Professor K

Kinetics

Reaction rate

- Speed of reaction
- Change in concentration of reactant or product with time
- Moles per liter per second ($ML^{-1}s^{-1}$)
- Appearance of product
- Disappearance of reactant

Rate law

- For aA + bB → cC + dD, the rate law is Rate = $k\,[A]^m[B]^n$
- Little k = rate constant
- NOT big K (equilibrium constant)
- Exponents *usually* small positive integers
- Exponents determined experimentally
- Exponents do NOT come from the balanced equation
- Repeat, exponents do NOT come from the balanced equation

Order of reaction

- Exponents in rate law give the order
- 0 = zero order
  - Changing concentration has no effect on rate
- 1 = first order
  - Double concentration, double rate
- 2 = second order
  - Double concentration, quadruple rate

Rate constant

- A proportionality constant
- Units vary with overall order of reaction
  - Zero Ms^{-1}
  - First s^{-1}
  - Second $M^{-1}s^{-1}$
  - Third $M^{-2}s^{-1}$

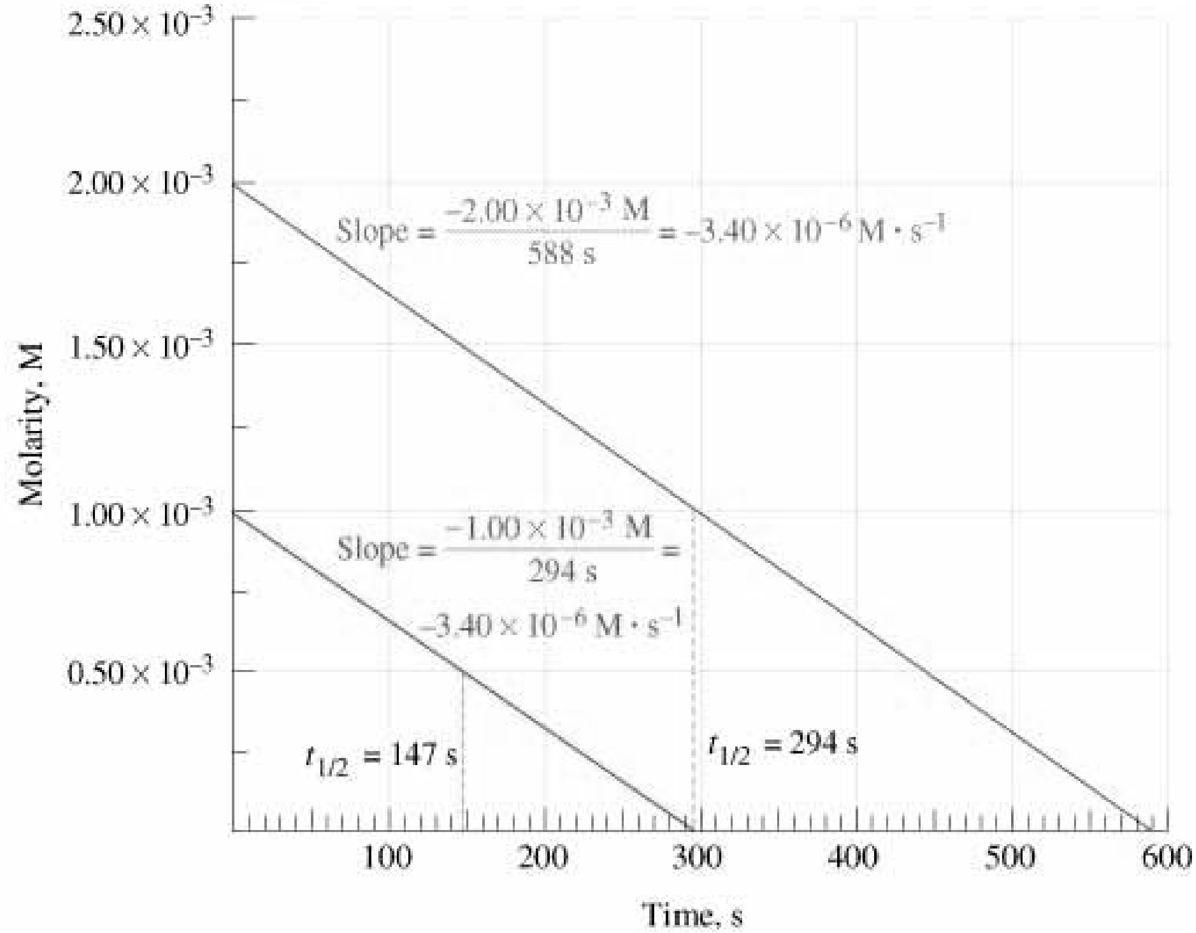
Problem solving

[NO]	$[Cl_2]$	rate
3	3	3
6	3	9
3	6	6

- 2NO (g) + Cl_2 (g) → 2NOCl (g)
- Rate = $k[NO]^2[Cl]$

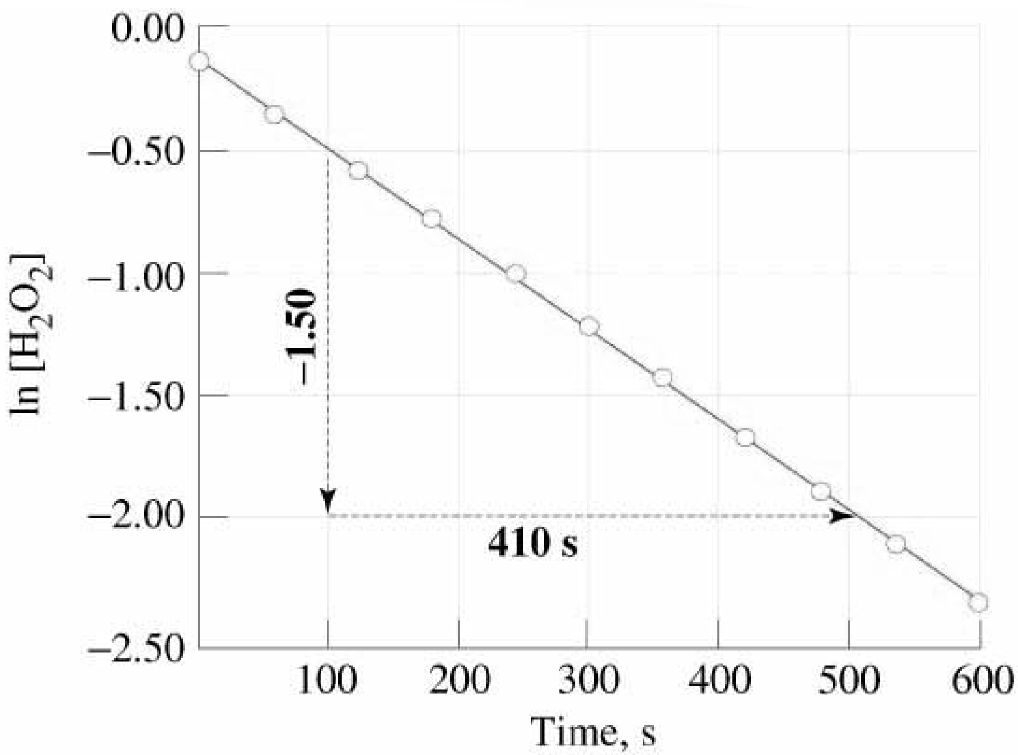
Zero order reactions

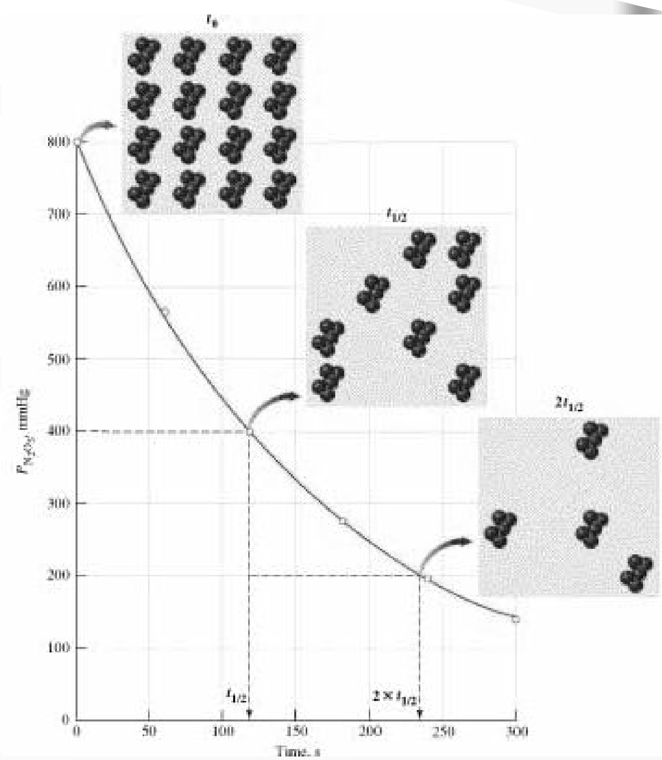
- Rate = k
- Plot of M vs t is straight line with slope = $-k$



First order reactions

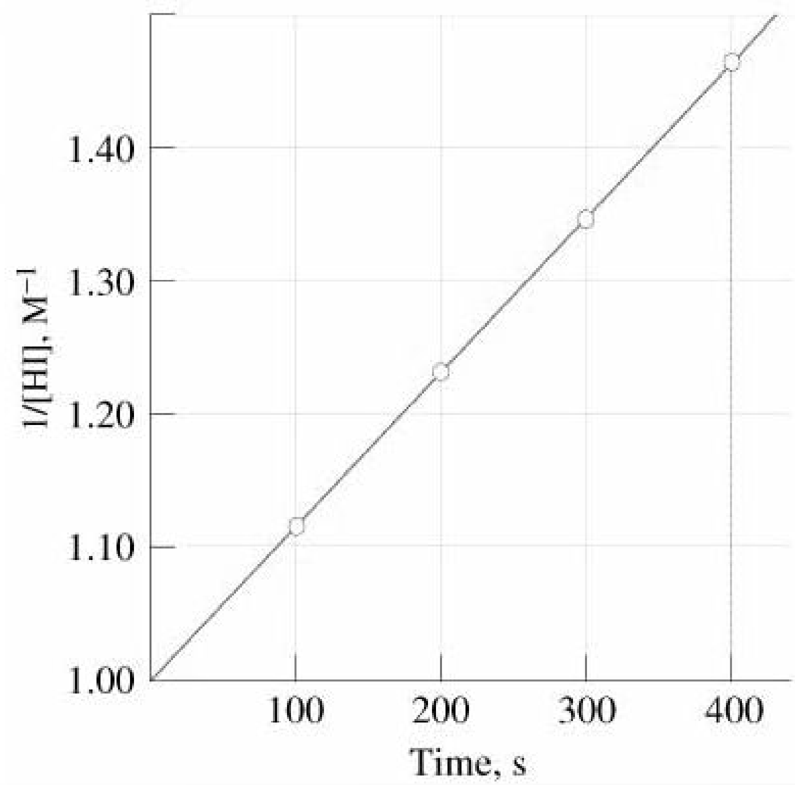
- Radioactive decay
- Integrated rate law = $\ln([A]_t/[A]_o) = -kt$
- Plot of ln[A] vs t = straight line with slope $-k$
- Half life $t_{½} = 0.693/k$
- After n half lives, $(½)^n$ of the initial concentration remains





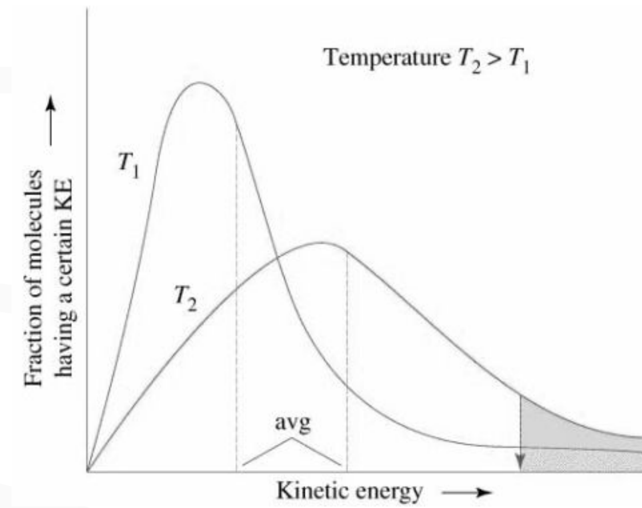
Second order reactions

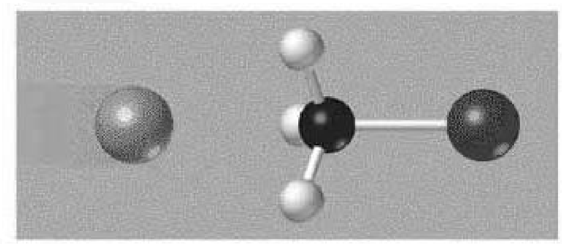
- $1/[A]_t = kt + 1/[A]_o$
- Plot of 1/[A] vs *t* is a straight line with slope = *k*



Collision theory

- Atoms and molecules must collide in order to react (form/break bonds)
- Not all collisions are effective; more are with increased T
- The ACTIVATION ENERGY is the minimum energy that must be supplied by a collision for a reaction to occur
- Orientation can also be important

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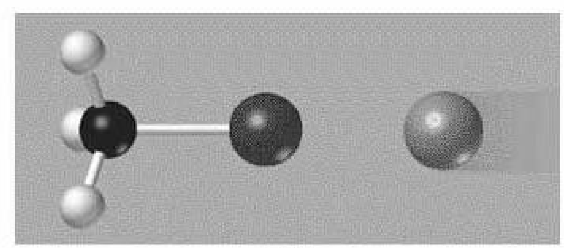
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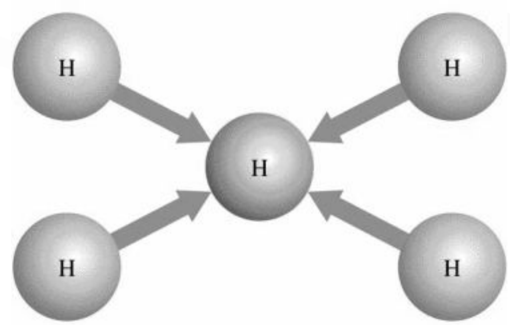
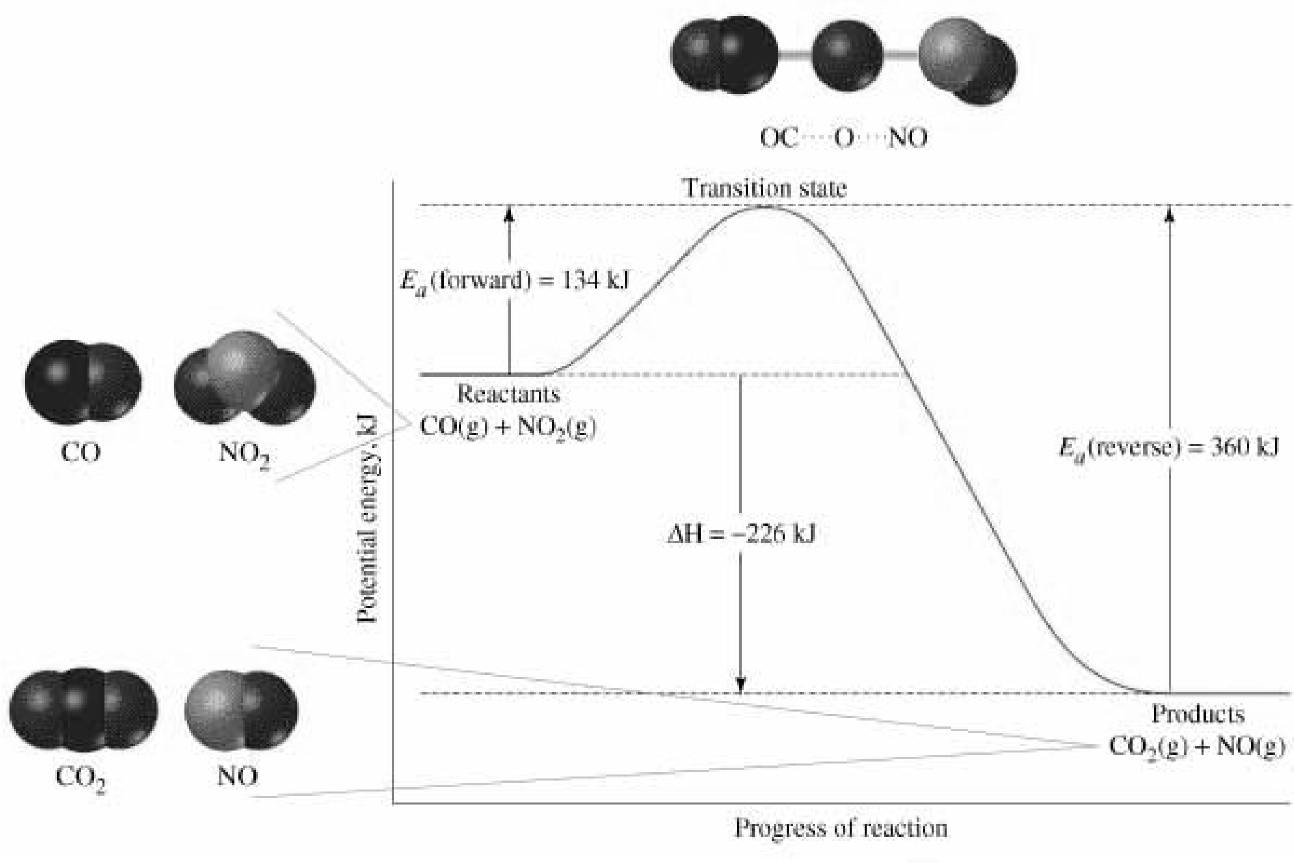


Transition state theory

- A REACTION PROFILE shows the movement from reactants to products through the ACTIVATED COMPLEX at the TRANSITION STATE



Catalysis

- A CATALYST lowers the activation energy of the reaction but is not consumed during the reaction
- An enzyme is a biological (protein) catalyst