

LESSON PLAN

SUBJECT-CHEMISTRY

CLASS-XII

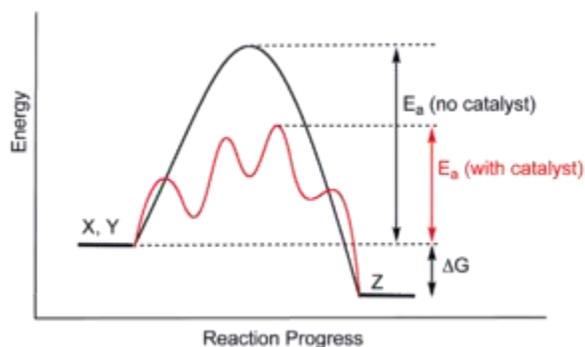
MASTER TOPIC-SURFACE CHEMISTRY

TOPIC-CATALYSIS

CONCEPTS/COMPETENCY-OBSERVATION, DISCOVERING FACTS, UNDERSTANDING

CONCEPT DETAIL-Catalysis is the increase in the rate of a chemical reaction of one or more reactants due to the participation of an additional substance called a catalyst. Unlike other reagents in the chemical reaction, a catalyst is not consumed by the reaction. With a catalyst, less free energy is required to reach the transition state, but the total free energy from reactants to products does not change. A catalyst may participate in multiple chemical transformations. The effect of a catalyst may vary due to the presence of other substances known as inhibitors or poisons (which reduce the catalytic activity) or promoters (which increase the activity). The opposite of a catalyst, a substance that reduces the rate of a reaction, is an inhibitor.

Catalyzed reactions have a lower activation energy (rate-limiting free energy of activation) than the corresponding uncatalyzed reaction, resulting in a higher reaction rate at the same temperature and for the same reactant concentrations. However, the mechanistic explanation of catalysis is complex. Catalysts may affect the reaction environment favorably, or bind to the reagents to polarize bonds, e.g. acid catalysts for reactions of carbonyl compounds, or form specific intermediates that are not produced naturally, such as osmate esters in osmium tetroxide-catalyzed dihydroxylation of alkenes, or cause dissociation of reagents to reactive forms, such as chemisorbed hydrogen in catalytic hydrogenation.



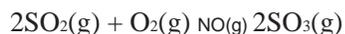
TYPES-

Catalysis can be broadly divided into two groups:

(a) *Homogeneous catalysis*

When the reactants and the catalyst are in the same phase (i.e., liquid or gas), the process is said to be homogeneous catalysis. The following are some of the examples of homogeneous catalysis:

(i) Oxidation of sulphur dioxide into sulphur trioxide with dioxygen in the presence of oxides of nitrogen as the catalyst in the lead chamber process.



The reactants, sulphur dioxide and oxygen, and the catalyst, nitric oxide, are all in the same phase.

(ii) Hydrolysis of methyl acetate is catalysed by H^+ ions furnished by hydrochloric acid.



Both the reactants and the catalyst are in the same phase.

(iii) Hydrolysis of sugar is catalysed by H^+ ions furnished by sulphuric acid.

Both the reactants and the catalyst are in the same phase.

(b) Heterogeneous catalysis

The catalytic process in which the reactants and the catalyst are in different phases is known as heterogeneous catalysis. Some of the examples of heterogeneous catalysis are given below:

(i) Oxidation of sulphur dioxide into sulphur trioxide in the presence of Pt.

The reactant is in gaseous state while the catalyst is in the solid state.

Enzymes and biocatalysts

In biology, enzymes are catalysts in metabolism and catabolism. Most biocatalysts are protein-based, i.e. enzymes, but other classes of biomolecules also exhibit catalytic properties including ribozymes, and synthetic deoxyribozymes

Biocatalysts can be thought of as intermediate between homogeneous and heterogeneous catalysts, although strictly speaking soluble enzymes are homogeneous catalysts and membrane-bound enzymes are heterogeneous

Factors affecting enzyme action

1. Temperature
2. pH
3. concentration of enzyme
4. substrate
5. products

ACTIVITY-

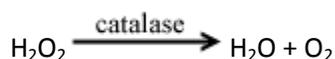
Each enzyme is specific for the reaction it will catalyze. In this laboratory,

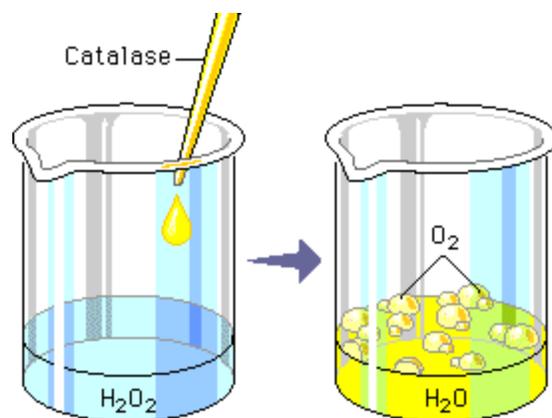
If a small amount of catalase is added to hydrogen peroxide, you will be able to observe bubbles of oxygen forming.

Enzyme = catalase

Substrate = hydrogen peroxide (H_2O_2)

Products = water and oxygen





FORMATIVE ASSIGNMENTS/INSTANT DIAGNOSTIC QUESTIONS-

1. What is homogenous catalysis?
2. What is heterogenous catalysis?
3. Give examples of heterogeneous catalysis
4. What are enzymes
5. Why are enzymes known as biocatalysts
6. What is activation energy
7. Define catalysis

LEVELWISE ASSIGNMENTS-LEVEL I

1. Define catalyst.
2. What are zeolites?
3. What is activated complex
4. Define homogeneous catalysis

LEVEL II

1. Differentiate between homogeneous and heterogeneous catalysis.
2. What is the role of a catalyst?

3. Why are metals often good catalysts?

4. What are some of the advantages of homogeneous catalysts?

LEVEL III

1. What is the nature of the bonding interaction between a reactant(metal) and a catalyst?
2. Explain the mechanism of heterogenous catalysis.
3. Why are enzymes highly specific in nature?

PROJECT : Development of Smart Metal-Based Catalysts for the Important and Challenging Organic Transformations