SOCHBADLOBYMAK

CLASS 10TH CHEMISTRY

CHAPTER-05 NOTES

Chapter No:05
"Reaction Kinetics"

"TOPIC WISE NOTES"

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Reaction:- **"Process in which reactants are transformed into products"**

→ old bonds are broken & new are formed.

→energy is absorbed(endothermic) or release (exothermic process)

R (left) → P (right)

$C + O_2 \rightarrow CO_2$

{ Reactant → Product }

Exothermic Reaction — Combustion Process

Reaction Kinetics:- **"Study of rate of chemical reactant,mechanism and factor that influence them"**

Rate of reaction:-

Definition:- **"The rate of reaction tells us how quickly the reactants are used up or how quickly product are formed over time"**

Mathematically:-

Rate of Reaction = Change in Concentration / Time Taken for Change
=product/time

Example:-

$H_2 + O_2 \rightarrow H_2O$

{ Reactant → Product }

Example:

2 mol dm^{-3} of H_2O is formed in 5 seconds. Calculate the rate of reaction.

Solution:-

Rate=2 mol dm−3/ 5 sec

Rate=0.4 mol dm−3 s−1 Final answer!

Info Box:
[ ] = Concentration (mol dm^{-3})

TYPES OF RATE REACTION

Average Rate

"total change in concentration over total time"

Mathematically:-

Average Rate = Total Change in Concentration / Total Time (in seconds)

Average Rate = ΔC / Δt

Instantaneous Rate

"change in concentration at specific moment in time"

Mathematically:-

Instantaneous Rate = Change in Concentration at a Specific Point / Time Interval
Instantaneous Rate = ΔC / Δt (at a specific point)

Example:-

Reaction A → B

Rate of Reaction with Respect to Reactant:-

Rate of Reaction = -d[A] / dt

→ Rate of reactant decreases with passage of time

Rate of Reaction with Respect to Product:-

Rate of Reaction = d[B] / dt

[A] = concentration of reactant A (mol dm^{-3})
d[A] = small change in concentration of A
dt = small change in time (seconds)
Negative sign (-) = indicates concentration of reactant decreases with time

[B] = concentration of product B (mol dm^{-3})
d[B] = small change in concentration of B
dt = small change in time (seconds)
Positive sign (+) = indicates concentration of product increases with time

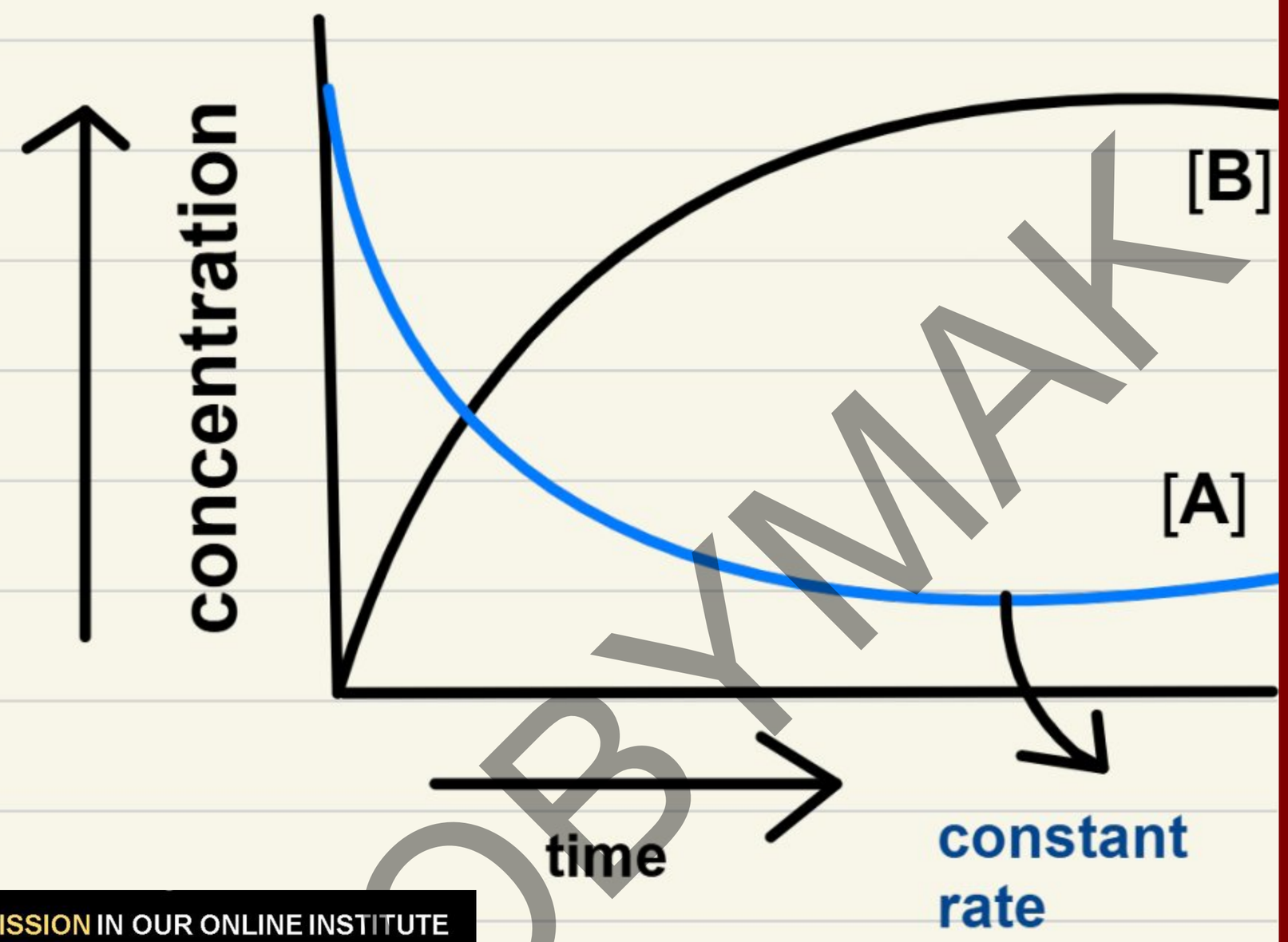
Graph:-

Reactant A → B

→ As reaction happens, amount of reactant decreases

→ Amount of product increases

→ Concentration is measured in mol dm^{-3}



Example Pg 65:-

Interpreting Data:- **A + B → C (product)**

Time (min)	conc(mol.dm^{-3})
0.0	0.0
20	15
40	21
60	23
80	25
100	25

Info Box:
{ Steep slope = Curved line = Rise or fall quickly }

Instantaneous Rate at 40 min:-

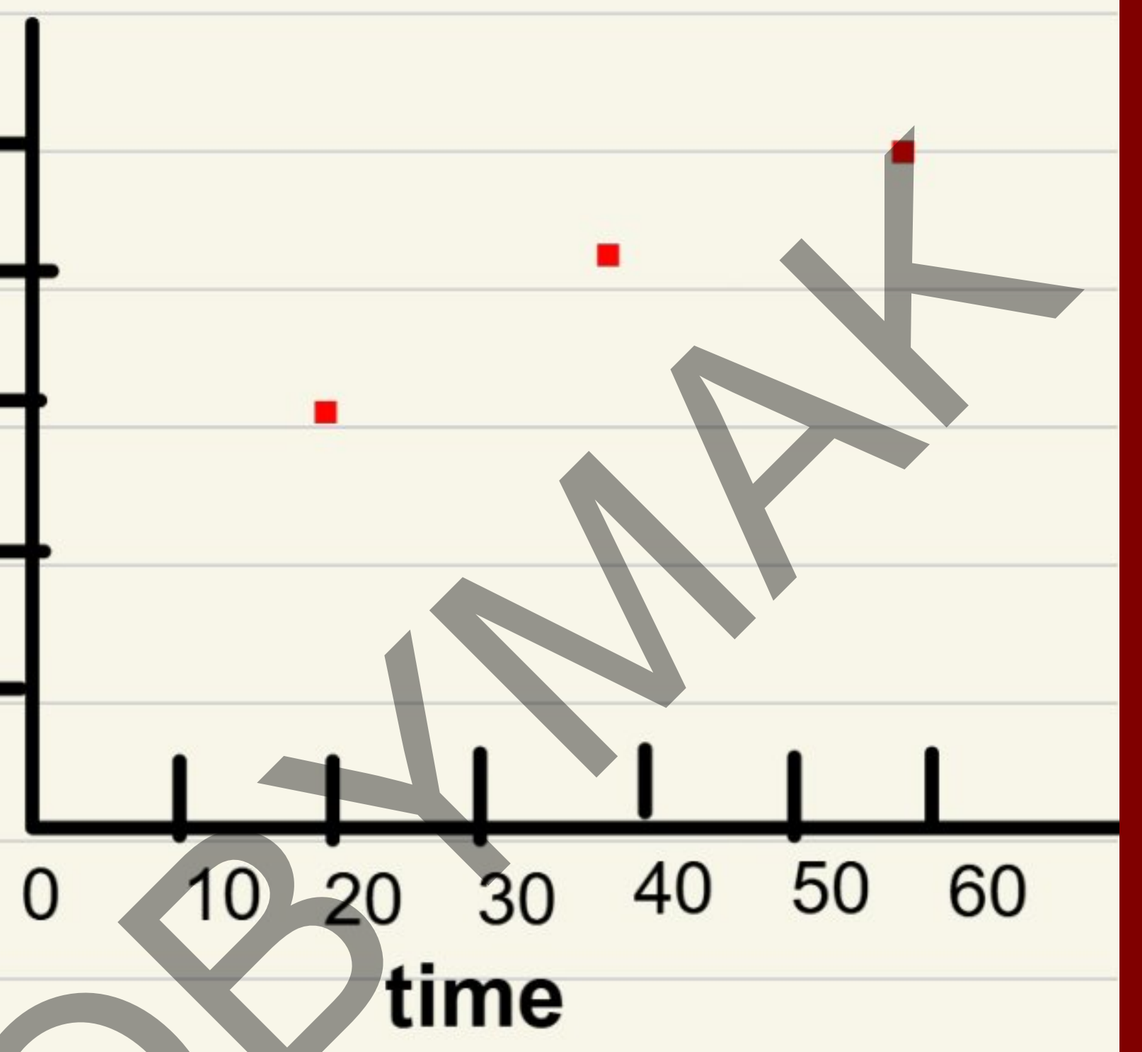
Rate of Reaction= ΔC / Δt

=24/40 min × 60 sec

=24 mol dm^{-3} / 2400 s

Final Answer:

Rate = 0.01 mol dm^{-3} s^{-1}



Average Rate of Reaction:-

Average Rate = ΔC / Δt

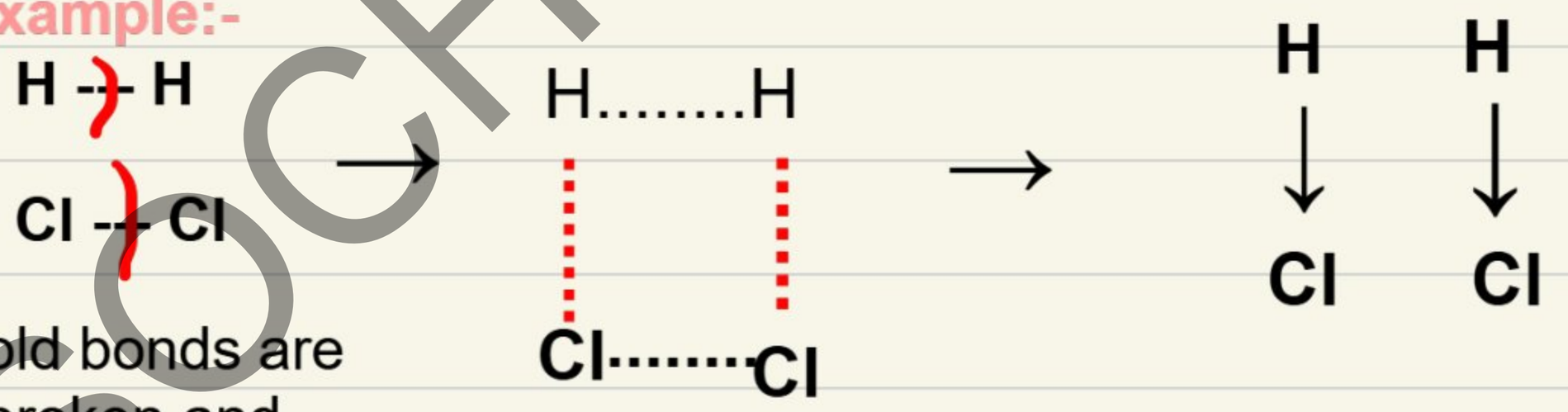
Average Rate = 24 mol dm^{-3} / 2400 s

Final Answer:

Average Rate = 0.01 mol dm^{-3} s^{-1}

Collision Theory:- **"States that a chemical reaction occurs when reacting particles collide with each other with sufficient energy** (equal to or greater than activation energy) **and proper orientation to break old bond and form new one."**

Example:-



old bonds are broken and new bonds are formed

Explination:-

1.Bond:- In a chemical reaction bonds between atom are broken and new bonds are formed.

2.Energy:- The colliding particle must have enough energy to overcome replusive forces between the outer electron.

3.Orientation:- Particle must be aligned in a way that allows necessary atoms to come together and formm new bond.

Activation Energy:- (Ea) "Smallest amount of energy needed to start reaction."

Condition:-

→If **Energy of Reactant ≥ E_a** → Reaction will proceed

→ If **Energy of Reactant < E_a** → Reaction will not occur

→**High Activation Energy** → Slower rate of reaction

→**Low Activation Energy** → Higher rate of reaction

Catalyst And their role in reaction:-

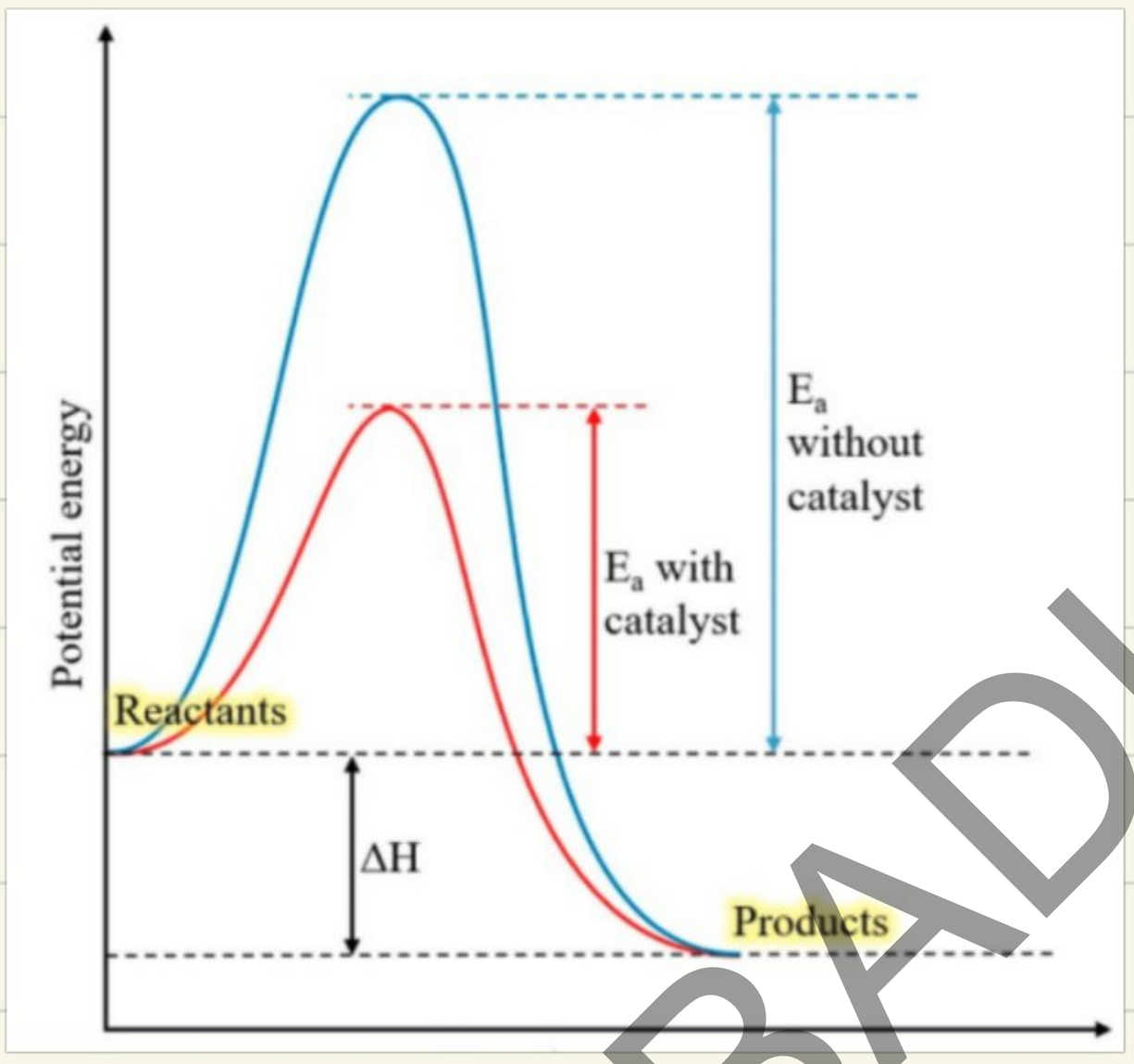
Definition:- " A catalyst is a substance that speed up a chemicalreaction without being consumed"

Role Of Catalyst:-

1 Decrease and provide Ea needed to start the reaction.

2 Product will be produced in less time.
3 Rate of reaction increases.
4 Change pathway for reaction.
5 Catalyst is never consumed.

Graph:-



Physical Parameters Affect Rate of Reaction:-

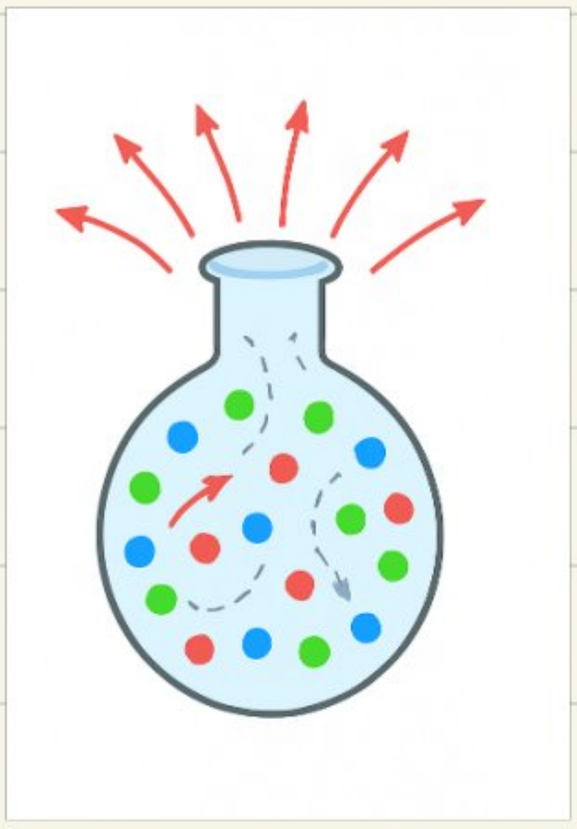
1 Change In mass:- During a chemical reaction.mass of reactant is decreases because they are converted to product (mass of product increases).

$A + B \rightleftharpoons C + D$

2 Formation of Gas:-

Open Container

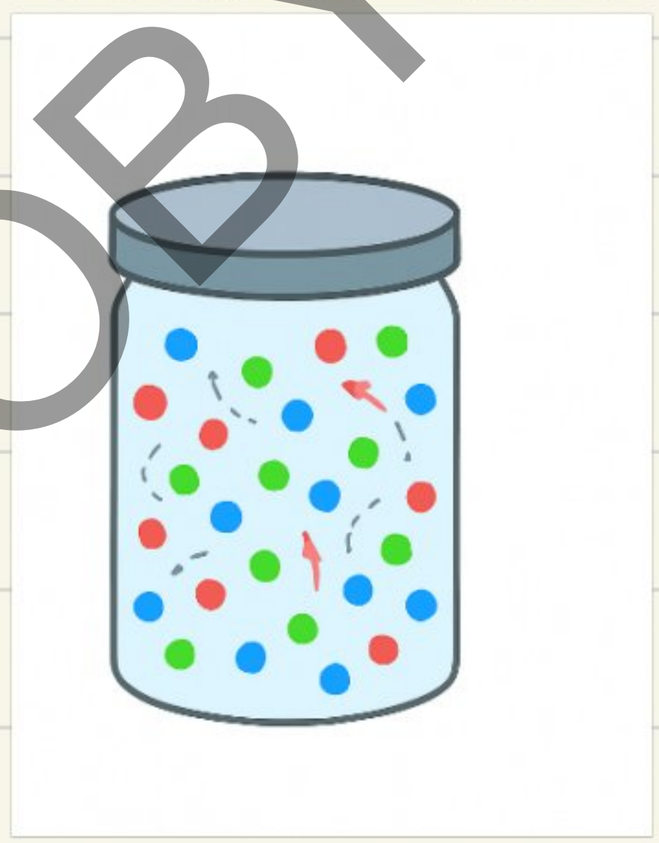
If gas product the total mass reaction minute decrease.



Decrease in total product mass

Closed Container

If closed system gas escape the pressure increase but volumn/mass reamain same.



Pressure increase total volumn mass remains constant.

3 Temperature ∝ Rate of Reaction:-

Temperature increases→Particles move faster→More collisions→Rate of reaction increases

Factors affecting rate of reaction:-

The rate of reaction is the speed at which reactants change into products. It depends on how frequently and effectively particles collide. The main factors are:

1. Concentration ⚡ ∝ Rate of Reaction

Active Mass = Product increase

Higher concentration → more particles in the same volume.
More particles → more frequent collisions → faster reaction.
Active Mass: The greater the amount of reactant available, the more products formed.

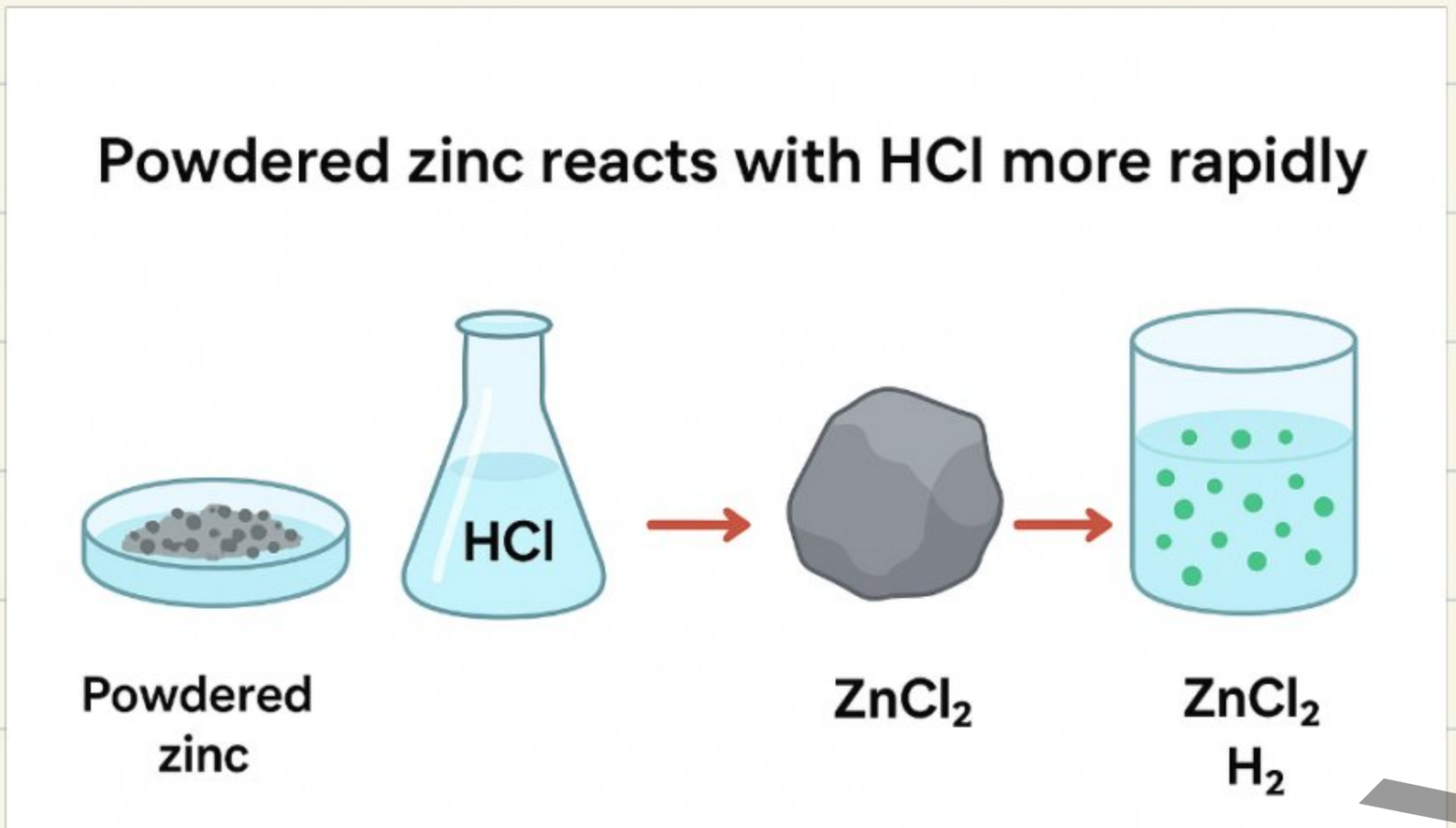
👉 Example: Strong HCl reacts faster with Mg ribbon compared to dilute HCl.

2 Surface Area ∝ Rate of Reaction:-

$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

Powder **Zinc** react **HCL** more faster than pieces of Zn because it has more surface area.

Greater surface area → more particles exposed for collisions.
More exposed surface → faster reaction.

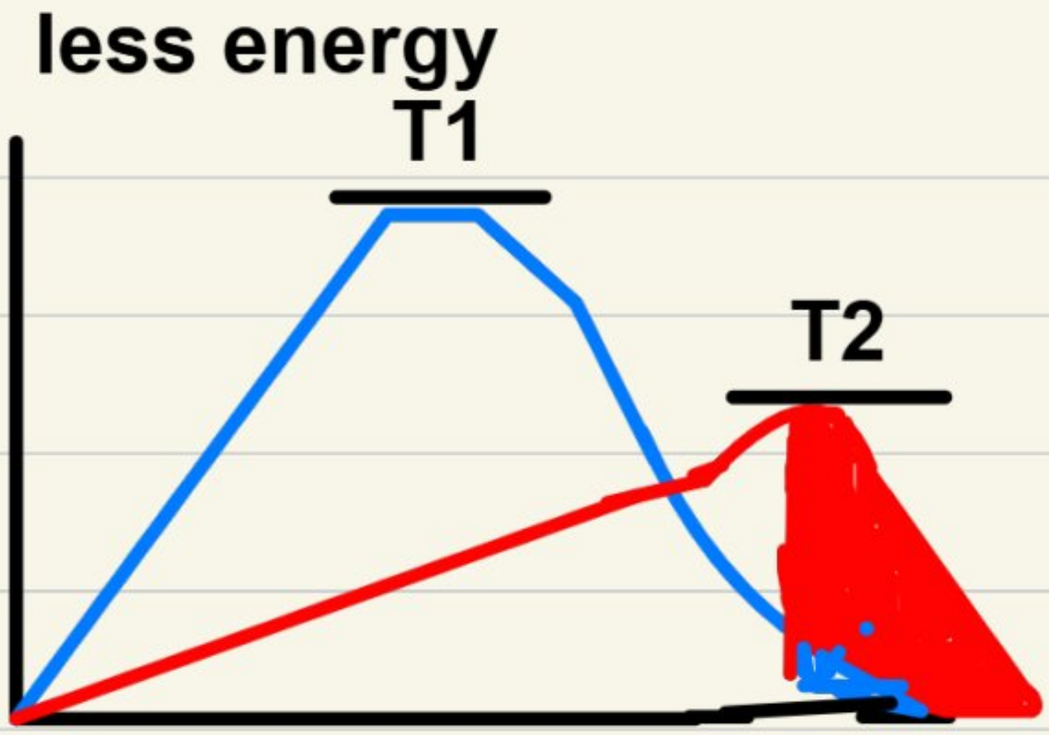


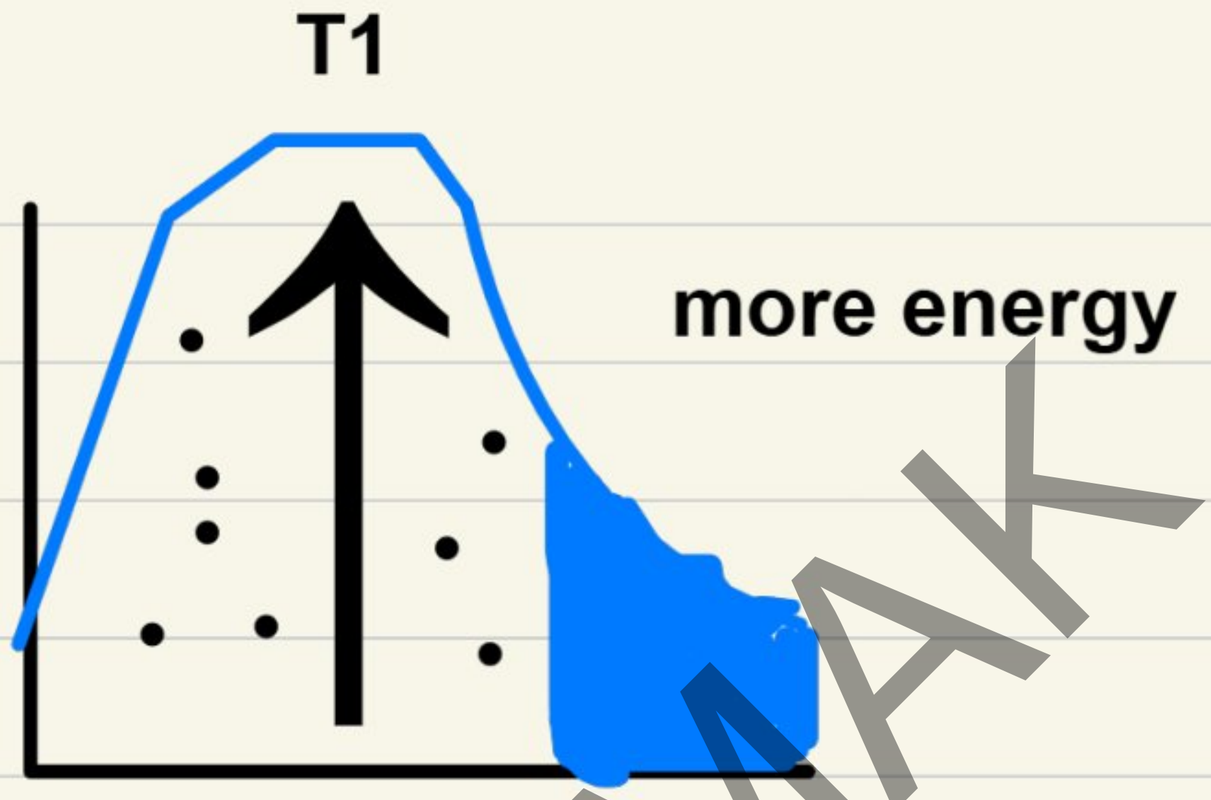
3 Temperature ∝ Rate of Reaction:-

Temperature less → Rate of Reaction less

Temperatue high → Rate of Reaction high

Higher temperature → particles move faster → more frequent collisions.
More particles gain energy ≥**Activation Energy** → more successful collisions.
Lower temperature → slower movement, fewer successful collisions → slower reaction.
👉**Example:** Food spoils quickly in heat but slowly in a refrigerator.





Enzymes:- **"Biocatalyst that speed up chemical reaction".**

Example:-

Protein ⟶(protease) Amino acids

Lipid ⟶(lipase) Fatty acids + Glycerol

🔑 Role of Enzymes

Biological catalysts → Enzymes speed up chemical reactions in living organisms.

Lower activation energy → They reduce the energy needed to start a reaction.

Specificity → Each enzyme works only on a particular substrate (like a "lock and key").

Reusability → Enzymes are not consumed in the reaction; they can be used repeatedly.

Control of metabolism → They regulate processes such as digestion, respiration, photosynthesis, and DNA replication.

Work under mild conditions → Unlike industrial catalysts, enzymes work efficiently at normal body temperature and pH.

⚡Example:

Protease breaks down proteins into amino acids.

Lipase breaks down lipids into fatty acids + glycerol.

CONCEPT ASSESMENT EXERCISE 5.1

1. How does the presence of a catalyst alter the activation energy of a reaction?

Answer: **A catalyst lowers the activation energy of a reaction by providing an alternative pathway, allowing the reaction to proceed faster without being consumed.**

2. Why is it important for a catalyst to remain unchanged at the end of a reaction?

Answer: **It is important for a catalyst to remain unchanged at the end of a reaction because it allows the catalyst to be reused many times without losing effectiveness. This makes reactions faster, more efficient, and cost-effective, since only a small amount of catalyst is needed to process a large quantity of reactants.**

CONCEPT ASSESMENT EXERCISE 5.2

1. In what way does increasing the surface area of a solid reactant affect the rate of reaction?

Answer:When the **surface area of a solid reactant increases**, the **rate of reaction increases**.

✅**Reason:**
A larger surface area exposes **more particles of the solid** to the reactant (e.g., acid or gas).
This results in **more frequent collisions** between reacting particles.
According to the **collision theory**, more collisions per unit time lead to a **faster reaction rate**.

👉 Example: **Powdered zinc reacts with HCl faster than zinc granules** because the powder has a greater surface area.

2. How does temperature affect the rate of reaction?

Answer:An **increase in temperature increases the rate of reaction** because particles gain more kinetic energy, move faster, and collide more frequently with enough energy to overcome the **activation energy barrier**.

👉 Higher temperature = faster reaction.
👉 Lower temperature = slower reaction.

3. Discuss the effect of changing the concentration of a reactant on the rate of reaction.

Answer:When the **concentration of a reactant increases**, the **rate of reaction also increases**.

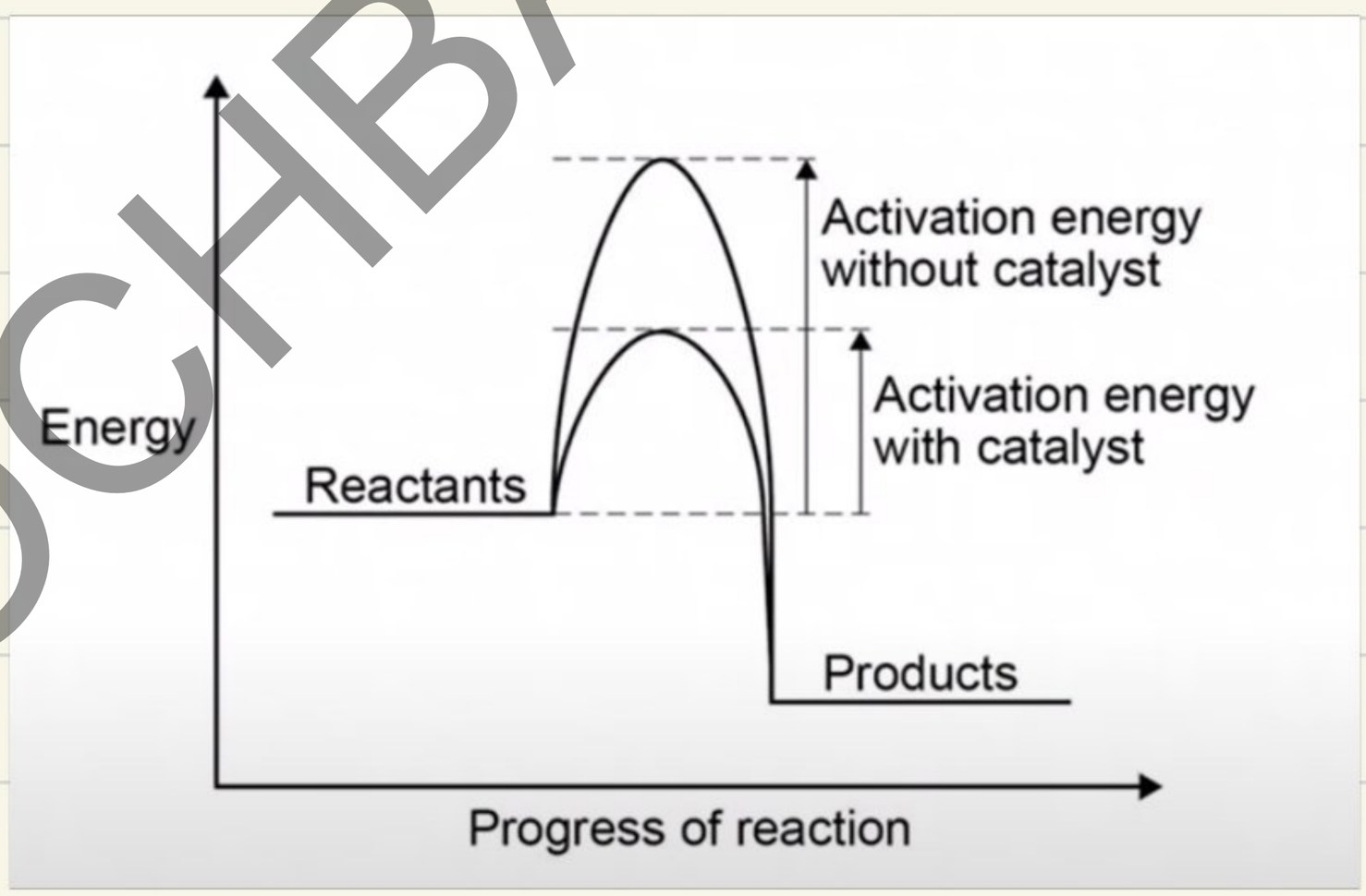
✅**Reason:**
Higher concentration means **more particles per unit volume**.
This increases the chances of **frequent and effective collisions** between reactant particles.
As a result, the reaction happens **faster**.

👉 Example: **Concentrated HCl reacts with zinc more quickly** than dilute HCl because there are more H^+ ions available to collide with Zn.

Short Question Answer

1 Draw energy diagram that represent the activation energy and show the effect of a catalyst.

Answer:



2. What is the effect of a catalyst on the following?
a) the rate of reaction
b) the energy of activation

Answer: **Effect of a catalyst:**

a) **On the rate of reaction:**
A catalyst **increases the rate of reaction** by providing an alternative reaction pathway.

b) **On the activation energy:**
A catalyst **lowers the activation energy** required for the reaction, so particles can react more easily.

3. Why powdered Zn reacts faster with acid than a piece of Zn? give reason.

Answer: **Powdered Zn reacts faster with acid than a piece of Zn because:**
Powdered zinc has a **larger surface area** exposed to the acid.
This allows **more frequent collisions** between zinc atoms and acid particles.
According to the **collision theory**, more collisions per unit time →**faster reaction rate**.

4. List physical parameters which are affected by reaction rates.

Answer:**Physical parameters affected by reaction rates:**

Temperature – Higher temperature increases the rate of reaction.
Concentration of reactants – Higher concentration leads to faster reactions.

Surface area of reactants – Greater surface area increases rate.
Pressure (for gases) – Higher pressure speeds up reactions involving gases.
Catalyst – Presence of a catalyst increases the rate by lowering activation energy.

5. Explain collision theory and its key components?

Answer:**Collision Theory:**

According to this theory, a chemical reaction occurs when the reactant particles **collide with each other** with enough energy and proper orientation.

Key Components:
Collision Frequency – Rate of reaction depends on how often particles collide.
Effective Collision – Only collisions with proper orientation and sufficient energy (≥ activation energy) lead to a reaction.
Activation Energy – The minimum energy required for a successful reaction.
Orientation of Particles – Particles must collide in the correct orientation for bonds to break and form.

6.Discuss the effect of changing the concentration of a reactant on the rate of reaction.

Answer:**Effect of changing the concentration of a reactant on the rate of reaction:**

When the **concentration of a reactant increases**, the number of particles per unit volume also increases.

This causes **more frequent collisions** between reactant particles.
As a result, the **rate of reaction increases**.
Conversely, when the **concentration decreases**, there are fewer collisions, so the **rate of reaction decreases**.

👉 Example: Concentrated HCl reacts with Zn much faster than dilute HCl.

7. Describe how graphs are used to interpret the rate of reaction.

Answer: In chemistry, graphs are often drawn with **time on the x-axis** and either **amount of reactant used** or **amount of product formed** on the y-axis.
The **slope (steepness) of the curve** at any point shows the **rate of reaction**.
Steeper slope → faster reaction
Gentle slope → slower reaction
Over time, the curve levels off when the reaction is complete (no further change in reactants/products).

8. Why is the activation energy important in determining the rate of reaction?

Answer: **Importance of activation energy in determining the rate of reaction:**
Activation energy (Ea) is the **minimum energy** that reacting particles must have for a reaction to occur.
If particles have **less energy than Ea**, collisions will be ineffective, and no reaction happens.
If particles have **equal or greater energy than Ea**, they can collide effectively, break bonds, and form new products.
A reaction with **high activation energy** occurs slowly, while a reaction with **low activation energy** occurs quickly.

9. If you increase the temperature of a reaction, how does this affect the kinetic energy of the particles?

Answer:**Effect of temperature on the kinetic energy of particles:**

Increasing the **temperature** increases the **kinetic energy** of particles.
As a result, particles move **faster** and collide **more frequently**.
More particles will also have energy **equal to or greater than the activation energy**, leading to **more effective collisions**.
Therefore, the **rate of reaction increases** with temperature.

10. Why do only a fraction of collisions lead to a reaction according to collision theory?

Answer: According to collision theory, not all collisions are effective. For a reaction to occur, two conditions must be satisfied:

Sufficient Energy: The colliding particles must have energy equal to or greater than the activation energy.
Proper Orientation: The particles must collide in the correct orientation so that bonds can break and new bonds can form.
Since many collisions do not meet both of these conditions, only a fraction of collisions lead to a successful reaction.

11. Evaluate how increasing activation energy affects the rate of reaction.

Answer: **Effect of increasing activation energy on the rate of reaction:**
Activation energy is the minimum energy required for a reaction to occur.
When activation energy is increased, fewer particles will have enough energy to cross this barrier.

This decreases the number of effective collisions.
As a result, the rate of reaction becomes slower

12. Suggest a way to identify if a catalyst has been effective in a reaction.

Answer: A catalyst is considered effective if it **increases the rate of reaction** without being consumed in the process. This can be identified by comparing the reaction with and without the catalyst: if the reaction finishes faster or produces products more quickly in the presence of the catalyst, while the catalyst remains chemically unchanged at the end, it is effective.

13. Assess the impact of catalysts on industrial chemical processes.

Answer: **Impact of catalysts on industrial chemical processes:**

Catalysts play a vital role in industries because they speed up reactions by lowering the activation energy without being consumed. This allows reactions to occur faster and at lower temperatures and pressures, which saves energy and reduces production costs. Catalysts also improve the yield and selectivity of products, making processes more efficient and environmentally friendly.

👉 Example: Iron catalyst in the Haber process for ammonia production.

14. Evaluate the impact of adding an enzyme to a biochemical reaction.

Answer: **Impact of adding an enzyme to a biochemical reaction:**

Enzymes act as biological catalysts. When added to a biochemical reaction, they lower the activation energy, allowing the reaction to occur more quickly and efficiently under mild conditions of temperature and pH. This increases the rate of reaction without being consumed in the process. Enzymes also provide high specificity, ensuring that only the desired reaction takes place, which is essential for proper biological function.

👉 Example: The enzyme **amylase** speeds up the breakdown of starch into glucose.

15. Analyse how temperature control during transportation can affect the quality of the product.

Answer: **Effect of temperature control during transportation on product quality:**

→ High temperature may cause degradation or spoilage of the product.
→ Low temperature may slow down reactions, affecting effectiveness or consistency.
→ Proper temperature control maintains product quality, stability, and safety.
→ Essential for sensitive products like vaccines, medicines, and perishable foods.

SLO QUESTIONS

1.How do the rates of reactants and products differ?

Answer: In a chemical reaction, the **rate of reactants** refers to how quickly the reactants are being used up, while the **rate of products** refers to how quickly the products are being formed. Both are directly related: as the concentration of reactants decreases, the concentration of products increases. However, the rate of reactants is usually expressed as a **negative value** (since they are consumed), and the rate of products as a **positive value** (since they are produced).

2. If the concentration of a reactant becomes zero, does the rate of reaction also become zero instantly?

Answer: Not instantly. Even if the concentration of a reactant becomes zero, the reaction may still continue for a short time if other reactant molecules are still colliding and reacting. However, once all the required reactants are fully consumed, no further collisions can occur, and at that point the **rate of reaction becomes zero**.

3. What happens if the reactant becomes zero in a chemical reaction?

Answer: If the reactant becomes zero, no particles are left to collide, so the reaction cannot continue. This makes the **rate of reaction fall to zero**, and the reaction stops completely.

4. If the collision is not affective does we get the product ?

Answer: No. If a collision is not effective, it means the particles either don't have enough energy or are not oriented correctly to break old bonds and form new ones. In that case, **no product is formed**. Only **effective collisions** (with sufficient energy and proper orientation) lead to product formation.

5. Difference between exothermic reaction and endothermic reaction?

Answer:

Exothermic Reaction	**Endothermic Recation**
Releases heat to surroundings	Absorbs heat from surroundings
Surroundings become warmer	Surroundings become cooler
Energy released when new bonds form is greater than energy needed to break old bonds.	Energy required to break bonds is greater than energy released when new bonds form.
Often spontaneous (e.g., combustion)	Often requires continuous energy input (e.g., photosynthesis)
Example: Combustion of fuels, Respiration, Neutralization	Example:Photosynthesis, Electrolysis, Dissolving NH_4Cl in water.

6. Differentiate between reversible and irreversible reaction.

Answer:

Reversible Reaction	Irreversible Reaction
A reaction in which products can change back into reactants.	A reaction that goes only in one direction and cannot be reversed.
Represented by a double arrow (⇌).	Represented by a single arrow (→).
Does not go to completion; reaches a dynamic equilibrium.	Usually goes to completion until reactants are used up.
Forward and backward reactions may absorb and release energy.	Energy is released or absorbed only once.
Example: Haber process ($N_2 + 3H_2 \rightleftharpoons 2NH_3$), Dissociation of acids and bases.	Example: Combustion of fuels, Neutralization, Rusting of iron.

1. Multiple Choice Questions (MCQs)

i. The rate of a reaction _____ as the reaction proceeds.

(a) Increases
(b) Decreases
(c) Remains the same
(d) May increase or decrease.

ii) The activation energy for a reaction can be;

(a) Increased by increasing temperature
(b) Increased by decreasing temperature
(c) Decreased by increasing concentration of reactants
(d) None of these

(iii) Reactions with high activation energy are usually;

(a) Fast (b) Slow (c) Exothermic (d) Reversible

(iv) In a reversible reaction catalyst lowers the activation energy of the;

(a) Forward reaction
(b) Reverse reaction
(c) Forward as well as reverse reaction
(d) Forward reaction but increases for the reverse reaction

(v) Which of the following is NOT a factor affecting the rate of reaction according to collision theory?

a) Number of particles per unit volume
b) Activation energy
c) Presence of a catalyst
d) Molar mass of reactants

(vi) How does a catalyst increase the rate of reaction?

a) By decreasing the number of particles per unit volume
b) By increasing the activation energy
c) By providing an alternate pathway with higher activation energy
d) By providing an alternate pathway with lower activation energy

(vii) Which physical parameter is NOT typically affected by the rate of reaction?

a) Change in mass
b) Temperature
c) Formation of gas
d) Colour of the reactants

(viii) Which factor can affect the rate of reaction involving gases?

a) Change in solubility
b) Change in pressure
c) Change in volume
d) Change in viscosity

(ix) Increasing the surface area of solids generally:

a) Decreases the rate of reaction
b) Increases the rate of reaction
c) Has no effect on the rate of reaction
d) Makes the reaction irreversible

(x) How does temperature affect the rate of reaction according to collision theory?

a) Higher temperature decreases the frequency of collisions
b) Higher temperature increases the activation energy
c) Higher temperature decreases the kinetic energy of particles
d) Higher temperature increases the frequency of collisions and kinetic energy of particles