Unit 3 – Kinetics

1. In order for a reaction to occur, particles must collide at the correct orientation & with a minimum energy to break bonds...(This minimum energy is called the activation energy...the height of the "hill".)
2. How to write a rate law for an elementary step… $2A + B \rightarrow C + D$ Rate = $k[A]^2[B]^1$
3. Rate constant (k) Units: 0^{th} order = Ms^{-1} 1^{st} order = s^{-1}; 2^{nd} order = $M^{-1}s^{-1}$
4. Graphs: 1^{st} order is linear for ln[A] vs time; 2^{nd} order is linear for 1/[A] vs time
   Absolute value of the slope = k
5. Ways to speed up a reaction: (1) Add a catalyst...lowers the activation energy by creating an alternate pathway for the reaction to take place or by helping to orient the molecules to a favorable orientation (2) Increase reactant concentration...more collisions (3) Increase surface area...more collisions (4) Increase pressure of gases...increases the concentration of the gas, so there are more collisions (5) increase temperature...more collisions AND more of them have the minimum activation energy.
6. ½ life for a 0^{th} order process: $t_{1/2} = [A]_0/2k$, 1^{st} order: $t_{1/2} = 0.693/k$, 2^{nd} order: $t_{1/2} = 1/k[A]_0$
7. A 1^{st} order reaction has a constant half-life regardless of the initial concentration.
   (Radioactive decay is a 1^{st} order process.)
8. The taller the "hill" (or activation energy) the slower the reaction.
9. The slow step (rate-determining step) will dictate the speed of the reaction, and this step will determine the rate law.
10. Reaction Mechanisms: Intermediates are produced in one step and used up in a later step.
11. Reaction Mechanisms: Catalysts are used in an early step, and remade/produced in a later step.

Thou Shalt Not Forget Questions

Credit: Dan Reid

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1. What are the 3 characteristics that an effective collision must have?
2. Write the rate law for the following reaction...assume it is an elementary step: $2N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$
3. What is the unit for the rate constant (k) for 1st order? For 2nd order? For 3rd order?
4. a) If [A] vs. time is linear, then the reaction has what order?
   If ln[A] vs. time is linear, then the reaction has what order?
   If 1/[A] vs. time is linear, then the reaction has what order?

   b) What is graphed on the x and y axis to make a linear plot in order to determine if a reaction is 1st order? If a reaction is 2nd order?
5. a) List 3 "completely different" ways to speed up a reaction.
   b) How does a catalyst speed up a reaction?
6. What order of reaction has a half-life that does not change regardless of the initial concentration?
7. Radioactive decay is what order?
8. If a "reaction profile" has a taller 'hill' (or activation energy) then is the reaction is slower or faster?
   If a "reaction profile" has a shorter 'hill' (or activation energy) then is the reaction is slower or faster?
9. Which step of a reaction mechanism determines the rate: the slow step or the fast step?
10. _____ are produced in one step and used up in a later step.
11. _____ are used up in one step, and produced in a later step.