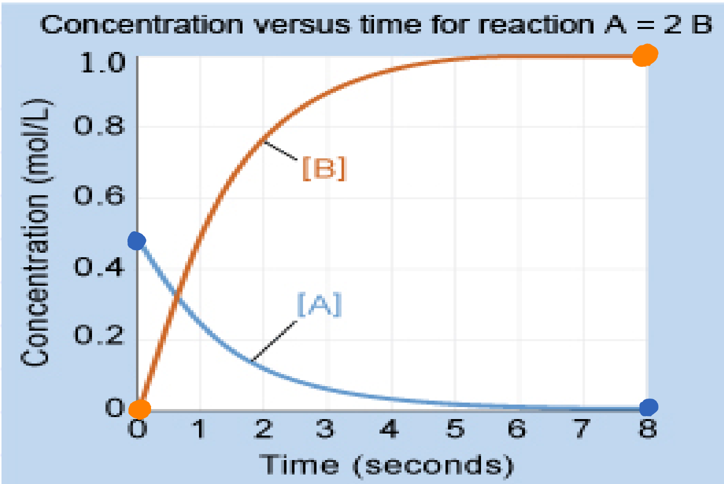
14.2 Expressing the Rate of a Reaction

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, that 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

$$A = 2B$$

Average Rate of Reaction $= \frac{1}{2}\frac{\Delta[B]}{\Delta t} = -\frac{1}{1}\frac{\Delta[A]}{\Delta t}$

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

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

* See previous slide to see where these numbers come from.

Generalization: $aA + bB = cC + dD$

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**?

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

$$-\frac{\Delta[H_2O_2]}{\Delta t} = 8.08\times10^{-5}\ M.min^{-1}$$

$$\frac{\Delta[O_2]}{\Delta t} = -\frac{1}{2}\frac{\Delta[H_2O_2]}{\Delta t}$$

$$= \frac{1}{2}\left(-\frac{\Delta[H_2O_2]}{\Delta t}\right)$$

$$= 1/2\,(8.08\times10^{-5}\ M.min^{-1})$$

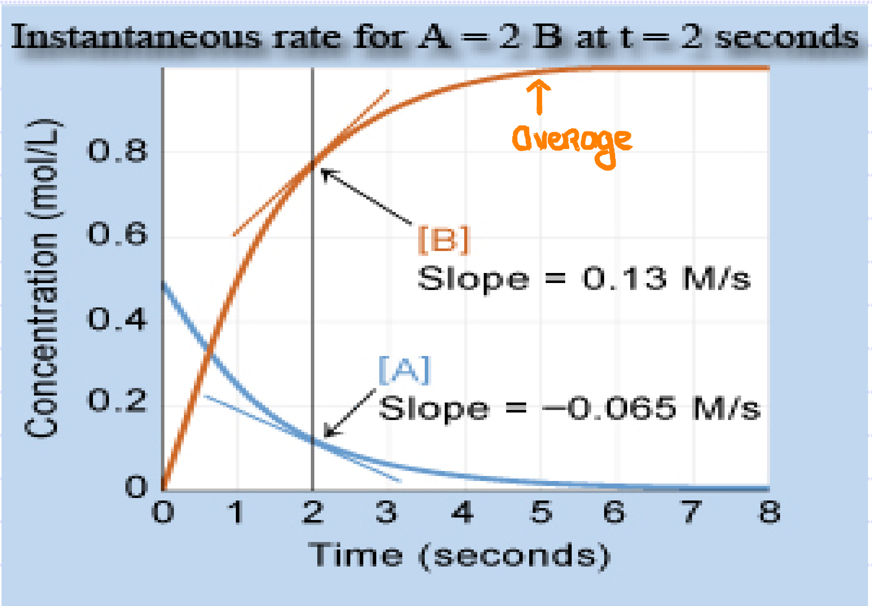
$$= 4.04\times10^{-5}\ M.min^{-1}$$

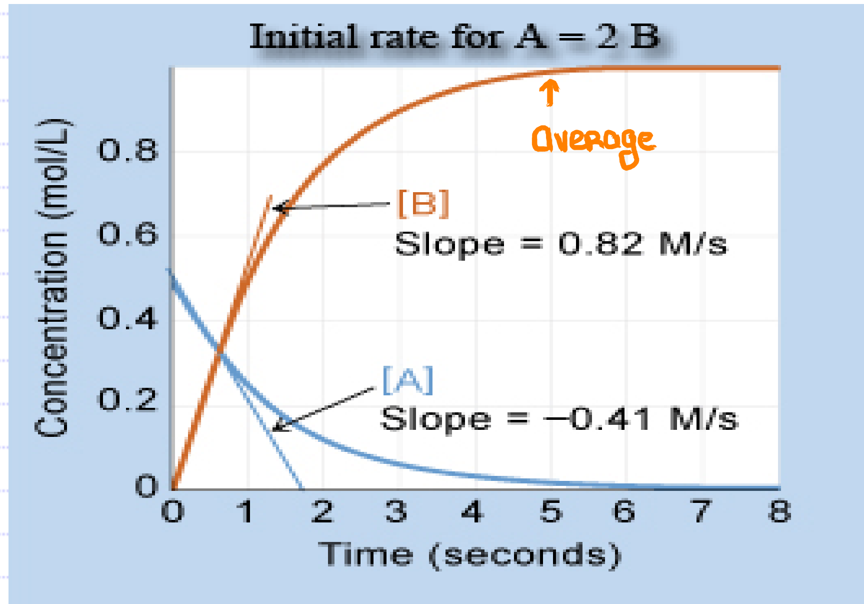
$$\text{Average Rate of Reaction} = \frac{\Delta[O_2]}{\Delta t}$$

$$= 4.04\times10^{-5}\ M.min^{-1}$$

14.2 **Expressing the Rate of a Reaction**

Instantaneous and Initial Rates





Initial Rate : Is where the Rate of Formation and the Rate of Dissapearance is linear and thus becomes our region of choice.