

Collision Theory

- Reactions can occur:
 - Very fast – such as a firecracker
 - Very slow – such as the time it took for dead plants to make coal
- A “rate” is a measure of the speed of any change that occurs within an interval of time
- In chemistry, reaction rate is expressed as the amount of reactant changing per unit time

Collision Model

- Key Idea: Molecules must collide to react.**
- However, only a small fraction of collisions produces a reaction. Why?
- Particles lacking the necessary kinetic energy to react bounce apart unchanged when they collide

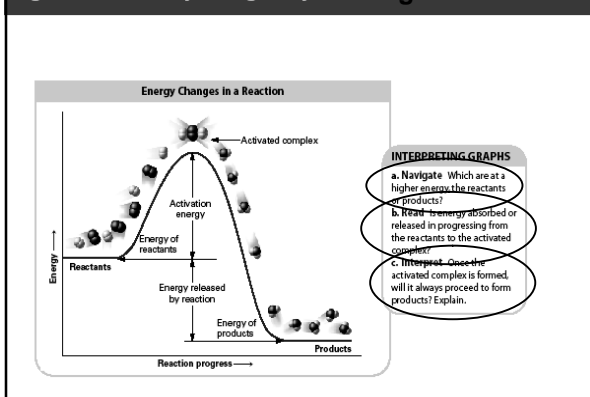
Collision Model

- Collisions must have enough energy to produce the reaction (must equal or exceed the activation energy – the minimum energy needed to react).
- Think of clay clumps thrown together gently – they don’t stick, but if thrown together forcefully, they stick tightly to each other.

Collision Model

- An “activated complex” is an unstable arrangement of atoms that forms momentarily (typically about 10^{-13} seconds) at the peak of the activation-energy barrier.
 - This is sometimes called the transition state
- Results in either a) forming products, or b) reformation of reactants
 - Both outcomes are equally likely

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Collision Model

- The collision theory explains why some naturally occurring reactions are very slow
 - Carbon and oxygen react when charcoal burns, but this has a very high activation energy
 - At room temperature, the collisions between carbon and oxygen are not enough to cause a reaction

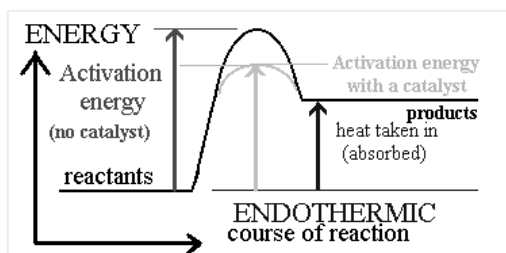
Factors Affecting Rate

- 1) **Temperature**
Increasing temperature always increases the rate of a reaction.
- 2) **Surface Area**
Increasing surface area increases the rate of a reaction
- 3) **Concentration**
Increasing concentration **USUALLY** increases the rate of a reaction
- 4) Presence of **Catalysts**

Catalysts

- **Catalyst**: A substance that speeds up a reaction, without being consumed itself in the reaction
- **Enzyme**: A large molecule (usually a protein) that catalyzes biological reactions.
 - Human body temperature = 37 °C, much too low for digestion reactions without catalysts.
- **Inhibitors** – interfere with the action of a catalyst; reactions slow or even stop

Endothermic Reaction with a Catalyst



Exothermic Reaction with a Catalyst

