Using colligative props to find $\mathcal{M}$

↑ $\Delta T_f, \Delta T_b, \Pi$

ex: 0.150 g (#g) of polyvinylalcohol (PVA) is dissolved in H_2O w/ a total vol of 250. mL. The osmotic pressure of the soln @ 25°C is 0.0676 mm Hg.

What's $\mathcal{M}$

$\Pi = M \cdot R \cdot T \rightarrow M = \frac{\Pi}{RT}$

$\Pi = 0.0676\ mmHg \times \frac{1\ atm}{760\ mmHg} = 8.89 \times 10^{-5}\ atm$

$\rightarrow M = \frac{8.89 \times 10^{-5}\ atm}{0.0821 \frac{atm \cdot L}{mol \cdot K} \times 298\ K} = 3.637 \times 10^{-6} \frac{mol}{L}$

F↑ $\mathcal{M}$↓

$\mathcal{M} = \frac{\#g}{\#mol}$ ← 0.150 g

$\frac{250\ mL}{1000\ mL} \left| \frac{1\ L}{} \right| \frac{3.637 \times 10^{-6}\ mol}{1\ L}$

$\Rightarrow \#mol = 9.09 \times 10^{-7}\ mol$

$\mathcal{M} = \frac{0.150\ g}{9.09 \times 10^{-7}\ mol} = 165{,}000\ g/mol.$

Colligative properties of electrolytes

So far, we've only considered non-electrolytes.

ex: $C_6H_{12}O_6(s) \xrightarrow{H_2O} C_6H_{12}O_6(aq)$

glucose

1 : 1

$NaCl(s) \xrightarrow{H_2O} Na^+(aq) + Cl^-(aq)$

1 mol → 1 mol + 1 mol

2 mol total solute.

ex: 1 M NaCl(aq) = 1 M Na^+ + 1 M Cl^- } total solute conc 2 M

ex: $Na_2SO_4(s) \xrightarrow{H_2O} 2Na^+(aq) + SO_4^{2-}(aq)$

1 mol → 2 mol + 1 mol

3 mol ions

$K_3PO_4(s) \xrightarrow{H_2O} 3K^+(aq) + PO_4^{3-}(aq)$

1 mol → 4 mol

ex: What's fp of 0.20m $CaCl_2(aq)$?

nfp = 0°C , $K_f = 1.86\ °C/m$

$\Delta T_f = K_f \cdot m$

$= 1.86\ °C/m \times 0.20m$

$CaCl_2(s) \xrightarrow{H_2O} Ca^{2+}(aq) + Cl^-(aq) + Cl^-(aq)$

1 → 3

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

i = #particles each solute

breaks down into.

- van't Hoff factor

$CaCl_2 = 3$

"exact"

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

$= 1.86\ °C/m \times 3 \times 0.20m$

$= 1.116°C = 1.1°C$ (2 s.f.)

$\Rightarrow$ fp = 0°C − 1.1°C = −1.1°C

nfp depression

Same idea for bp elevation!

ex: what's bp of 3.0m iron(III) nitrate (aq).

Fe^{3+} NO_3^- (3)

$Fe(NO_3)_3$

$Fe^{3+}(aq) + 3NO_3^-(aq)$

nbp(H_2O) = 100°C

$K_b(H_2O) = 0.52\ °C/m$

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

$= 0.52 \frac{°C}{m} \cdot 4 \cdot 3.0m$

$= 6.24°C$

$\Rightarrow$ bp = 100°C + 6.24°C

= 106.2°C

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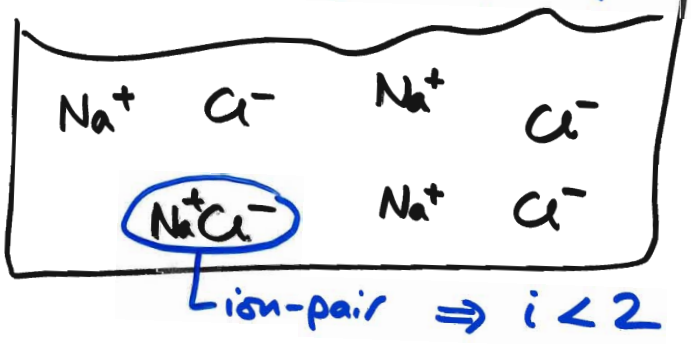
van't Hoff factor = i

- theoretical value = # ions / compound.

ex: NaCl : $i = 2$

in reality, this is a maximum (theoretical) value. - Often smaller.

- as conc ↑, ion-pairing reduces (i)



Ch 14 - Chemical kinetics.

How fast is a chemical rxn?

- how do we measure speeds of rxns?
- can we predict speeds of rxns?

Car speed: speed or velocity

$$= \frac{\text{distance travelled}}{\text{time}}$$

Rates of chem. rxns : Rate $\cong$ $\frac{\text{change in conc}}{\text{change in time}}$ (M)

$\frac{M}{s}$ OR $M \cdot s^{-1}$ (s)

$\frac{1}{x} = x^{-1}$

$A \rightarrow B$

always make rxn arrow true by using Θ infront of Reactants!

$$\text{rate} = -\frac{\Delta[A]}{\Delta t} = \frac{\Delta[B]}{\Delta t}$$

what about:

$$2A \longrightarrow B$$

$$\text{rate} = -\frac{1}{2}\frac{\Delta[A]}{\Delta t} = \frac{\Delta[B]}{\Delta t}$$

in general:

$$aA + bB \rightarrow cC + dD$$

$$\text{rate} = -\frac{1}{a}\frac{\Delta[A]}{\Delta t} = -\frac{1}{b}\frac{\Delta[B]}{\Delta t}$$

$$= +\frac{1}{c}\frac{\Delta[C]}{\Delta t} \quad = +\frac{1}{d}\frac{\Delta[D]}{\Delta t}$$

ex: $3O_2(g) \longrightarrow 2O_3(g)$

rate =