

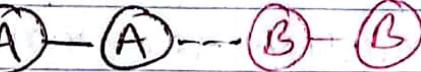
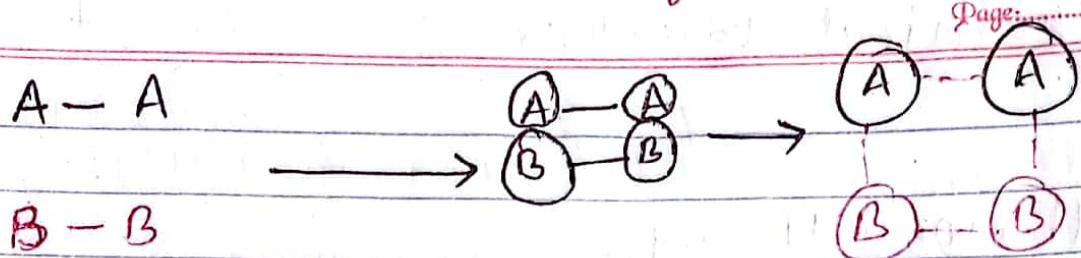
Chemical kinetics.

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Collision Theory:-

This theory is based upon the kinetic theory of gas, which explains that gas molecules are continuously moving in all directions and colliding with one another. As in case of chemical reaction the reacting species collide each other which results the breaking of chemical bond of reactant and formation of bond of products. So the concept of collision theory summarised as.

1. There must be collision between the reacting species in order to occur a reaction.
2. All collision do not cause a chemical change. The molecule should possess sufficient energy for effective collision.
i.e. reacting particle must gain energy of activation. (E_a).
3. The reacting particle must ~~not~~ be properly oriented.
4. The increase of temperature and concentration of reaction speed up the rate of molecular collision.



improper orientation
(not effective collision)

No. product.

Fig: Representation of effective collision and ineffective collision.

* Energy of activation (Activation Energy) (E_a)

According to the concept of activation, reactants do not directly convert into product. At first, reactants must gain sufficient energy to pass through energy barrier before they get converted into product. ~~now~~ at this state, existing bond ~~broke and new weakened and new bond~~ is partially formed

The minimum amount of energy

required for reacting molecule to convert into product is called activation energy (E_a)

From the concept of activation energy can be explained by plotting energy content (~~energy~~) against the progress of reaction.

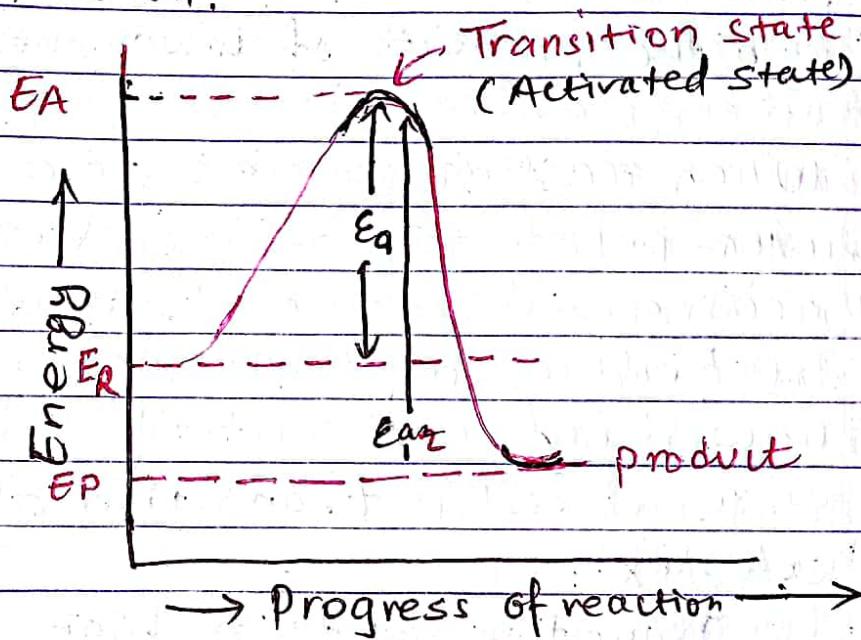


Fig: Activation Energy profile diagram

E_R = average energy of reactant

E_P = Energy of product

E_A = minimum energy in activated state

Point to remember (significance of E_a)

lower activation energy \rightarrow reaction becomes fast

and High E_a \rightarrow slower the rxn.

zero $E_a \rightarrow$ Explosive rxn.

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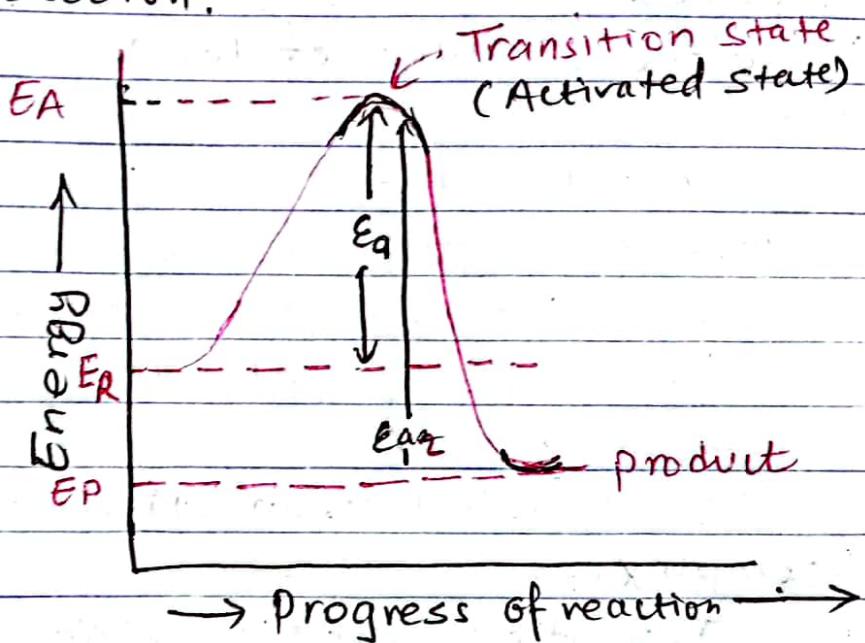


Fig: Activation Energy profile diagram

E_Q = average energy of reactant

E_P = Energy of product

E_A = minimum energy in activated state.

Point to remember. (significance of E_a)

lower activation energy \rightarrow reaction becomes fast

and High E_a \rightarrow slower the rxn.

zero $E_a \rightarrow$ Explosive rxn.

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Transition state Theory

→ (Activated Complex) high energy.

This theory explains that, a transition state (T.S) or intermediate state is formed in between the reactants and product. → The T.S state soon converts into the product of lower energy.

When reacting species come closer then inter-penetration of the electron clouds occurs and valence electrons are rearranged, the bond of reactants are breaking and new bond are partially formed. This state is called transition state or activated complex.

Transition state is high energy state for a short time, then it converts into stable products.

Energy profile diagram for exothermic and endothermic reaction, as follows.

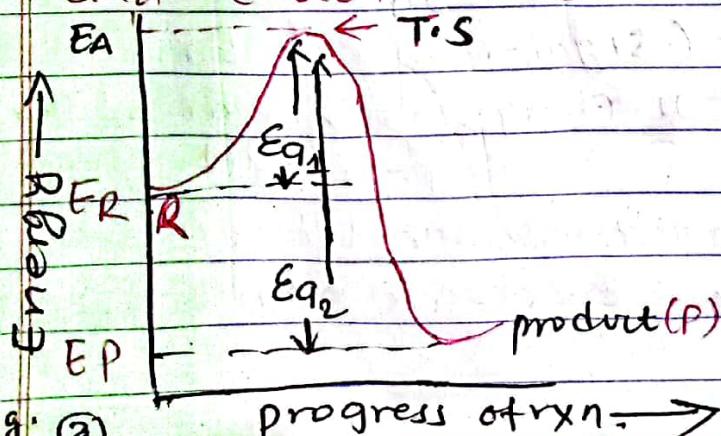


Fig: (2)

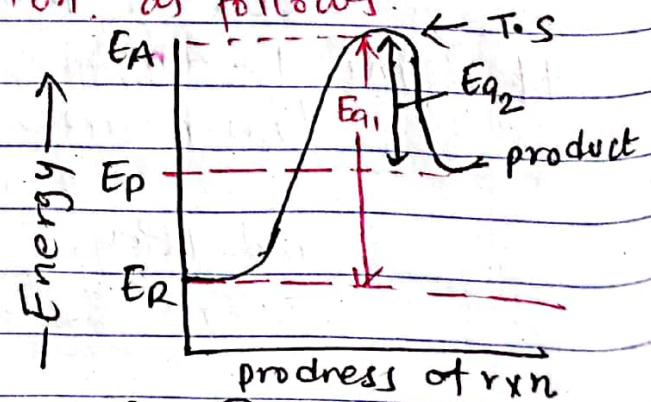


Fig. (5)

Above fig. (2) Energy profile for exothermic rxn.
 (b) Energy profile for Endothermic reaction.

~~Significance~~

When $Ea_2 > Ea_1$ the reaction is known as exothermic

When $Ea_2 < Ea_1 \rightarrow$ The reaction is known as endothermic.

Ea_1 = minimum energy that the reactants must possess to react (activation Ea of reactant)

Ea_2 = activation energy of backward rxn.



~~V.VL~~

Factor affecting the rate of reaction.

Rate of rxn depend on the following factors.

(i) Nature of reactant:- Ionic compounds in solution proceed at higher rate than covalent compound.

(ii) Concentration of reactant:-

The rate of rxn is directly proportional to the concentration of reactant. Higher the concentration more will be the effective collision of molecules and faster the reaction.

e.g. CaO₂ reacts more vigorously with conc. HCl than dil HCl.

(III)

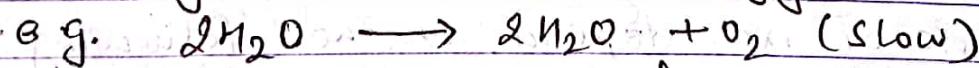
Temperature:-

On increasing temperature, the kinetic energy of reactant increases which increases the effective collision. Due to this rate of reaction increases. Generally, rate of reaction increases by 2 or to 3 times with every 10°C rise in temperature.

(IV) Use of catalyst:-

A catalyst is the substance which alters (increases or decreases) rate of reaction but itself not consumed in the reaction.

Catalyst increases the rate of reaction by lowering the activation energy.



Use of small amount of KI (potassium iodide)

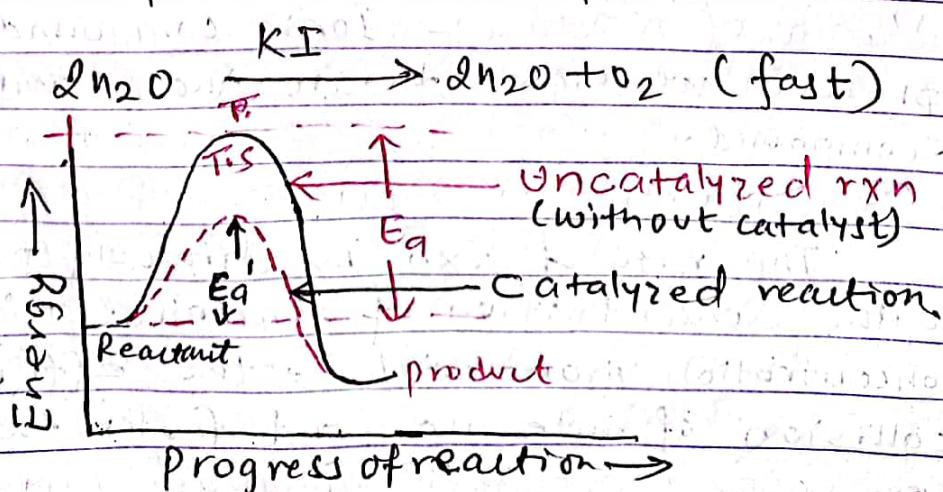


Fig. (a)

Fig (a) Energy profile diagram for catalyzed and uncatalyzed reaction.

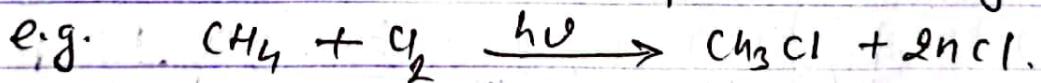
(v) surface area of reactant:

The rate of reaction increases with increase in surface area of reactants which is exposed to reaction. i.e.

e.g. powdered CaCO_3 reacts more vigorously with dil HCl than marble chips.

(vi) Light:- (radiation),

The rate of reaction increases for photochemical reaction. The light photon provides essential activation energy, E_a and forms activated complex after absorbing it.



Arrhenius Equation

The effect of temperature on the rate of reaction ~~grows~~ given by Arrhenius in 1889 A.D. It relate the rate constant with absolute temperature.

The Arrhenius equation is,

$$K = Ae^{-E_a/RT} \quad \dots \dots \dots \quad (1)$$

Where, K = rate constant.

~~log₁₀K~~

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$$\ln K = 2.303 \log_{10} M$$

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E_a = activation energy.

A = a constant called frequency factor (depends on collision frequency)

T = temperature in kelvin.

R = gas constant:
natural.

Taking log on both side of above eqⁿ.

$$\ln K = \ln A + \ln(e^{-E_a/RT})$$

$$\text{or, } \ln K = \ln A - \frac{E_a}{RT}$$

$$\log K = \log A - \frac{E_a}{2.303 RT}$$

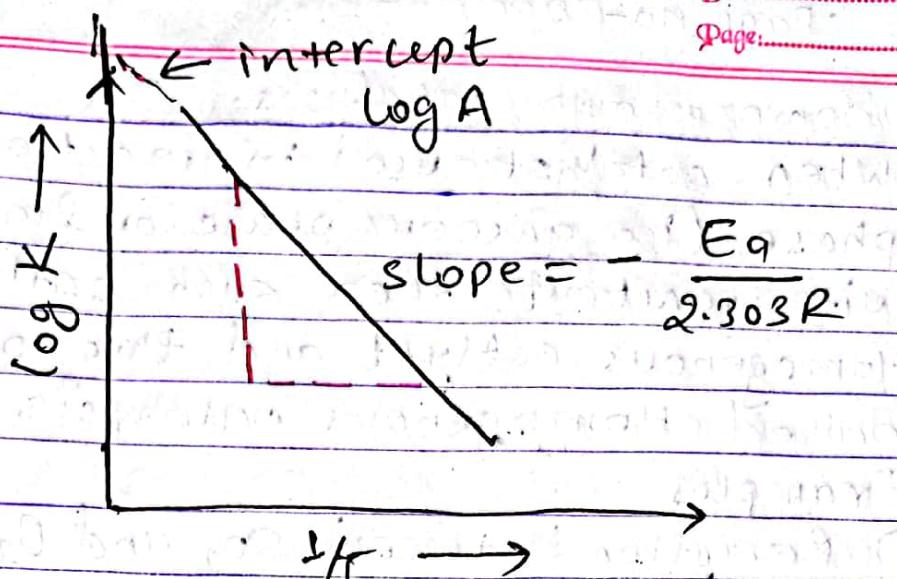
$$\boxed{\log K = \left(-\frac{E_a}{2.303 R}\right) \frac{1}{T} + \log A}$$

(ii)

This eqⁿ (ii) is used to calculate the activation energy (E_a).

~~where~~ this ^{can be} compared with the eqⁿ of straight line, $y = mx + c$.

Then, on plotting $\log K$ against $1/T$ we get straight line with slope equal to $(-\frac{E_a}{2.303 R})$.
~~Slope and inter~~

Fig: A plot of $\log K$ Vs $\frac{1}{T}$

Significance of Arrhenius Equation.

- (I) It can be used to determine the effect of a change of temperature on the rate constant and on the rate of rxn.
- (II) It can be used to calculate activation energy.

(Catalysis)

Catalysts and it's type.

Catalyst is the substance which provides alternative path for the reaction and changes the rate and is recovered chemically unchanged at the end of rxn. This phenomenon is called catalysis. Its type are

(a) Homogenous catalysis

(b) Heterogenous - catalysis

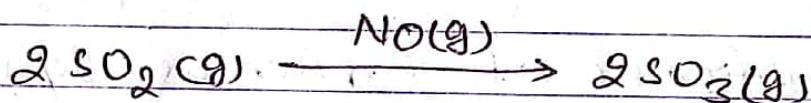
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(A) Homogenous catalysis.

When catalyst used in reaction is in same phase (i.e gaseous phase or liquid phase) with reactant, then such catalyst is called Homogenous catalyst and this phenomena is called Homogenous catalysis.

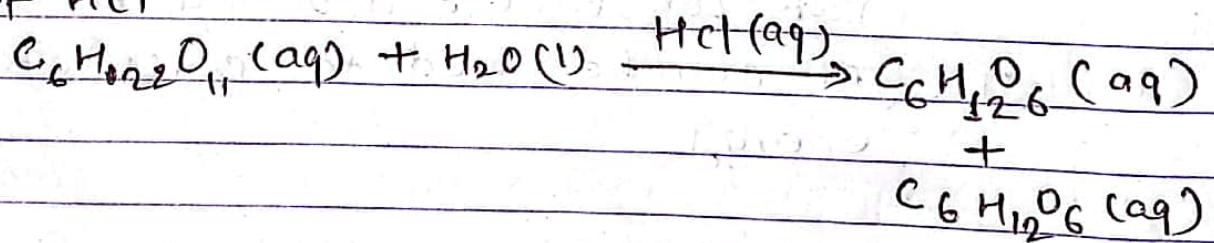
Examples

- ① Reaction between SO_2 and O_2 catalysed by NO . (gas phase example)



- ② Liquid phase example:-

Inversion of cane sugar in the presence of HCl

(B) Heterogenous catalysis:-

If the catalyst is in different phase from the reactant, then such catalyst is called heterogenous catalyst and phenomena is called Heterogenous Catalysis.

Example.

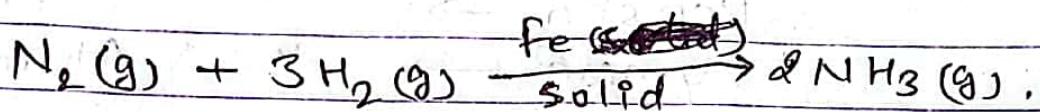
- ① Heterogenous catalysis in gaseous reactant

3,000 enzyme identified upto date.

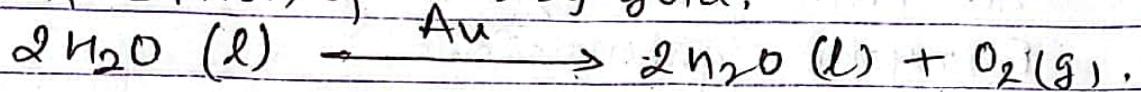
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(2) Finely divided iron (as solid) act as catalyst for manufacture of NH_3 .

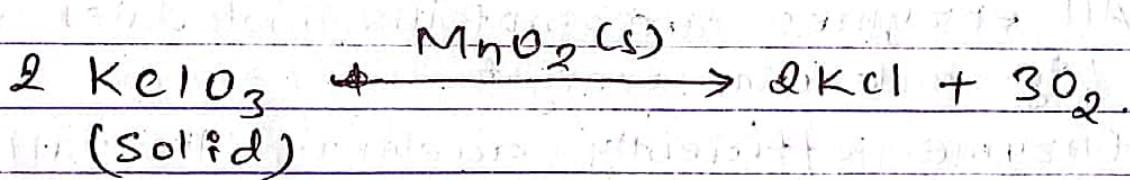


(II) (B) Heterogenous catalysis involving liquid reactant
- decomposition of N_2O_2 by gold.



Au = gold.

(III) Heterogenous catalysis involving solid reactant



Enzyme Catalysis:-

Enzyme are non-living complex organic nitrogenous ~~complex~~ organic compound, they are protein molecules and act as catalyst to speed up ~~any~~ reaction in living cells.

Digestion, breathing, heartbeat, cell division, muscular movements etc. are some biological action which depend on enzyme.

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examples of enzymes

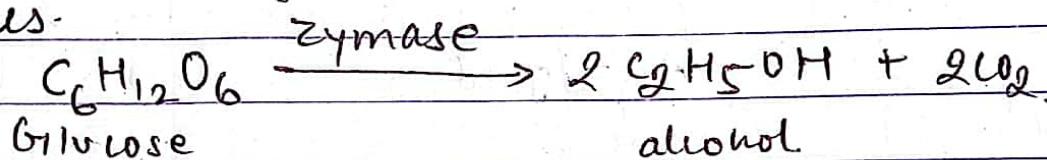
Amylase → catalyzed starch

Pepsin → " " protein

zumase → " " Glucose, fructose.

The phenomenon in which chemical reactions are catalyzed by enzyme is known as Enzyme catalysis.

examples-



* Characteristics of enzyme catalysis *

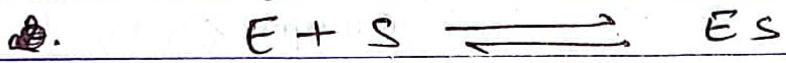
1. All enzymes are protein molecules of high molecular weight.
 2. Enzyme efficiently accelerate the rate of biochemical reactions millions times as compared to uncatalyzed reactions.
 3. The rate of enzyme catalyzed reaction at moderate temperature (optimum temp.) and optimum pH is maximum. They lose their activity High temp (above 37°C) and strong acidic or alkaline medium (above or below pH-7).
 4. Enzymes catalysts are more specific in nature. It means certain ~~particular~~ enzyme catalyzed a particular rxn. e.g. Urea is catalyzed by Urease enzyme.

* Mechanism of Enzyme catalysis:-

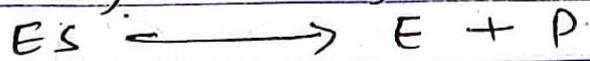
The mechanism of enzyme catalysis is explained on the 'lock' and 'key' hypothesis. This theories assume, enzyme have cavity cavities or active sites on their surface, these cavities trap the specific molecules, that fit on the cavity and give the product.

This reaction can be proceed through the following steps.

- I.** The enzyme (E) combine with reactant also called & substrate and forms enzyme- substrate complex (ES).



- ⑪ The ES dissociates to form product (EP) and enzyme is regenerated at the end.



enzyme product

- (III) The overall process is expressed as,

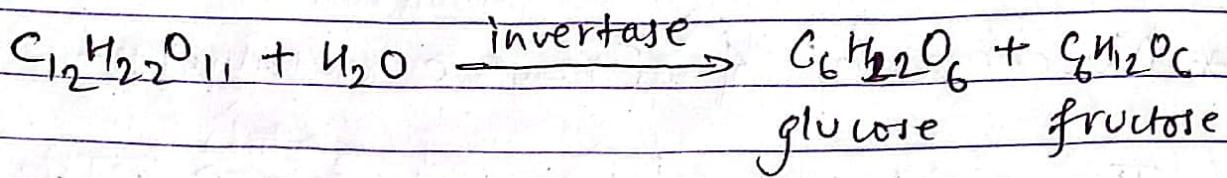


e.g. hydrolysis of sucrose in the presence of enzyme invertase.

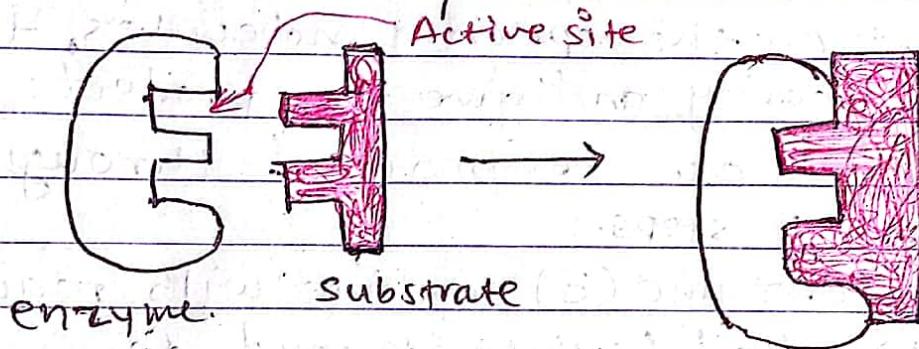
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lock and key mechanism.



Enzyme - substrate complex.

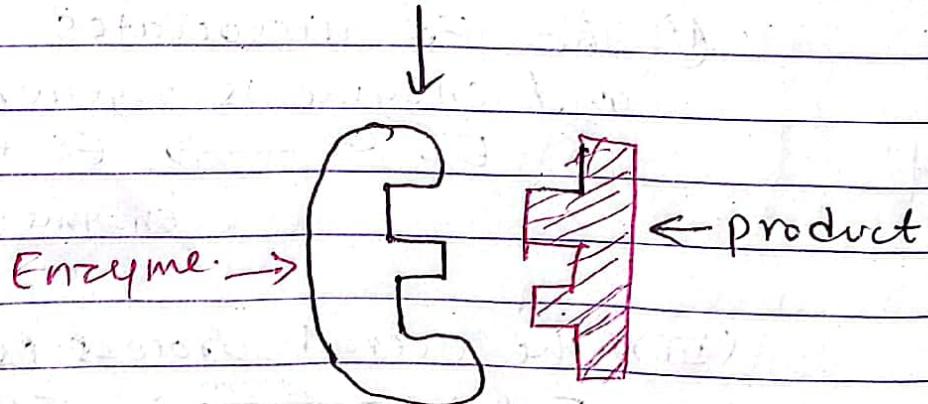


Fig: Lock and key mechanism of enzyme action.

Questions.

1. Write short notes on.
 - (a) collision theory of reaction rate.
 - (b) factor affecting the rate of rxn.
 - (c) Effect of temperature and catalyst on the rate of reaction.
2. What are the fact
3. Explain the enzyme catalysed reaction with appropriate examples and Mechanism.
4. Write the difference between Enzymes and inorganic catalysis.
5. Write the Arrhenius equation to relate the rate constant with temperature.
6. What do you mean by activation energy?
draw the energy profile diagram of
 - (a) exothermic reaction.
 - (b) endothermic rxn.
 - (c) Enzyme catalyzed rxn.