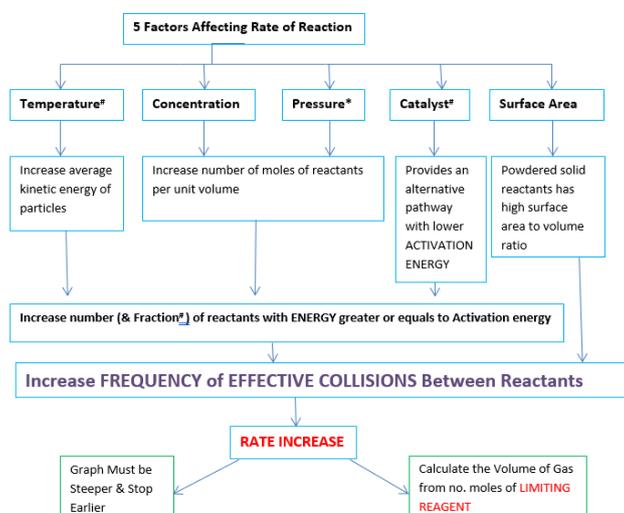


**Rate of Reaction:** Change in concentration of a reactant or product per unit time

For a reaction to occur, reactants must have an **Effective Collision** with each other:

- Reactants must have minimum energy ( $E_a$ , activation energy)
- Reactants must collide in the correct orientation

### Factors affecting rate of reaction



Example Question: How does an increase in temperature change the rate of reaction

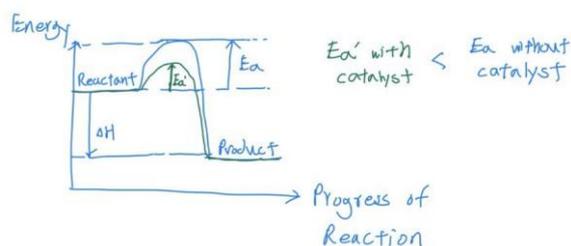
Sample Answer:

1. An increase in temperature increases the average kinetic energy of the reactant particles,
2. thereby increasing the number and fraction of reactants with energy greater or equal to Activation Energy.
3. This increases the frequency of effective collisions between the reactants.
4. Therefore, the rate of reaction increases.

**Catalyst:** Molecule that increases the rate of reaction by providing an alternative reaction pathway with lower  $E_a$  and remains chemically unchanged at the end of the reaction.

### Characteristics of Catalyst

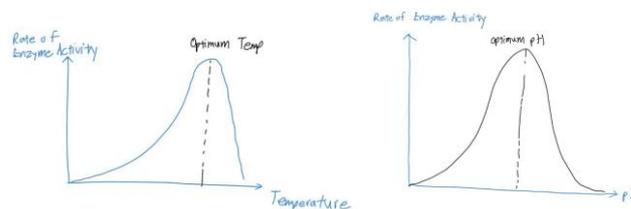
- Catalyst changes the rate of reaction while remaining chemically unchanged
- Yield of the reaction does not change
- Only a small amount of catalyst is needed to speed up rate of reaction
- Many catalysts are transition metals due to variable oxidation states



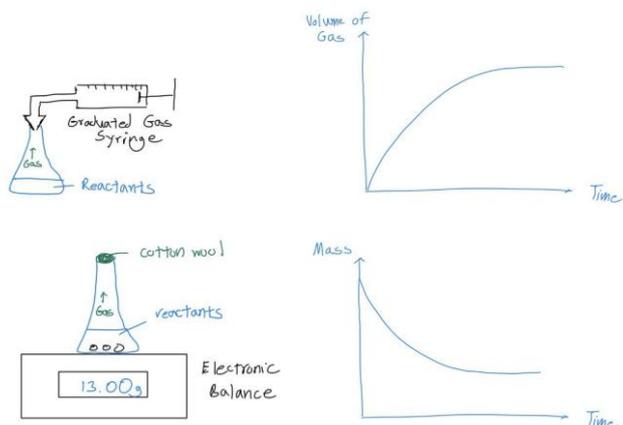
**Enzyme:** Biological Catalyst that speeds up rate of reaction in living organisms

### Characteristics of Enzymes

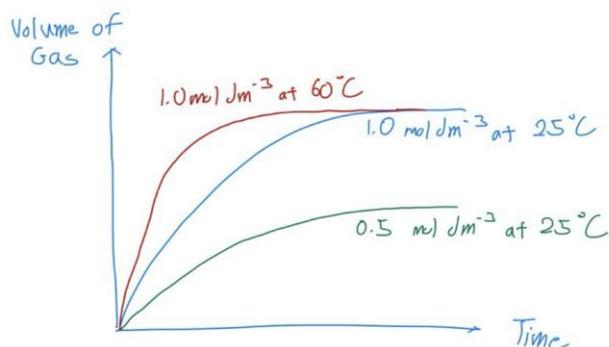
- Highly Specific: Each enzyme has a unique 3D structure
- Highly selective: Each enzyme can only bind to particular reactants
- Lower Activation Energy of Reaction
- Highly Sensitive to temperature and pH changes



### Example Experiment to Determine Rate of Reaction



### Interpreting Graphs of Rate of Reaction



Two things to take note of when interpreting graphs for rate of reaction questions!

1. Gradient: The Gradient usually represents the rate of reaction
2. Plateau point: Ask yourself, what is the maximum amount of product that can be produced?
  - a. Usually change in concentration or volume or mass of reactants, would change the maximum amount of product that can be produced