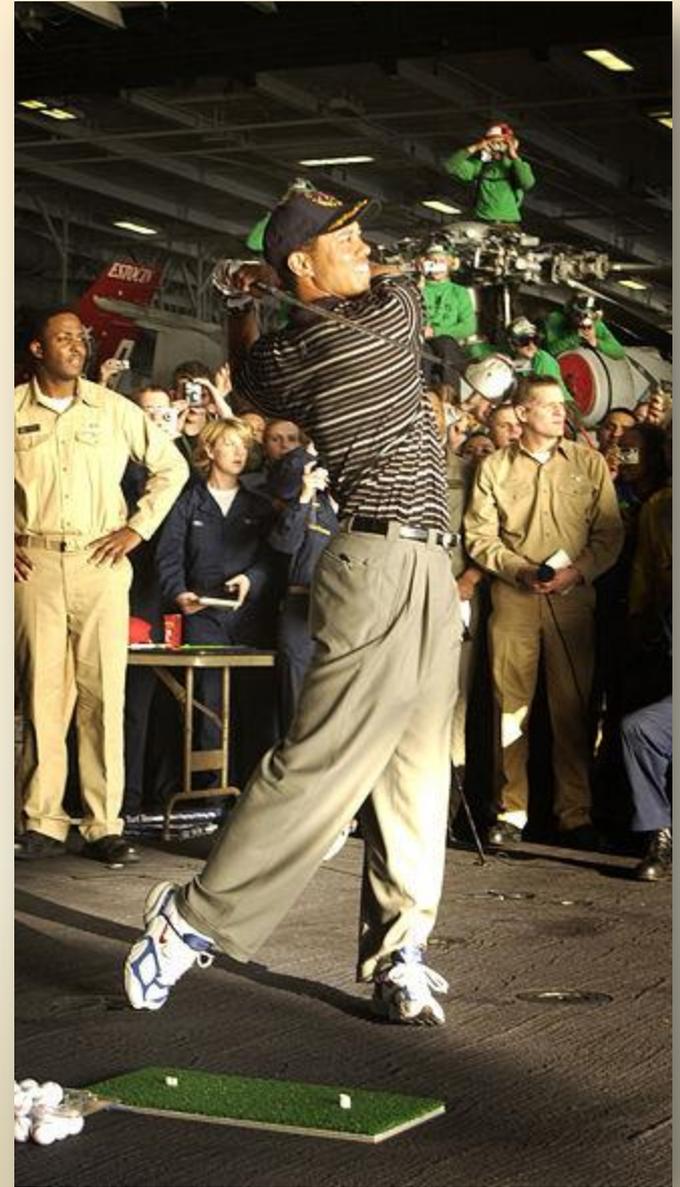


# Chemical Kinetics



# Collision Model

- **Collisions must have enough energy** to produce the reaction (must equal or exceed the activation energy).
- **Reactants must have proper orientation** to allow the formation of new bonds.



# Activation Energy

*The minimum energy required to transform reactants into the activated complex*

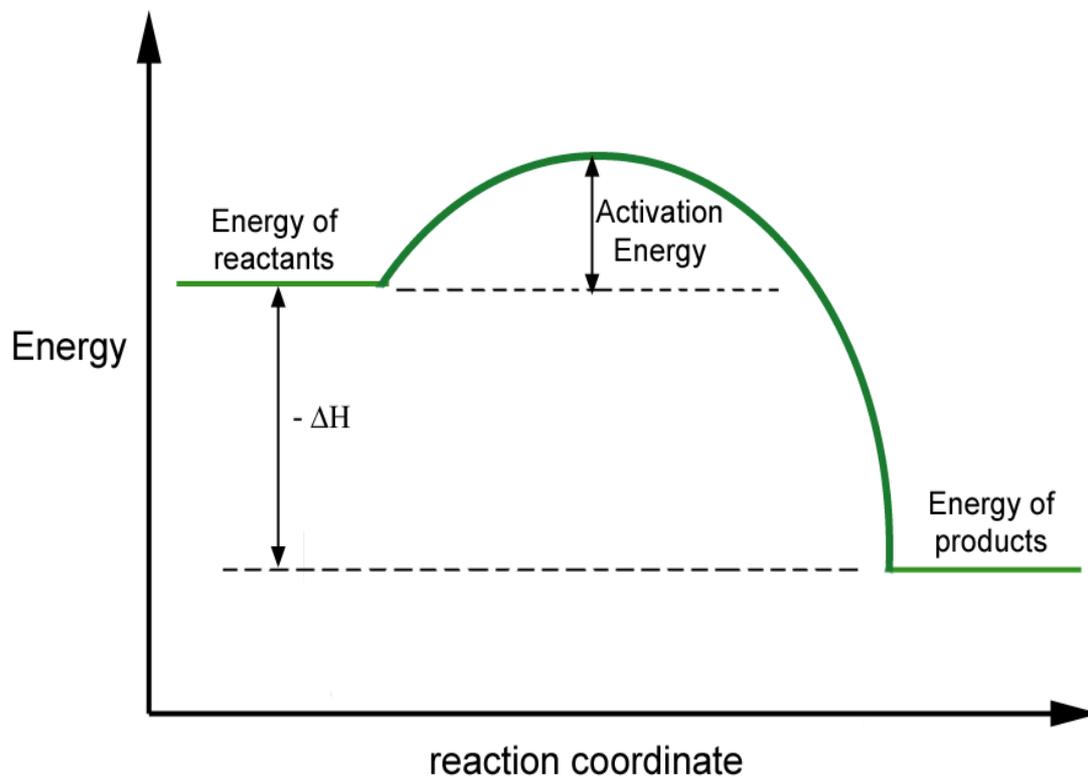
(The minimum energy required to produce an effective collision)



Flame, spark, high temperature, radiation are all sources of activation energy

# Exothermic Processes

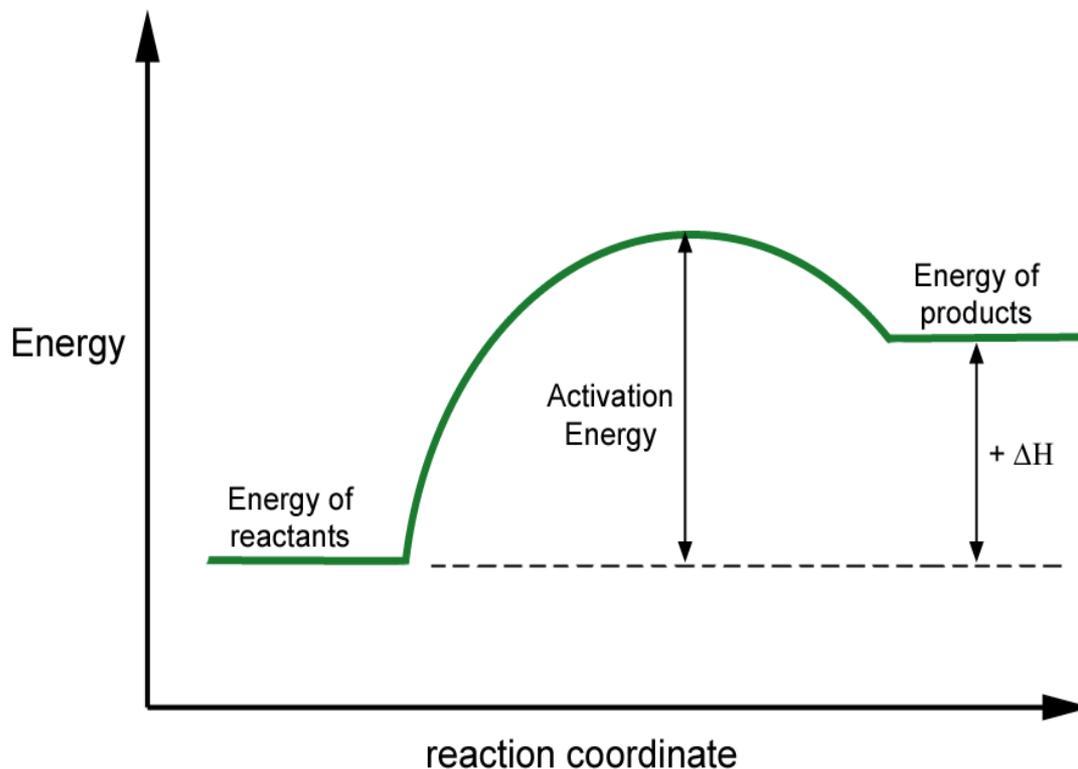
Processes in which energy is released as it proceeds, and surroundings become warmer



**Reactants → Products + energy**

# Endothermic Processes

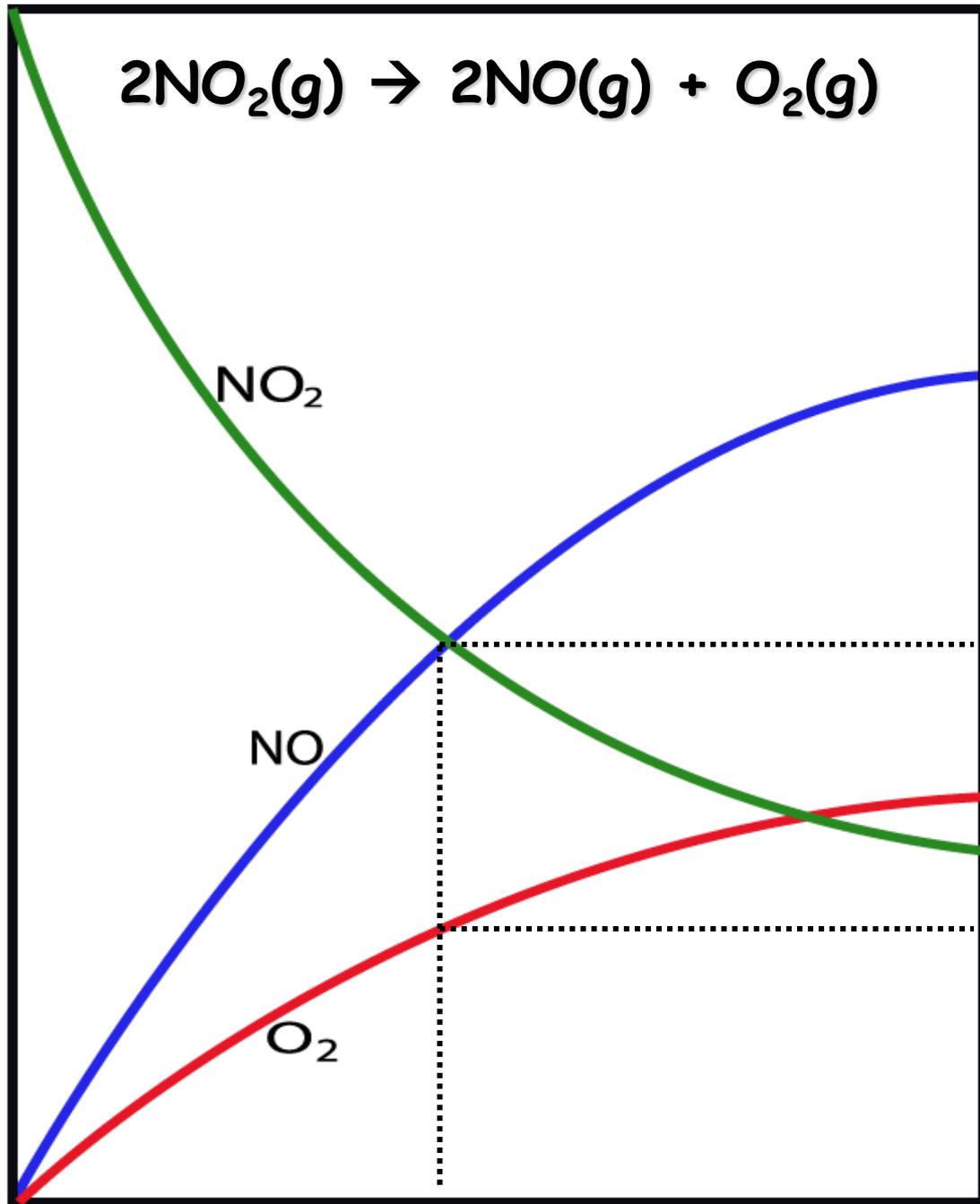
Processes in which energy is absorbed as it proceeds, and surroundings become colder



**Reactants + energy → Products**



Concentration



Time

Reaction Rates:

1. Can measure disappearance of reactants
2. Can measure appearance of products
3. Are proportional stoichiometrically

# The Reaction Mechanism

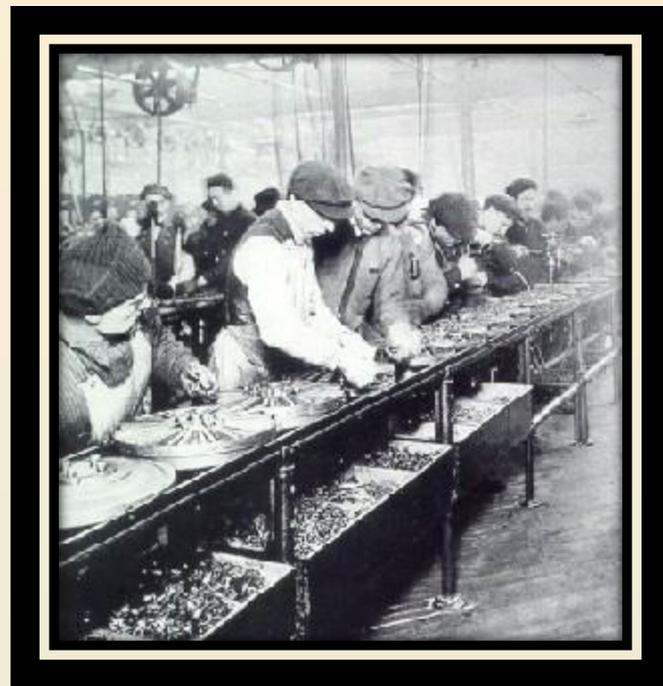
- The reaction mechanism is the series of steps by which a chemical reaction occurs.
- A chemical equation does not tell us how reactants become products; it is a summary of the overall process.

Reactants → Products

The → sign has represents the reaction mechanism, but gives no indication of the steps in the mechanism

# The Rate-Determining Step

In a multi-step reaction, the slowest step is the rate-determining step. It therefore determines the rate of reaction.



# Factors Affecting Rate

## ❖ Temperature

Increasing temperature always increases the rate of a reaction.

## ❖ Surface Area

Increasing surface area increases the rate of a reaction

## ❖ Concentration

Increasing concentration **USUALLY** increases the rate of a reaction

## ❖ Presence of Catalysts

# Catalysis

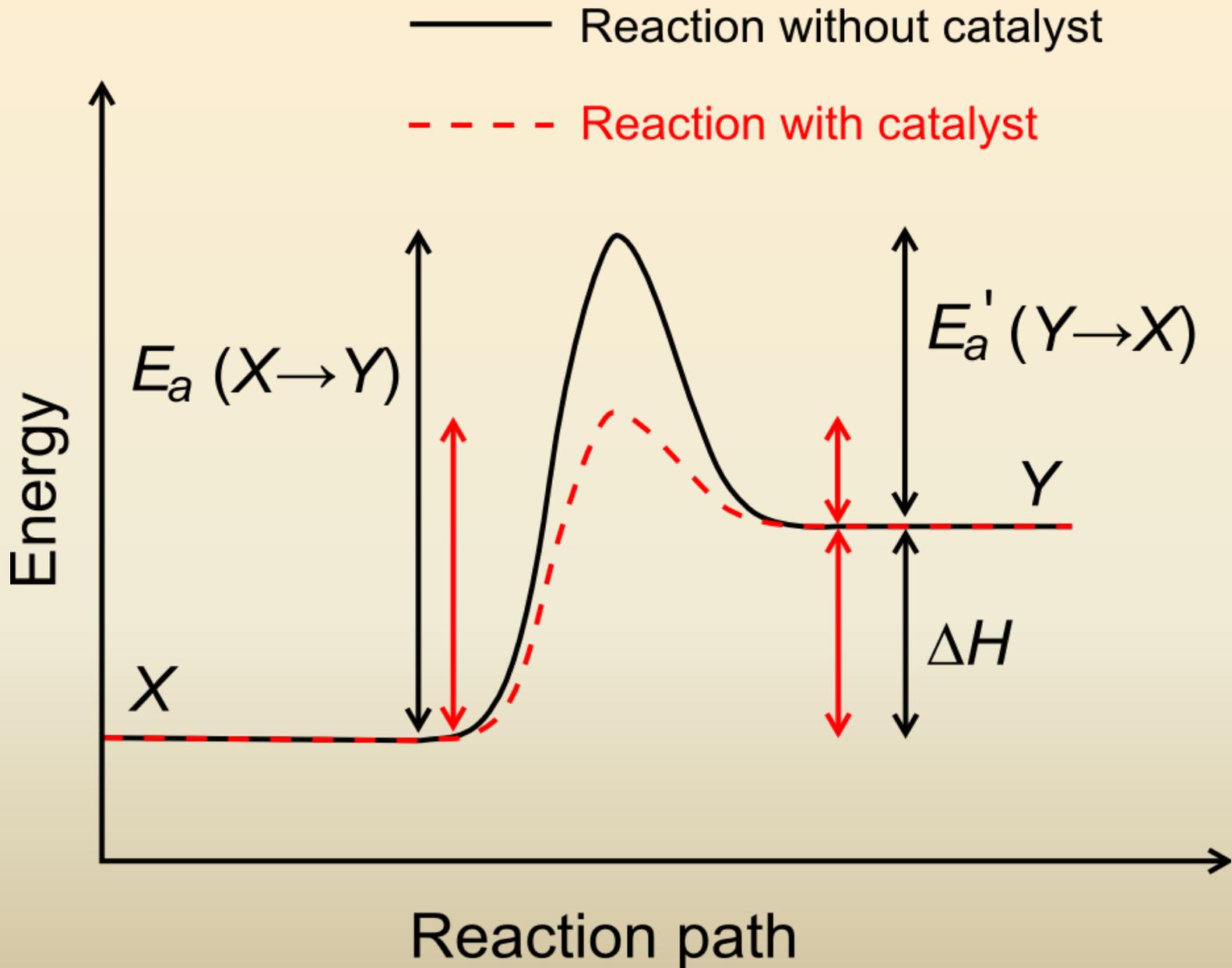
• Catalyst: A substance that speeds up a reaction by lowering activation energy

• Enzyme: A large molecule (usually a protein) that catalyzes biological reactions.

• Homogeneous catalyst: Present in the same phase as the reacting molecules.

• Heterogeneous catalyst: Present in a different phase than the reacting molecules.

# Endothermic Reaction w/Catalyst



# Exothermic Reaction w/Catalyst

— Reaction without catalyst

- - - Reaction with catalyst

