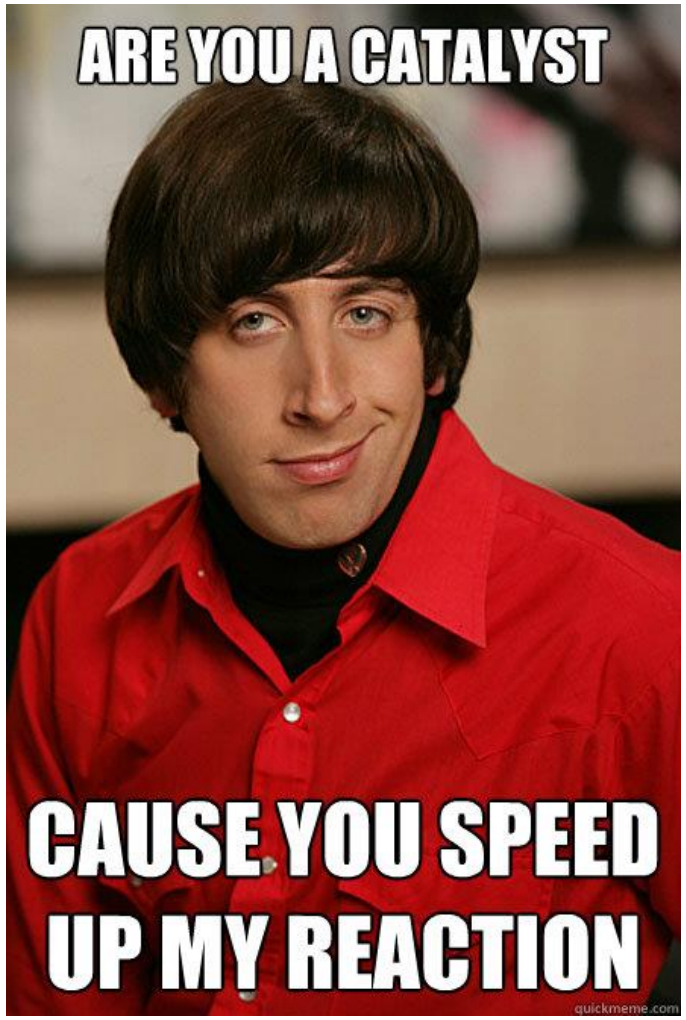
Mechanisms, Catalysts & Coordinate Diagrams



Outcomes:

- **Draw potential energy diagrams for endothermic & exothermic reactions.**
- **Explain the concept of a reaction mechanism.**

Coordinate Diagrams & Mechanisms:

Reaction Coordinate Diagrams From Mechanisms:

We can draw a coordinate diagram from a mechanism with more than one step, if we know the **RATES** of each step, and the **ENTHALPY** of the reaction…

The **LARGER** the E_A, the **SLOWER** the reaction, so the **RATE DETERMINING STEP** should have the **HIGHEST** E_A.

FASTER steps should have **LOWER** E_A's, with the **FASTEST** having the **LOWEST**.

If **EXOTHERMIC**, $H_{reacts} > H_{prods}$

If **ENDOTHERMIC**, $H_{reacts} < H_{prods}$

Coordinate Diagrams & Mechanisms:

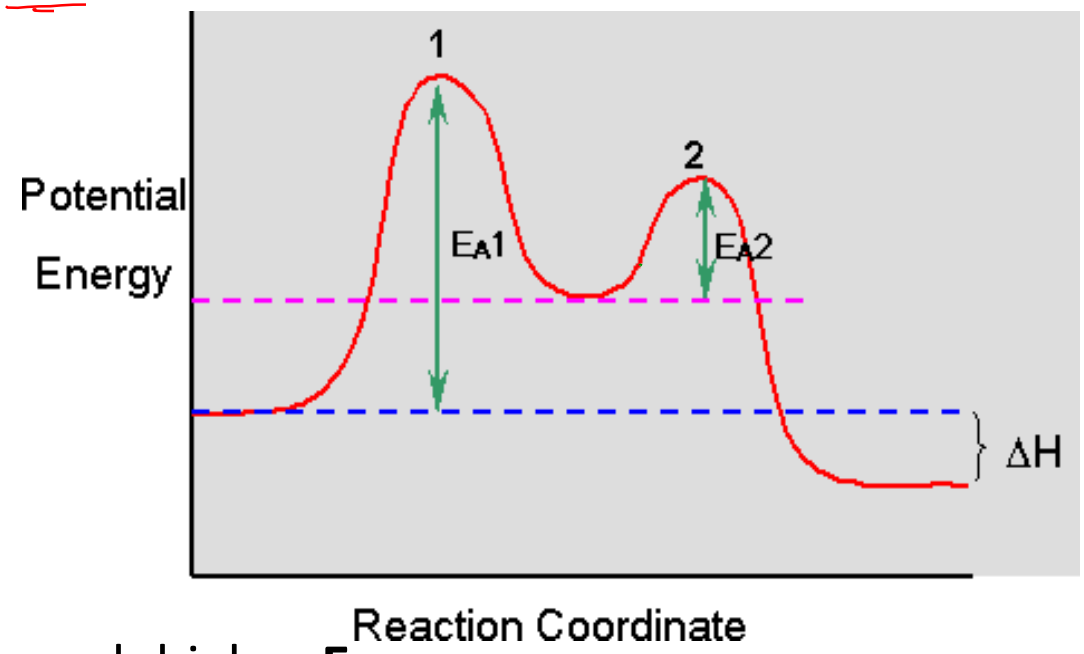
Example 1:

Given the following mechanism for an exothermic reaction:

Step 1: $NO_2 + NO_2 \rightarrow NO_3 + NO$ *(slow)*

Step 2: $NO_3 + CO \rightarrow NO_2 + CO_2$ *(fast)*

The coordinate diagram may look like:



Notice: → **STEP 1** has a much higher $\mathbf{E_A}$

→ **ΔH** is **NEGATIVE** for the reaction.

Coordinate Diagrams & Mechanisms:

Example 2:

Draw the coordinate diagram, given the following mechanism:

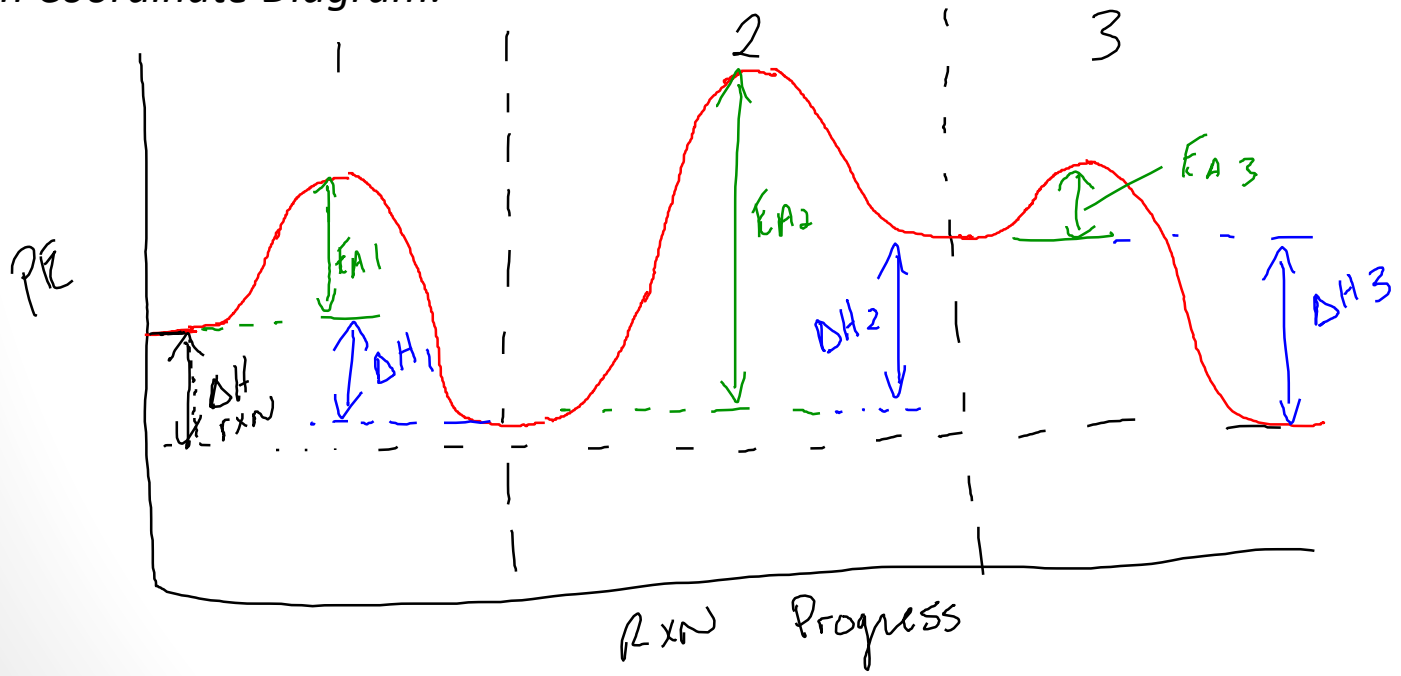
Step 1: A + B → I_1 + C **(moderate, exothermic)**

Step 2: I_1 + B → I_2 + D **(slow, endothermic)**

Step 3: I_2 + A → C + E **(fast, exothermic)**

Net Rxn: 2A + 2B → 2C + D + E (slow, exo)

Reaction Coordinate Diagram:



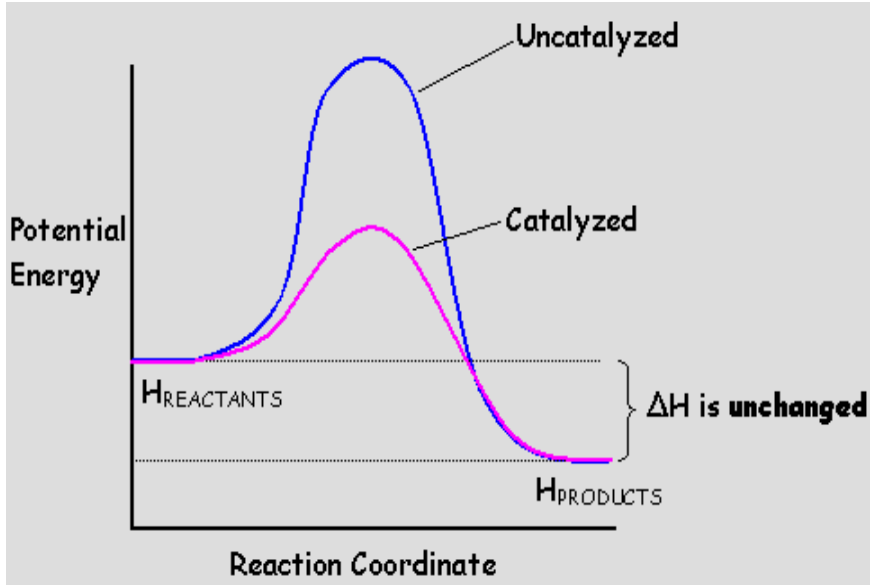
Coordinate Diagrams & Mechanisms:

Catalysts:

- **SPEED** up a reaction without being **USED UP** in the reaction.
- **ENZYMES** are **BIOLOGICAL** catalysts.
- **HOMOGENOUS** Catalysts are in the **SAME PHASE** as the reactants.
- **HETEROGENEOUS** Catalysts are in a **DIFFERENT PHASE** as the reactants.

How Catalysts Work:

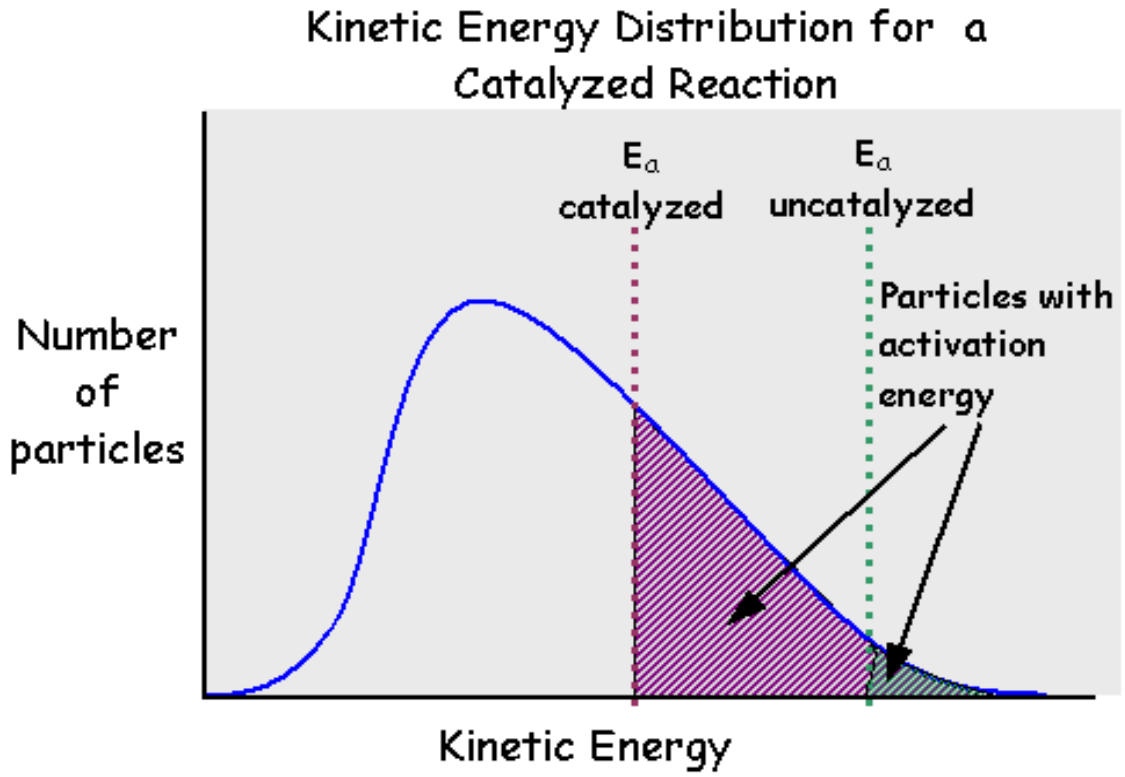
- Catalysts allow reactions to proceed by a **DIFFERENT MECHANISM** - a new **PATHWAY**.
- New **PATHWAY** has a **LOWER ACTIVATION ENERGY**:



Coordinate Diagrams & Mechanisms:

How Catalysts Work:

- **MORE MOLECULES** will have the required **Ea**:



- Catalysts do not change **ΔH**, since **ΔH** is determined by the **BONDS BROKEN** and **FORMED**.

Coordinate Diagrams & Mechanisms:

Examples of Catalysts:

- **ENZYMES** in your body
- **CATALYTIC CONVERTERS** in cars
- **CFC'S** catalyze the reaction of **OZONE** into **OXYGEN** gas

Notes:

- They can be **INVOLVED** in the reaction as a **REACTANT**, but are ***NOT*** **USED UP** like a reactant.
- After the reaction is **OVER**, the catalyst is left behind **UNCONSUMED**.