CONCEPT: INTEGRATED RATE LAW

- **Integrated Rate Law** describes the relationship between [reactants] and _____.
  - □ Helps determine how long it takes for X amount of moles per L of reactant to be _____
  - □ Integrated rate law depends on the _____ of the reaction

Zero-Order Integrated Rate Law

- For reactions following zero order rate law, we use the following equation:

Zero-Order Integrated Rate Law

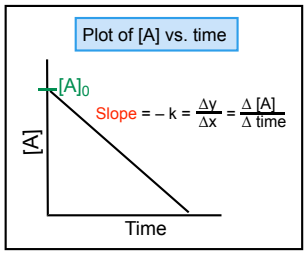
- □ $[A]_t$ = Final Reactant Concentration
- □ $[A]_0$ = Initial Reactant Concentration
- □ k = Rate Constant in _____
- □ t = time

$$[A]_t = -kt + [A]_0$$

Related to equation of a straight line:

$$y = mx + b$$

Slope = – k



EXAMPLE: A plot of $[NO_3]$ vs time with a slope of 0.260 gives a straight line. What was the initial concentration of NO_3 if after 35 seconds its concentration dropped to 2.75×10^{-2} M?

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First-Order Integrated Rate Law

- For reactions with first order, we use the following equation:

First-Order Integrated Rate Law

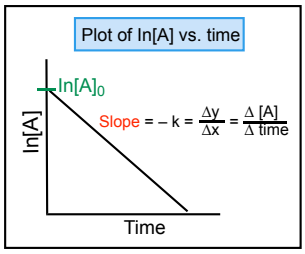
- □ $[A]_t$ = Final Reactant Concentration
- □ $[A]_0$ = Initial Reactant Concentration
- □ k = Rate Constant in _____
- □ t = time

$$\ln[A]_t = -kt + \ln[A]_0$$

Related to equation of a straight line:

$$y = mx + b$$

Slope = – k



□ All _____ processes (reactions) follow 1st order rate law.

EXAMPLE: A certain reaction has a rate constant of 0.289 s^{-1}. How long (seconds) would it take for the concentration of reactant A to decrease from 1.43 M to 0.850 M?

Second-Order Integrated Rate Law

- For reactions with second order, we use the following equation:

Second-Order Integrated Rate Law

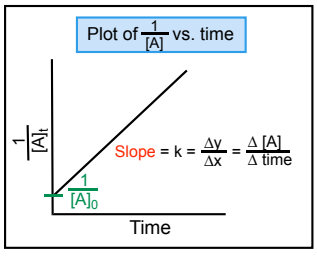
- □ $[A]_t$ = Final Reactant Concentration
- □ $[A]_0$ = Initial Reactant Concentration
- □ k = Rate Constant in _____
- □ t = time

$$\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$$

Related to equation of a straight line:

$$y = mx + b$$

Slope = k



EXAMPLE: The reactant concentration for a second-order reaction was 0.670 M after 300 s and 7.3 x 10^{-2} M after 750 s. What is the rate constant k for this reaction?

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PRACTICE: For the reaction A $\longrightarrow$ B, the rate constant is 0.0837 M^{-1}•sec^{-1}. How long would it take for [A] to decrease by 85%?

PRACTICE: The following reaction has a rate constant of 3.7 x 10^{-3} M•s^{-1} at 25ºC:

$$A \longrightarrow B + C$$

Calculate the concentration of C after 2.7 x 10^{-3} sec where $[A]_0$ was 0.750 M at 25ºC; assume $[C]_0$ = 0 M.

PRACTICE: For the decomposition of urea, NH_2CONH_2 (aq) + H^+(aq) + $2H_2O$ (l) $\longrightarrow$ $2NH_4^+$ (aq) + HCO_3^- (aq), the rate constant is 3.24 x 10^{-4} s^{-1} at 35ºC. The initial concentration of urea is 2.89 mol/L. What fraction of urea has decomposed after 3.5 minutes?

PRACTICE: Iodine-123 is used to study thyroid gland function. As this radioactive isotope breaks down, after 5.7 hrs the concentration of iodine-123 is 56.3% complete. Find the rate constant of this reaction.