2.22.19

The Arrhenius Equation

Diff rate law: $\text{Rate} = k[A]^m[B]^n$

(integrate)

Int Rate law: $[A]_t = \text{function}(t)$

— HALF LIFE —

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

$$\frac{1}{[A]_{0/2}} = \frac{1}{[A]_0} + kt_{1/2}$$

$$\frac{2}{[A]_0} - \frac{1}{[A]_0} = kt_{1/2}$$

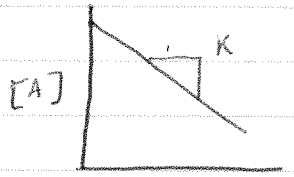
$$\frac{1}{[A]_0} = kt_{1/2}$$

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

(*) ZERO ORDER RXN —

$\text{Rate} = k[A]^m \leftarrow 0 = k$ ∴ $\text{Rate} = k$ ← rate doesn't change as RXN proceeds (w/ time)

Ex/ $2N_2O_{(g)} \rightarrow 2N_{2(g)} + O_{2(g)}$



$$\text{Rate} = k = \frac{-d[A]}{dt}$$

(*) Integrated Rate Law — Half Life for zero-order

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

$y = b + mx$

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

→ **Factors that affect RXN rate** ←

- reactant concentration (in rate law $[A]^m[B]^n$)
- physical state of reactants
- RXN temp
- catalyst

} in rate constant, k.

Contributions to k: geometry (collisions must have correct geometry for RXN to occur.)

$\text{Rate} = k[A]^m[B]^n$

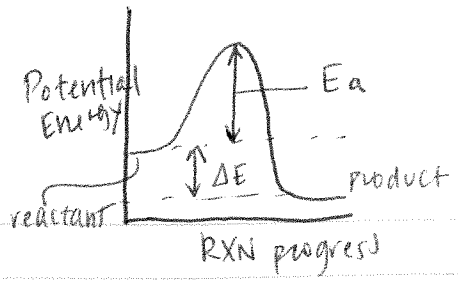
$k = c * g * f$

c: Frequency of collision; g: geometric factor; f: Fraction of molecules w/ $E > E_a$

A=Frequency Factor

A=Frequency

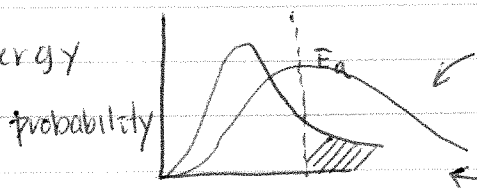
$k = A * f$



RXN progress

- highest energy state is transition state (Activated complex)
- The Ea is the height of the barrier above the reactants
- The overall RXN can be endothermic or exothermic (ΔE is + or −)

T => Kinetic Energy



← increasing Ea decreases # of molecules w/ energy.

← Larger fraction of molecules reacts at higher temp.

fraction of molecules $E > Ea$

$f = e^{-Ea/RT}$ $K = Ae^{-Ea/RT}$ << THE ARRHENIUS EQUATION >>

$k = Ae^{-Ea/RT}$

- Smaller Ea, means larger K,
- Larger K, faster rate.
- Larger Ea, means smaller K, and thus a slower rate.
- Larger temperature, means larger K and thus faster rate.
- Smaller temp, smaller K, and slower rate.