CONCEPT: HALF-LIFE

- **Half-Life** is the _____ it takes for _____ of a reactant to decay (decompose) in a certain time period.
  - □ Depends on the order of the reaction

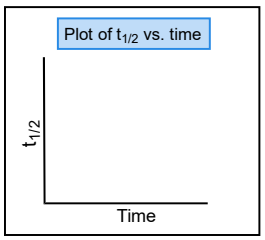
Zero-Order Half-Life

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

Zero-Order Half-Life

$$t_{1/2} = \frac{[A]_0}{2k}$$

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



- □ Half-Life _____ on the initial concentration and gets _____ as concentration decreases.

EXAMPLE: The reverse Haber reaction: $2\ NH_4\ (g) \longrightarrow 3\ H_2\ (g) + N_2\ (g)$, has a rate constant of $1.45 \times 10^{-6}\ M \cdot s^{-1}$ at 25ºC. Calculate the half-life for the reaction where $[NH_4]_0 = 2.47 \times 10^{-2}$ mol/L.

PRACTICE: Decomposition of a certain substance Y at 45ºC was found to be zero order. What is the half-life of substance Y if it took 15.5 minutes to decompose 67% of this substance? $[Y]_0 = 0.25$ M.

CONCEPT: HALF-LIFE

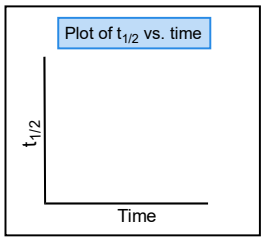
First-Order Half-Life

- Recall: All radioactive processes follow a 1st order rate law.
  - □ For reactions with first order, we use the following equation:

First-Order Half-Life

$$t_{1/2} = \frac{\ln 2}{k}$$

- □ ln2 = Constant
- □ k = Rate Constant in _____
- □ t = time



□ Half-Life does _____ depends on the initial concentration and is _____ throughout the whole reaction.

EXAMPLE: Rate constant for the following reaction was found to be $2.3 \times 10^{-3}\ s^{-1}$ at 35°C:

$$2\ NO_2 \longrightarrow N_2O_4$$

If the initial concentration of NO_2 was 1.4×10^{-1}, what is the half-life on this reaction?

PRACTICE: Radioactive plutonium-239 ($t_{1/2} = 2.41 \times 10^5$ yr) is used in nuclear reactors and atomic bombs. If there are 5.70×10^2 g of plutonium isotope in a small atomic bomb, how long will it take for the substance to decay to 3.00×10^2 g?

PRACTICE: Which of the following statements is **False**?

a) The average rate of a reaction decreases during a reaction.

b) The rate of zero order reactions are not dependent on concentrations.

c) The rate of a first order reaction is dependent on concentrations.

d) The half-life of a first order reaction is dependent on the initial concentration of reactant.

CONCEPT: HALF-LIFE

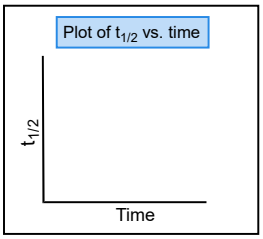
Second-Order Half-Life

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

Second-Order Half-Life

$$t_{1/2} = \frac{1}{k[A]_0}$$

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



□ Half-Life _____ on the initial concentration and gets _____ as concentration decreases.

EXAMPLE: The half-life of a certain reaction with 2nd order was found to be 0.45 seconds. What was the initial concentration of a reactant if the slope of the straight line for this reaction is 3.5×10^{-3}?

PRACTICE: Use the data below to determine the half-life of decomposition of NOCl reaction which follows 2nd order kinetics.

Time (s)	[NOCl] (M)
0	0.2563
200	0.2467
400	0.2425
600	0.2383
800	0.2347
1100	0.2314