C12 - 1.0 - Reaction Kinetics (Rates)

Catalyst ↑ Rate (Both R*)(↓ E_a)
Inhibitors ↓ Rate

Reaction Factors

-Pressure (Gases)
-Volume (Container?)
-Geometry
-Orientation
-Moles/Mass
-Temperature
-Energy
-Catalyst
-Inhibitor
-Atomic Radii
-Nature (Chem)
-Ions > Atom > Molecule
-Bonds
-Homo vs Heterogeneous (SA)
-pH
-Collisions*
-Electrons
-State

$$Rate = \frac{amount}{time}$$

$$v = \frac{d}{t}$$

$v \propto d$ ∝ : directly proportional d↑v↑, d↓v↓

$v \propto \frac{1}{t}$ Inversely proportional t↑v↓, t↓v↑

Fastest ⟶ Slowest
Aqueous Ions Gases/Liquids Solids

Amount : Colour Intensity/Volume/Temperature/Pressure/Moles/Mass

Nature of Reactant : Chemical Properties of a Substance.

Rule of thumb - for a slow reaction, a 10^o temperature increase will double the rate.

Potential Energy (PE) - Energy of an object's position in space.
- And the sum of the attractive and repulsive forces of the particles in an object.

Collision Theory (Kinetic Molecular Theory) - Particles collide and transfer energy. Rate ∝ # of successful collisions*.

Kinetic Energy (KE) - Energy due to movement.

Bond Energy - Energy required to Break a Bond (PE↑).

↑ Temperature primarily ↑ # of particles with sufficient energy to react.

More than one step because successful collisions are unlikely to occur. (3 Pool Balls)

Catalyst in reactants of first step and products of a next*.

↑Temp,↑Reaction Rate
Particles moving Faster
↑ # Collisions
↑↑Energy
↑↑ # Successful Collisions w/↑PE

Rate Monitoring :
$If\ (s) + \cdots \rightarrow (g) + \cdots$
↓ Mass of (s)

If Contained*
↑P/↑ Volume

If Uncontained
↑ Volume (g)/↑ Mass (g)/↑ [ ] (g)

Conservation of Energy - Energy cannot be created or destroyed.

As molecules approach each other, the outer electrons repel each other, slowing down the molecules converting KE to PE. After the reaction, the outermost electrons repel each other converting PE to KE.

Activated Complex - Arrangement of atoms which occurs when the reactants are in the process of rearranging to form products. (An intermediate molecule.) Reaction Intermediaries - Products of each step.

Activation Energy (E_a) - Energy required for successful collisions. Minimum PE to change reactants into activated complex.

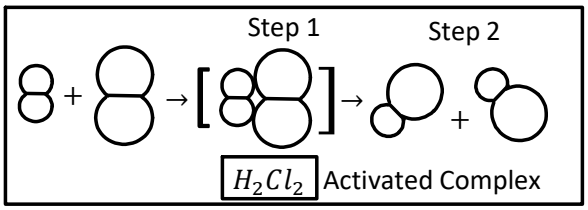
Reaction Mechanism - Sequence of steps of a reaction. (Elementary process is an individual step).
Activated Complex Formula - Adding up every reactant atom and charge in that step.

C12 - 1.0 - Reaction Kinetics

Reactants→[Activated Complex]→Products

$H_2 + Cl_2 \rightarrow 2HCl$

Activated Complex
-Short lived
-Unstable species
-Partial Bonds

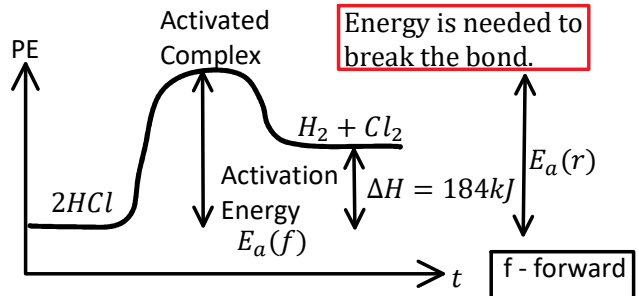


Alignment

$H-H$
$Cl-Cl$
Correctly (Parallel)

$H-H$
$Cl-Cl$
Not Correct

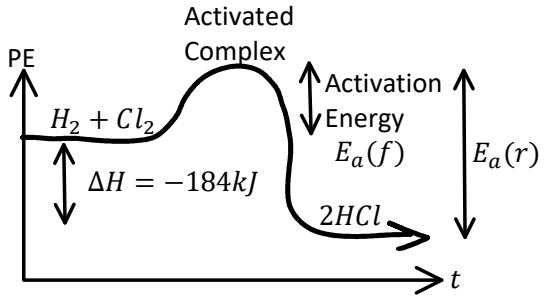
Endothermic Reaction : absorbes heat ($\Delta H = +$).



f - forward
r - reverse

$HCl + energy \rightarrow H + Cl$ *Add Energy*
$HCl + 184kJ \rightarrow H + Cl$

Exothermic Reaction : Releases heat ($\Delta H = -$).



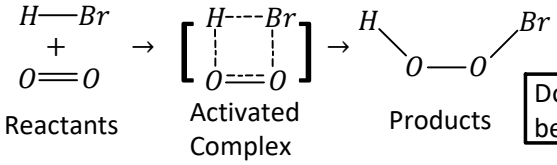
$HCl \rightarrow H + Cl + energy$ *Releases Energy*
$H + Cl \rightarrow HCl + 184kJ$
$H + Cl - 184kJ \rightarrow HCl$

Enthalpy : H, KE+PE in a system. $\Delta H = change\ in\ Enthalpy = H_{products} - H_{reactants}$

$4HBr + O_2 \rightarrow 2H_2O + 2Br_2$ Overall Reaction

Rate Determining Step - Slowest Step

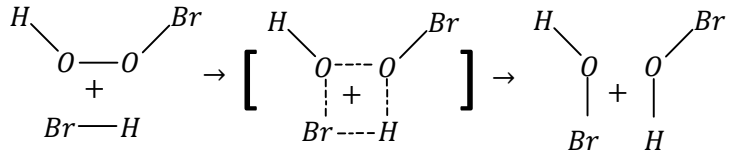
Step #1 $HBr + O_2 \rightarrow HOOBr$ (experimentally slow) HO_2Br



Dotted line - Bonds being made or broken

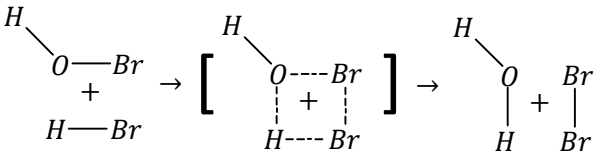
Speed up reaction -Changing speed of Rate determining step.

Step #2 $HOOBr + HBr \rightarrow 2HOBr$ (experimentally fast) $H_2O_2Br_2$



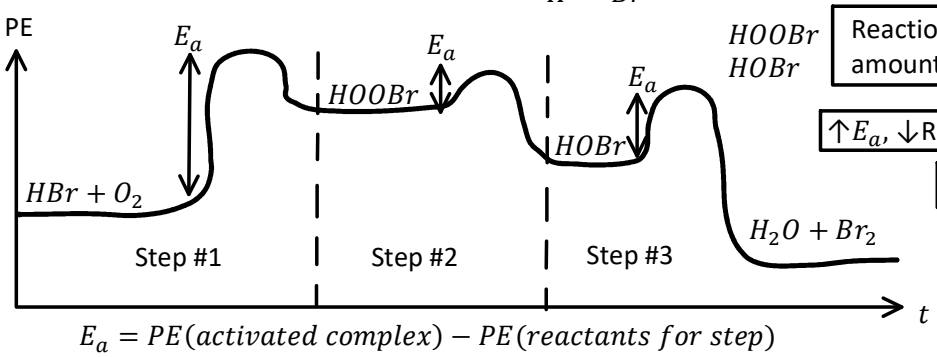
Reaction Intermediary
-Ordinary chemical species
-Produced in one step
-Used up in another [ ] ≈ 0
-Normal Bonds

Step #3 $HOBr + HBr \rightarrow H_2O + Br_2$ (experimentally fast)



$HBr + O_2 \rightarrow \cancel{HOOBr}$ $(slow)$
$HBr + \cancel{HOOBr} \rightarrow \cancel{2HOBr}$ $(fast)$
$2HBr + \cancel{2HOBr} \rightarrow 2H_2O + 2Br_2$ $(fast)$
$4HBr + O_2 \rightarrow 2H_2O + 2Br_2$

Intermediaries' = # Steps* -1



$HOOBr$
$HOBr$

Reaction Intermediaries - Small amount, used up as fast as it is made)

$\uparrow E_a, \downarrow$Reaction Rate, $\uparrow$Reaction Time

Small Hill (Fast)

$E_a = PE(activated\ complex) - PE(reactants\ for\ step)$