Activation Energies

1. The existence of a minimum energy requirement before a molecule can react means that there is a "barrier" to overcome

\[
\text{ACTIVATION ENERGY (Ea)} = \text{the minimum amount of energy required for reactants to form the activated complex}
\]
2. When reactant molecules approach each other during a chemical reaction, they slow down and their kinetic energy is converted into potential energy.

- if the molecules gain enough PE, bonds can be broken and new bonds made and an **ACTIVATED COMPLEX** is formed.

**ACTIVATED COMPLEX** = high E, unstable arrangement of atoms which occurs when reactants are in the process of rearranging to form products (reaction intermediate)
• after the reaction occurs, the newly formed molecules repel each other and speed up
• PE is then converted to KE as the product molecules move away from each other

\[ \text{Total Energy} = \text{PE} + \text{KE} \]

![Diagram](image)

• on the PE diagram, the reactants are assumed to collide with **ideal geometry**
• if the molecules do not have ideal geometry, the reaction can still take place but it reflected as an increase in activation energy
• consider the PE diagrams for an endothermic and exothermic reaction

> Activation Energy (Ea) = energy difference between reactant and activated complex

> Change in Enthalpy (ΔH) = energy difference between reactant and product
• for a reversible reaction

\[ \text{Reactant} \rightleftharpoons \text{Product} \]

> \( \text{Ea}_{(\text{fwd})} \) refers to the activation \( E \) for the forward reaction (reactant to activated complex)

> \( \text{Ea}_{(\text{rev})} \) refers to the activation \( E \) for the reverse reaction (products to activated complex)
• the rate of a reaction can be related to the activation energy of the reaction

Consider the following diagram:

A relationship can be seen when we compare the KE distribution to a PE diagram:
• Ea very high - few molecules will have enough energy to react, reaction rate will be low
• Ea low - more molecules will have enough energy to react, reaction rate will be high

The higher the activation energy, the slower the reaction rate and vice versa.