Energy Changes in Chemical Reactions

1. Different types of energy

Potential Energy = stored energy

- related to E of e- in chemical bonds as well as the number and types of atoms in the molecule
- ↑ when bonds are broken and ↓ when new bonds are formed

Kinetic Energy = energy of motion

- a result of movement of molecules within a system
- can be related to the temperature of the system

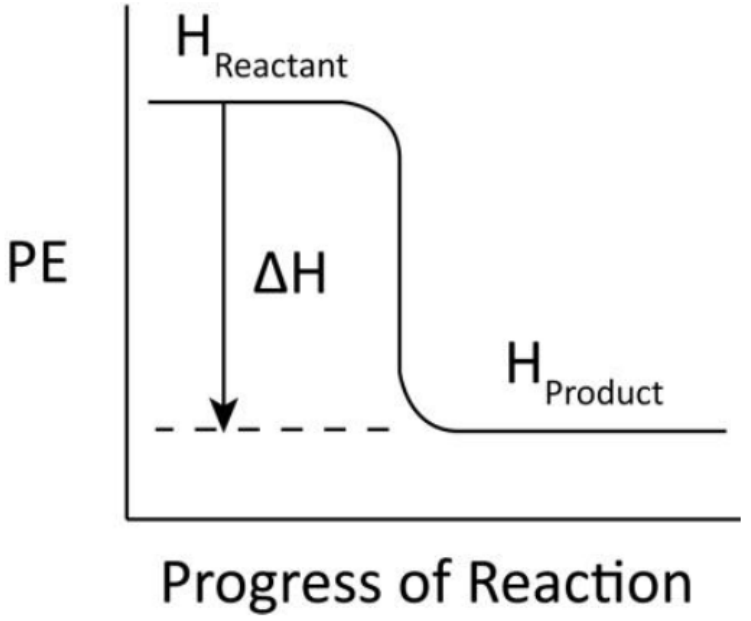
Enthalpy (H) = heat of reaction

- total kinetic and potential energy which exists in a system at constant pressure

$$\Delta H = H_{products} - H_{reactants}$$

2. During a chemical reaction, bonds of the reactant molecules are broken, the atoms are re-arranged and new bonds are formed

- heat may be transferred in or out
- change in potential E shown with **potential energy diagram**



- when products have less enthalpy = **exothermic**

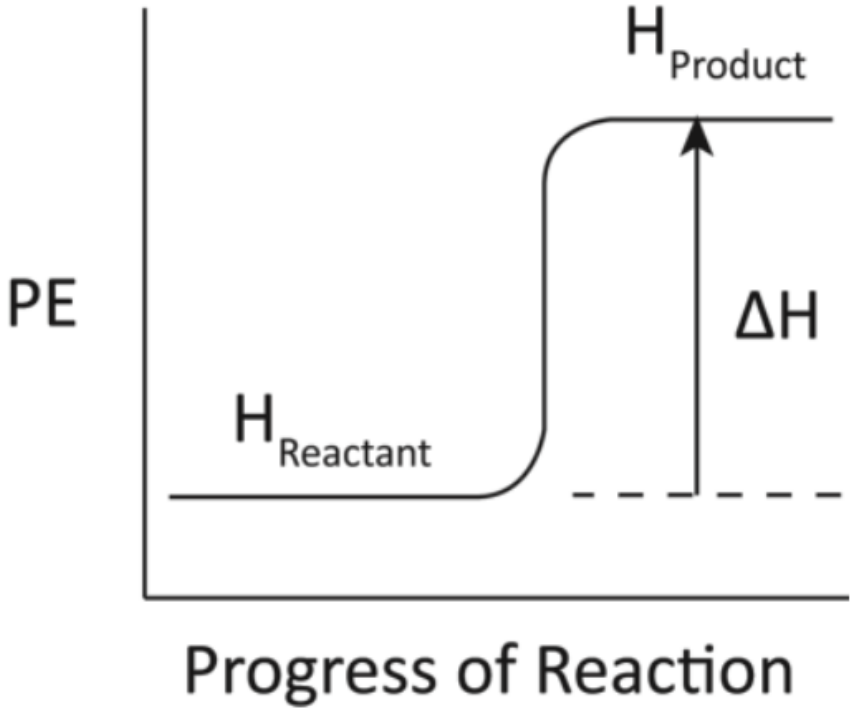
$$\Delta H < 0$$

- two ways to express reaction:

$$H_2 + Cl_2 \rightarrow 2HCl + 184\ kJ$$

or

$$H_2 + Cl_2 \rightarrow 2HCl \qquad \Delta H = -184\ kJ$$



- when products have more enthalpy than reactants = **endothermic**

$$\Delta H > 0$$

- two ways to express reaction:

$$2N_2 + O_2 + 164\ kJ \rightarrow 2N_2O$$

or

$$2N_2 + O_2 \rightarrow 2N_2O \quad \Delta H = +164\ kJ$$

Kinetic Energy Distributions

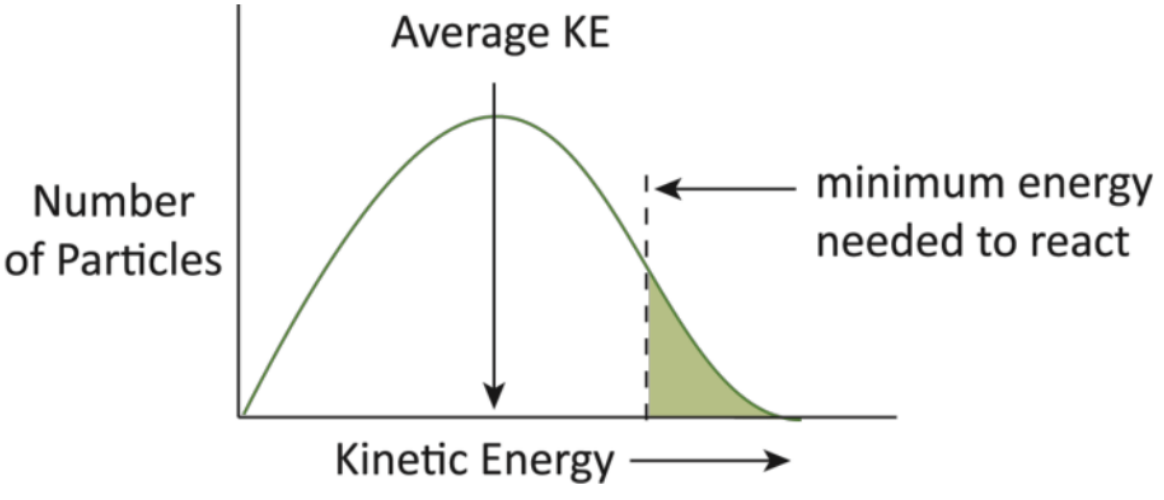
1. Consider the reaction:

$$C_2H_4OH \rightarrow C_2H_4 + H_2O$$

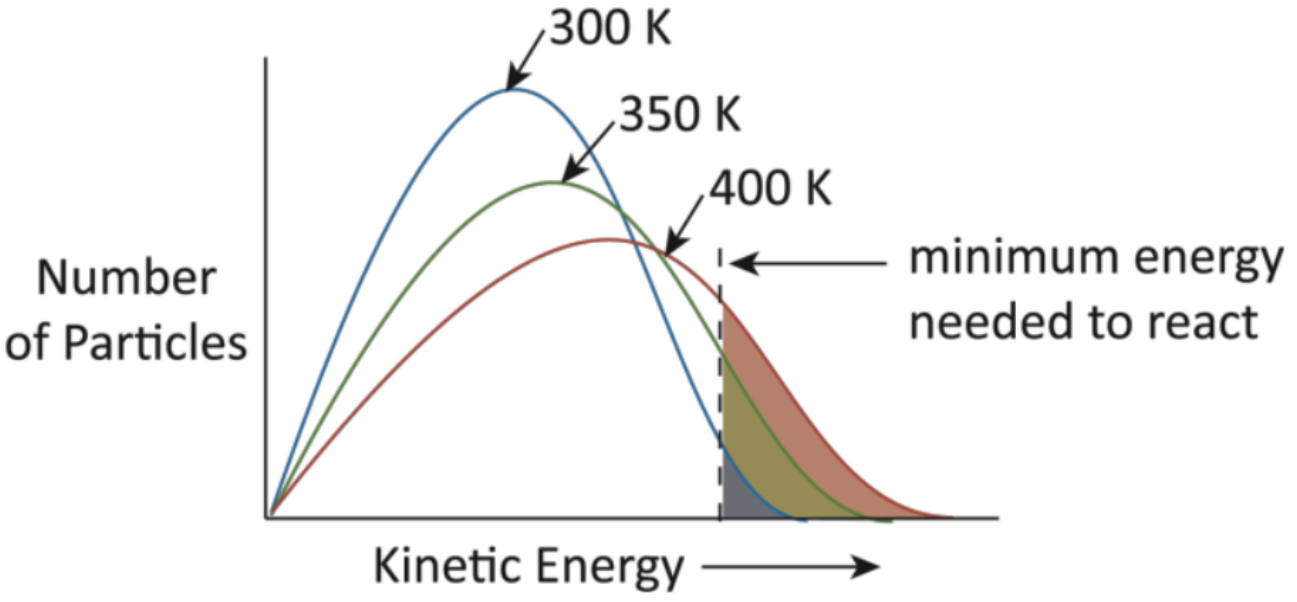
At room T, this reaction is very slow and the rate not detectable; however molecules at room T and P undergo about 10^{10} collisions/second so lack of reactivity is not due to a lack of collisions.

2. When T ↑, the reaction rate ↑. This is because the molecules have more energy.

- at a given T, the E of the molecules can be shown as a distribution



- some molecule have high KE while others have low KE
- increasing T increases the average energy of the system
- only molecules with KE ≥ minimum E will react



- although more collisions may occur when the T ↑, the ↑ reaction rate due to an ↑ T is **primarily due** to the ↑ number of molecules with sufficient E to react