Announcements – Lecture VI – Thursday, Feb 8th

1. Class Web Site: https://genchem.chem.umass.edu – Under Spring, click on Chem 112 – the click on my picture!

2. Quiz 2: Due on Tuesday, February 13th.

3. iClicker:  Pick any letter a-e

13.4 Colligative Properties

Vapor Pressure Lowering – van't Hoff Factor?

In our discussion of Raoult's Law we have stuck with non volatile liquids (nonelectrolytes) that dissolve in water.

What if we used soluble ionic compounds ?

$1M\ NaCl(aq) = 1M\ Na^{+} + 1M\ Cl^{-}$; $i = 2$.

$1M\ CaCl_2(aq) = 1M\ Ca^{2+} + 2M\ Cl^{-}$; $i = 3$.

How about using a weak acid ?

$1M\ HCN(aq) \Leftrightarrow ?M\ H^{+} + ?M\ CN^{-}$; $i > 0$ but < 2.

13.4 Colligative Properties

Vapor Pressure Lowering – van't Hoff Factor?

Which of the following solutions would have the **highest boiling point**?

a)	**0.19m** NH_4NO_3	$NH_4^+ + NO_3^-$;	$i = 2$	$2 \times 0.19 = 0.38$
b)	**0.18m** KCH_3COO	$K^+ + CH_3COO^-$;	$i = 2$	$2 \times 0.18 = 0.36$
c)	**0.21m** NaCl	$Na^+ + Cl^-$;	$i = 2$	$2 \times 0.21 = 0.42$
d) ✓	**0.44m** Glucose (nonelectrolyte)		$i = 1$	$1 \times 0.44 = 0.44$ ✓

13.4 Colligative Properties

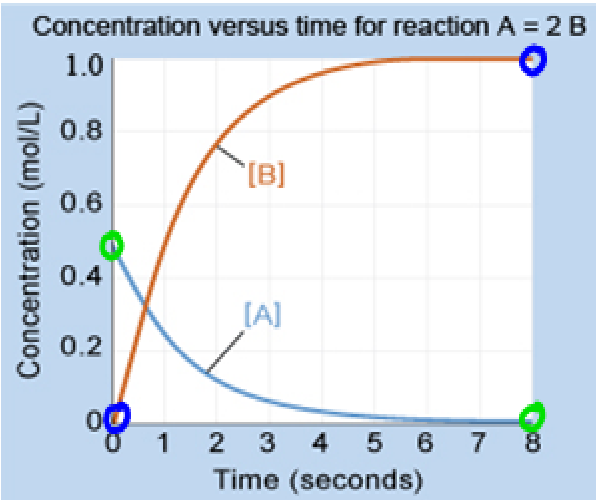
Vapor Pressure Lowering – van't Hoff Factor?

Which of the following solutions would have the **lowest freezing point**?

a)	0.15m CuI_2	$Cu^{2+} + 2I^-$	; $i = 3$	$3 \times 0.15 = 0.45$
b) ✓	0.17m $Zn(CH_3COO)_2$	$Zn^{2+} + 2\ CH_3COO^-$	; $i = 3$	$3 \times 0.17 = 0.51$ ✓
c)	0.14m CoI_2	$Co^{2+} + 2I^-$	; $i = 3$	$3 \times 0.14 = 0.42$
d)	0.47m Urea (nonelectrolyte)		$i = 1$	$1 \times 0.47 = 0.47$

14.2 Expressing the Rate of a Reaction

Average Rate and Reaction Stoichiometry



$$A = 2B$$

Timed from 0 to 8 seconds.

$$\text{Rate} = \frac{\Delta[B]}{\Delta t} = \frac{[B]_8 - [B]_0}{t_8 - t_0} = \text{Rate of Formation of B}$$

$$\text{Rate} = \frac{\Delta[A]}{\Delta t} = \frac{[A]_8 - [A]_0}{t_8 - t_0} = \text{Rate of Dissapearance of A}$$

For B:

$$\text{Rate} = \frac{1M - 0M}{8s - 0s} = 0.125\ M\ s^{-1}$$

For A:

$$\text{Rate} = \frac{0M - 0.5M}{8s - 0s} = -0.0625\ M.s^{-1}$$

No surprise, A = 2B, the average rate of Formation of B is twice the average rate of Dissapearance of A.

14.2 Expressing the Rate of a Reaction

Average Rate and Reaction Stoichiometry

* see previous slide.

$$A = 2B$$

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

$$= \frac{1}{2}(0.125\ M.s^{-1})^{*} = -(-0.0625\ M.s^{-1})^{*}$$

$$= 0.0625\ M.s^{-1} = 0.0625\ M.s^{-1}$$

In general : $aA + bB = cC + dD$

$$\text{Average rate of reaction} = -\frac{1}{a}\frac{\Delta[A]}{\Delta t} = -\frac{1}{b}\frac{\Delta[B]}{\Delta t} = \frac{1}{c}\frac{\Delta[C]}{\Delta t} = \frac{1}{d}\frac{\Delta[D]}{\Delta t}$$

14.2 Expressing the Rate of a Reaction

Average Rate and Reaction Stoichiometry

For the decomposition of hydrogen peroxide in dilute sodium hydroxide at 20 °C,

$$2\,H_2O_2(aq) \rightarrow 2\,H_2O(\ell) + O_2(g)$$

the **average rate of disappearance** of H_2O_2 over the period from t = 0 to t = 516 min is found to be 8.08×10^{-5} M/min.

What is the **average rate of appearance of O_2** over the same period?

What is the **average rate of the reaction**?

$$\text{Average Rate of Reaction} = -\frac{1}{2}\frac{\Delta[H_2O_2]}{\Delta t} = \frac{1}{2}\frac{\Delta[H_2O]}{\Delta t} = \frac{1}{1}\frac{\Delta[O_2]}{\Delta t}$$

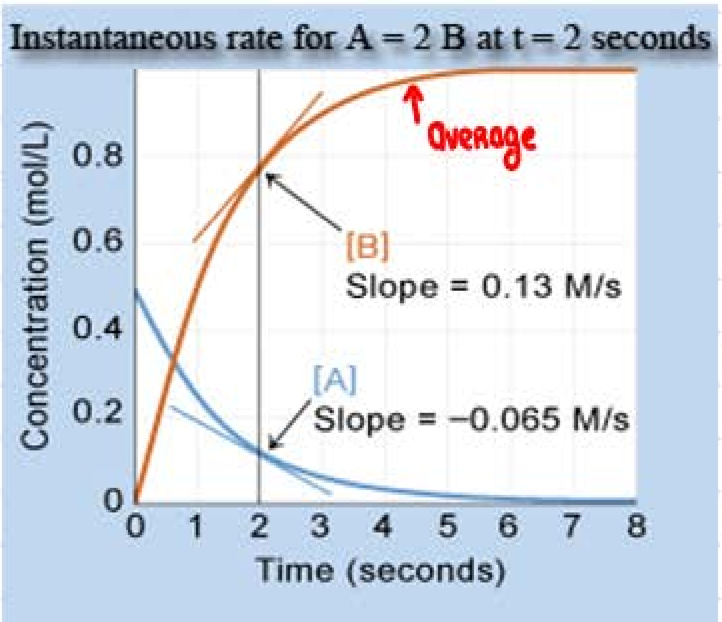
$$-\frac{\Delta[H_2O_2]}{\Delta t} = 8.08 \times 10^{-5}\ M.min^{-1}$$

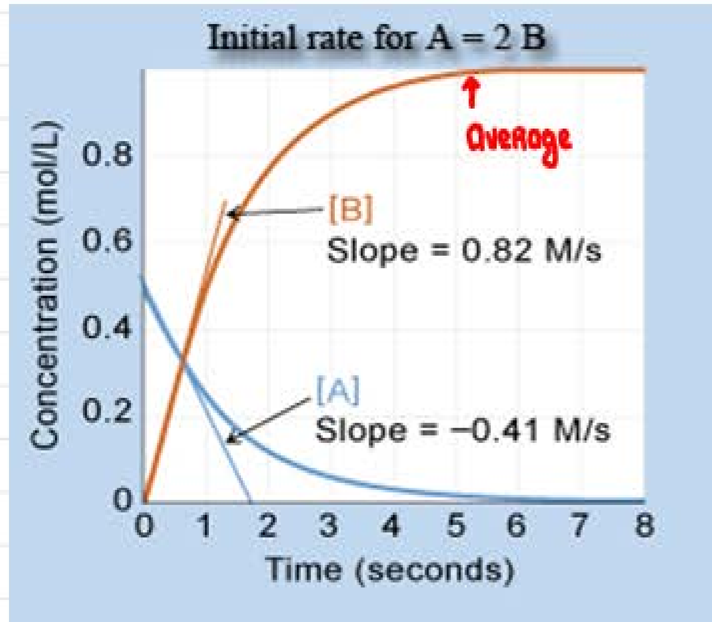
$$\frac{\Delta[O_2]}{\Delta t} = -\frac{1}{2}\frac{\Delta[H_2O_2]}{\Delta t}$$
$$= \frac{1}{2}\left(-\frac{\Delta[H_2O_2]}{\Delta t}\right)$$
$$= \frac{1}{2}(8.08 \times 10^{-5})$$
$$= 4.04 \times 10^{-5}\ M.min^{-1}$$

$$\text{Average Rate of reaction} = \Delta[O_2]/\Delta t$$
$$= 4.04 \times 10^{-5}\ M.min^{-1}$$

14.2 Expressing the Rate of a Reaction

Instantaneous and Initial Rates





Initial rates are where the rate of formation and the rate of Dissapearance is line.

Thus this is our region of choice.