\ H_2O}$$

$$\frac{10.0_g\ C_6H_{12}O_6}{100_g\ solution} \longrightarrow \frac{?\ mol\ C_6H_{12}O_6}{?\ kg\ H_2O}$$

$$100_g - 10_g = 90_g\ H_2O = 0.0900\ kg \longleftarrow$$

Subtract out the glucose to find the water's mass, then convert to kilograms

$C_6H_{12}O_6: 180.156\ g/mol$

$$10.0_g\ C_6H_{12}O_6 \times \frac{mol}{180.156_g} = 0.055507\ mol\ C_6H_{12}O_6$$

This is moles of glucose. Divide by solvent mass to get molality!

$$C_m = \frac{0.055507\ mol\ C_6H_{12}O_6}{0.0900\ kg\ H_2O} = 0.61675\ m\ C_6H_{12}O_6$$

$$\Delta T_F = (1.858\ ^\circ C/m)(0.61675\ m) = 1.15\ ^\circ C,\ so$$

$$T_F = 0.00\ ^\circ C - 1.15\ ^\circ C = \boxed{-1.15\ ^\circ C}$$

Subtract the depression from the original freezing point to get the new freezing point.