

Half-life <-- these are just little chemistry/math problems. Each rate order has a specific half-life form. Often you'll be asked to find k , the rate constant, or, if you are given the rate constant and the initial concentration, to find the half-life.

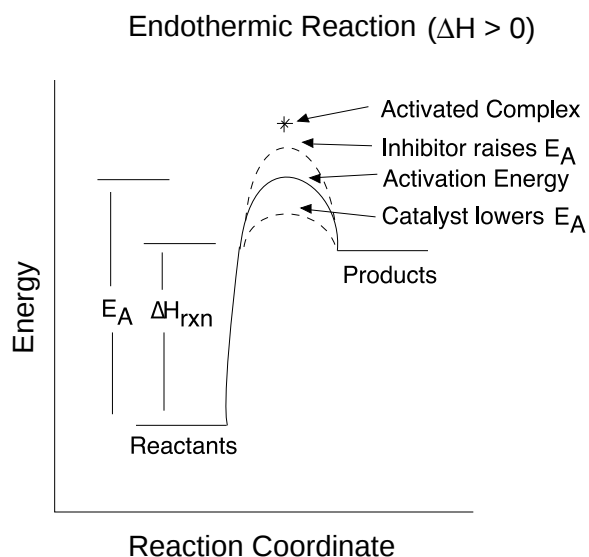
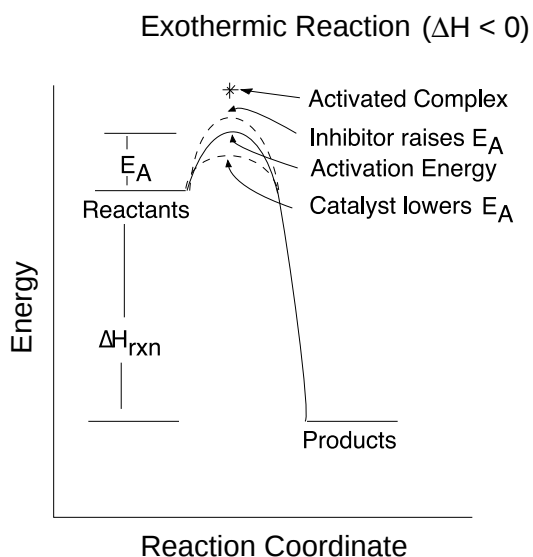
- What you want to do is look at the linear-forms of the concentration time expressions for each rate order.
- ★ Always remember that in half-life problems you don't have to be given numbers for concentrations. What you know is that at the half-life time the concentration of the reacting species is equal to half of its initial concentration ($[A] = 1/2[A]_0$).

Here's a summary for zero, first, and second order reactions:

Order	Linear $[A]$ vs time form	1/2-life expression	Dependence upon concentration
0	$[A] - [A]_0 = -kt$	$t_{1/2} = \frac{[A]_0}{2k}$	yes
1	$\ln[A] - \ln[A]_0 = -kt$	$t_{1/2} = \frac{.69}{k}$	no
2	$\frac{1}{[A]} - \frac{1}{[A]_0} = kt$	$t_{1/2} = \frac{1}{[A]_0 k}$	yes

Collision Theory, Activation Energy and Activated Complex

- This is just about trying to explain how the actual reaction occurs. Like what makes two reactant molecules actually react with each other when they collide. Sometimes they react, sometimes they don't. It's explained in terms of an activation energy that is required to trigger the reaction and an intermediate molecule, called the activated complex that is the unstable intermediate species occurring when the molecules collide. It's diagrammed out below for both an exothermic and an endothermic reaction (know each of these very well):



Student Packet: 4.3: Half-Life: AssessMe questions

- 1) A plot of $\log(\text{initial rate})$ vs. $\log([A])$ has a _____ which is equal to the reaction order for reactant A.
- A) y-intercept B) x-intercept C) slope D) none of the above E) I'm clueless
- 2) For reactions with unknown or different orders, direct rate comparison can be made by comparing
- A) reaction half-lives
B) rate constants
C) reaction lifetimes
D) reactant concentration
E) I'm clueless
- 3) The half-life of ^{14}C is 5,570 years. How many years will it take for 90% of a sample to decompose?
- A) 5,570 years
B) 17,700 years
C) 18,503 years
D) 50,100 years
E) I'm clueless
- 4) For a first order reaction of half-life 150 min., what is the rate constant in min^{-1} ?
- A) 0.00104 B) 0.00462 C) 69.3 D) 216 E) I'm clueless
- 5) The rate of the reaction $2\text{A} + \text{B} \longrightarrow \text{Products}$ is consistent with first order kinetics for both A and B. Which reaction mechanism is consistent with this information?
- | | |
|--|--|
| Step 1 | Step 2 |
| A) $\text{A} + \text{B} \longrightarrow \text{AB}$ (slow) | $\text{AB} + \text{A} \longrightarrow \text{Products}$ (fast) |
| B) $\text{A} + \text{A} \longrightarrow \text{A}_2$ (slow) | $\text{A}_2 + \text{B} \longrightarrow \text{Products}$ (fast) |
| C) $\text{A} + \text{B} \longrightarrow \text{AB}$ (fast) | $\text{AB} + \text{A} \longrightarrow \text{Products}$ (slow) |
| D) $\text{A} + \text{A} \longrightarrow \text{A}_2$ (fast) | $\text{A}_2 + \text{B} \longrightarrow \text{Products}$ (slow) |
| E) I'm clueless | |
- 6) The dissociation of HI molecules, as shown below, occurs at a temperature of 629 K. The rate constant $k = 3.02 \times 10^{-5} \text{ M}^{-1}\cdot\text{s}^{-1}$. What is the order of this reaction?
- $$2\text{HI}_{(\text{g})} \longrightarrow \text{H}_{2(\text{g})} + \text{I}_{2(\text{g})}$$
- A) 0 B) 1 C) 2 D) 3 E) I'm clueless

Student Packet: 4.3: Half-Life: ShowMe questions

- 1) A reaction is found to have the following integrated rate law:



- What is the expression for the half-life of the reaction?
- Based on the following data, what are the half-life and rate constant for the reaction $A \longrightarrow B$?

$\frac{[A]}{}$	Elapsed time
0.6 M	0
0.2 M	120 sec

- 2) The following first-order reaction, $A \longrightarrow B$, was found to have a half-life of 600 seconds:

- Calculate the rate constant of this reaction.
- How much time has elapsed when the reaction is 92% complete?

- 3) The integrated rate law of the reaction $A \longrightarrow B$ is as follows:

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

- What is the expression for the half-life of the reaction?
- Given the following data, calculate the half-life and rate constant of the reaction $A \longrightarrow B$.

$\frac{[A]}{}$	Elapsed time
3.0M	0 min
2.4M	200 min

- 4) A zeroth-order reaction, $A \longrightarrow B$, is found to have the following integrated rate law:

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

- What is the expression for the half-life of the reaction?
- Given the following data, calculate the rate constant and half-life of the reaction $A \longrightarrow B$.

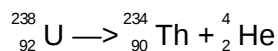
$\frac{[A]}{}$	Elapsed time
14 mM	0
3.0 mM	6 hr

Student Packet: 4.3: Half-Life: TestMe questions

- 1) A particular second order reaction was found to have a half-life of 120 seconds. The initial concentration of reactant was 2.5 M. At what time will the concentration of species A be 1.7 M?

A) 28 sec B) 56 sec C) 120 sec D) 240 sec E) 272 sec

- 2) $^{238}_{92}\text{U}$ decays via α -particle emission in the following reaction:



Where $k = 1.54 \times 10^{-10} \text{ years}^{-1}$ and the $t_{1/2} = 4.50 \times 10^9 \text{ years}$. What order is the decay reaction with respect to uranium?

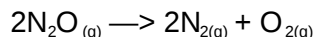
- A) Zeroth order
B) First order
C) Second order
D) None of the above
E) Cannot determine from the information given

- 3) A reaction has the following form: $a\text{A} \longrightarrow b\text{B}$

There is an initial concentration of A equal to $3.0 \times 10^{-2} \text{ M}$, a plot of $1/a$ vs. time yielded a straight line with a slope of $5.65 \times 10^{-4} \text{ M}^{-1}\text{sec}^{-1}$. What is the half-life of this reaction?

A) $1.3 \times 10^4 \text{ sec}$ B) 27 sec C) $1.3 \times 10^2 \text{ sec}$ D) $5.9 \times 10^4 \text{ sec}$ E) $1.8 \times 10^3 \text{ sec}$

- 4) The decomposition of nitrous oxide occurs on a platinum surface via the following reaction:



At a particular temperature, N_2O partial pressure vs. time measurements were obtained. A plot of PN_2O vs. time yielded a straight line with a slope of $-3.60 \times 10^{-3} \text{ torr sec}^{-1}$. If the initial partial pressure of $\text{N}_2\text{O}_{(g)}$ was 200 torr, what was the half-life of the decomposition reaction?

- A) $8.60 \times 10^3 \text{ sec}$
B) $5.56 \times 10^4 \text{ sec}$
C) $2.8 \times 10^4 \text{ sec}$
D) 193 sec
E) 1.39 sec

- 5) $^{238}_{92}\text{U}$ decays through a series of first order decay reactions to yield $^{206}_{82}\text{Pb}$ which is a stable nuclide. The half-life of $^{238}_{92}\text{U}$ is $4.5 \times 10^9 \text{ yrs}$. A rock containing $^{238}_{92}\text{U}$ and $^{206}_{82}\text{Pb}$ was discovered. The ratio of $^{238}_{92}\text{U}$ to $^{206}_{82}\text{Pb}$ was found to be 0.206. Assuming that no $^{206}_{82}\text{Pb}$ was initially present in the rock and that the number of nuclides intermediate in the decay series between $^{238}_{92}\text{U}$ and $^{206}_{82}\text{Pb}$ is negligible, how old is the rock?

- A) $1.15 \times 10^{10} \text{ yrs old}$
B) $1.54 \times 10^9 \text{ yrs old}$
C) $9.27 \times 10^8 \text{ yrs old}$
D) $6.37 \times 10^9 \text{ yrs old}$
E) 165 yrs old