

Explaining Reaction Rates

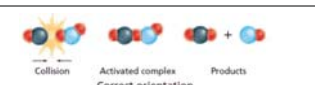
Sections 6.2 & 6.3

Homework
Pg. 365 #1-4
Pg. 372 #1-6 (skip 3)

Collision Theory:

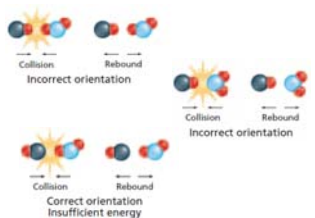
- Chemical reactions involve **collisions** between reactants.
 - Reactants must collide with **two requirements**:
 - correct **orientation**
 - sufficient **energy** (the activation energy, E_a)
- Effective collision*

Effective:
Activated complex is produced (unstable); products are formed



Ineffective:
No activated complex; No products

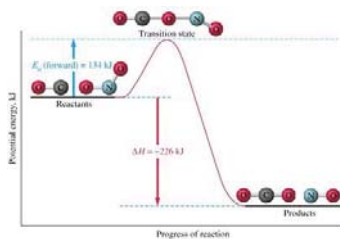
Reactant particles bounce off of each other without reacting



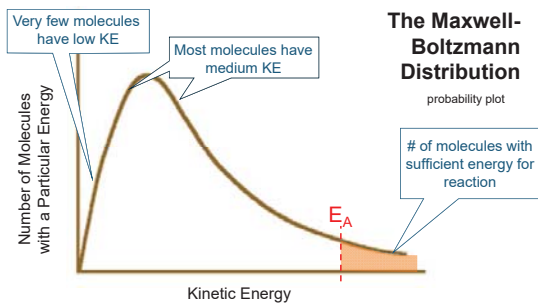
$$\text{Reaction Rate} = \text{Collision frequency} \times \text{Fraction of collisions that are effective}$$

effective collisions per second total collisions per second effective collisions per total collisions

Activation Energy is the minimum energy that the reactant molecules must possess.



The E_a is used to break bonds of reactant molecules



Factors That Affect Reaction Rate

1. Chemical nature of the reactants
2. Concentration of reactants
3. Surface area
4. Temperature
5. Presence of a catalyst

Collision Theory can explain why each factor affects reaction rate.

(1) Chemical Nature of Reactants

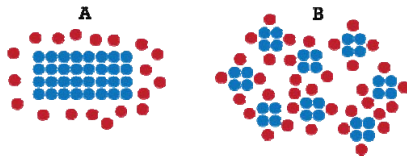
- **bond energy**
 - affects E_a required to break reactant bonds
- **molecule geometry**
 - complex molecular structure makes it harder to achieve correct orientation

(2) Concentration of Reactants

- higher concentration → higher collision frequency

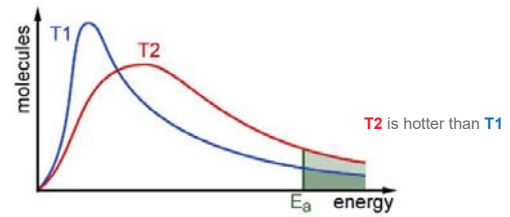
(3) Surface Area

- important for two-phase reactions (heterogeneous reactions)
 - solid and liquid; solid and gas
- reactants can only collide **at the surface of contact**
- increase SA → increase collisions



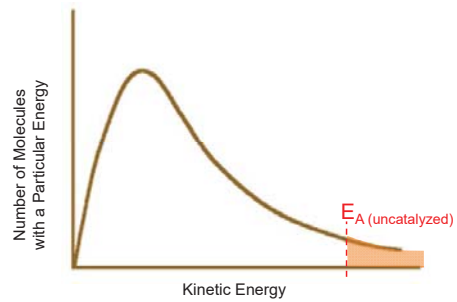
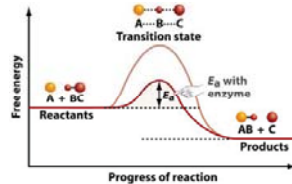
(4) Temperature

- higher temp means particles have higher ave kinetic energy
- molecules collide more frequently, AND
- with more energy



(5) Presence of a Catalyst

- **catalyst** – speeds up a reaction, without being used up in the process
- provides an **ALTERNATE PATHWAY** for the reactants to be converted to products. Alternate pathway has lower E_A
- **does NOT** alter overall ΔH for the reaction



$$\text{Reaction Rate} = \text{Collision frequency} \times \text{Fraction of collisions that are effective}$$

Concentration
Nature of reactants

Surface area
Temperature

Temperature
Catalyst

Summary

- Collision theory states that in order for a reaction to occur, reactant particles must collide effectively: with the correct orientation, and sufficient activation energy.
- Five factors affect the rate of reaction. Their effects can all be explained in terms of collision theory.
 - nature of reactants; concentration; surface area; temperature; catalysts