Chapter: 11

# Reaction Kinetics

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## Objective

1. The reaction rate can be measure by:
   - (A) Hit and trial method
   - (B) Graph method
   - (C) Both a and b
   - (D) None of these

2. In zero order reaction , the rate is independent of:
   - (A) Pressure of reaction
   - (B) Concentration of reactants
   - (C) Temperature of reaction
   - (D) Concentration of products

3. $3Fe^{+}\ 4H_2O \rightleftharpoons Fe_3O_4 + 4H_2$ is an example of ..... Equilibrium.
   - (A) Heterogeneous
   - (B) Isogeneous
   - (C) All of these
   - (D) Homogeneous

4. The order of the reactions is $2NO + 2H_2 \longrightarrow 2H_2O + N_2$:
   - (A) Zero
   - (B) Three
   - (C) Two
   - (D) One

5. A second order rate constant can have the units:
   - (A) $dm^3\ mole^{-1}\ s^{-1}$
   - (B) $dm^3\ mole\ s^{-1}$
   - (C) $dm^{-6}\ mole^{-2}\ s^{-1}$
   - (D) $dm^{-6}\ mole^{2}\ s^{-1}$

6. The rate of a reaction depends upon:
   - (A) Concentration
   - (B) T
   - (C) All of these
   - (D) P

7. If the rate of reaction for $2A + B \longrightarrow$ products is rate = $k\ [A]\ [B]^2$ and A is present in large excess , then order of reaction is:
   - (A) 4
   - (B) 3
   - (C) 2
   - (D) 1

8. The branch of chemistry which deals with the study of rate of reaction is called:
   - (A) Chemical kinetics
   - (B) Mechanistic studies
   - (C) Chemistry of reversibility
   - (D) Thermodynamics

9. The unit of the rate constant is same as that of the rate of reaction in:
   - (A) Third order reaction
   - (B) Second order reaction
   - (C) Zero order reaction
   - (D) First order reaction

10. Velocity constant is the rate of reaction when the concentrations of reactants are:
    - (A) Three
    - (B) Two
    - (C) Unity
    - (D) Zero

11. When a reaction proceeds in more than one steps the overall rate is determined by:
    - (A) Any step can be used
    - (B) Slowest step
    - (C) Rate cannot be determined
    - (D) Fastest step



12. The half-life period for the decomposition of $N_2\ O_5$ is:
    - (A) 50 minutes
    - (B) 54 minutes
    - (C) 24 minutes
    - (D) 48 minutes

13. If the energy of the activated complex lies close to energy of reactants , it means that reactions is:
    - (A) Endothermic
    - (B) Exothermic
    - (C) Fast
    - (D) Slow

14. The rate of a reaction is given by the relation:
    - (A) dx/dt
    - (B) dx/dv
    - (C) dx/dT
    - (D) dx/dp

15. Rate of a chemical reaction depends upon:

Ⓐ The number of molecules taking part in a chemical reaction.
Ⓑ The number of total collisions per second.
Ⓒ The number of fruitless collisions per second.
Ⓓ The number of fruitful collisions per second.

16. Under a given set of experimental conditions , with increase of concentration of the reactants , the rate of a chemical reaction:

Ⓐ Always increases Ⓑ Remains same
Ⓒ First decreases , than increases Ⓓ Always decrease

17. The minimum energy more than the average energy required for the molecules to undergo reaction is:

Ⓐ Kinetic energy Ⓑ Activation energy Ⓒ Free energy Ⓓ Internal energy

18. The value of activation energy is primarily determined by:

Ⓐ Chemical nature of reactants and products Ⓑ Collision frequency
Ⓒ Concentration of reactants Ⓓ Temperature

19. After 2 half-lives of a chemical reaction, the % fraction of the amount left is:

Ⓐ 50 Ⓑ 12.5 Ⓒ 75 Ⓓ 6.25

20. All radioactive disintegration nuclear reactions are of:

Ⓐ Zero order Ⓑ $3^{rd}$ order Ⓒ $2^{nd}$ order Ⓓ First order

21. Hydrolysis of Tertiary butyl bromide has order of reaction:

Ⓐ Third order Ⓑ Second order Ⓒ Pseudo first order Ⓓ First order

22. Half-life of a second order reaction in inversely proportional to:

Ⓐ Final concentration of products Ⓑ Final concentration of reactants
Ⓒ Initial concentration of reactants Ⓓ Initial concentration of products

23. In the hydrolysis of $CH_3COOC_2H_5$ the acid produce act as:

Ⓐ Inhibitor Ⓑ Catalyst Ⓒ Auto catalyst Ⓓ none of above

24. The factors which affect rate of reaction:

Ⓐ Surface area Ⓑ light Ⓒ Nature of reactants Light Ⓓ All of above

25. Arrhenius equation describe the effect of:

Ⓐ Pressure on rate of reaction Ⓑ All of these
Ⓒ Temp on rate of reaction Ⓓ Volume on rate of reaction

26. The reaction rate may be measure by:

Ⓐ Chemical method Ⓑ Physical method Ⓒ None Ⓓ Both a and b

27. By the use of catalysts the energy of activation is:

Ⓐ Not affected Ⓑ Decreased Ⓒ Increased Ⓓ All of these

28. The addition of small amount of catalyst in a reaction is called:

Ⓐ Catalytic poisoning Ⓑ Catalytic deactivation
Ⓒ None of these Ⓓ Both a and b

29. Catalysis may be:

Ⓐ Heterogeneous Ⓑ Homogeneous **Ⓒ Both a and b** Ⓓ None of these

30. For a hypothetical reaction A + 2B ⟶ products, the rate law is rate = k [A] [B]. the order of reactions is:

Ⓐ 4 Ⓑ 3 **Ⓒ 2** Ⓓ 1

31. Decrease in concentration is denoted by:

Ⓐ -dt/dx **Ⓑ -dx/dt** Ⓒ +dx/dt Ⓓ dx/dt

32. The number of atoms molecules or ions whose conc. determine the rate of reaction is called:

**Ⓐ Order of reaction** Ⓑ Value or reaction Ⓒ None Ⓓ Rate constant

33. The unit of rate constant depends on:

Ⓐ Concentration terms Ⓑ Molecularity of reaction
**Ⓒ Order of reaction** Ⓓ Number of reactants

34. For a forward reaction according to collision theory the molecules must have energy:

Ⓐ Less than Ea Ⓑ Equal to Ea Ⓒ None **Ⓓ Greater than Ea**

35. The change in the conc. of reactants and products in a unit time is called:

Ⓐ Rate constant Ⓑ Diffusion Ⓒ None **Ⓓ Reaction rate**

36. An increase in conc. is related to number of collisions:

Ⓐ All Ⓑ Indirectly Ⓒ No more **Ⓓ Directly**

37. The energy of activation is usually expressed in:

**Ⓐ Joules** Ⓑ Moles Ⓒ Calories Ⓓ Ergs

38. The addition of a catalyst to a reaction changes the:

Ⓐ Entropy Ⓑ Nature of reactants
**Ⓒ Energy of activation** Ⓓ Enthalpy

39. Pt is poisoned by:

Ⓐ Argon Ⓑ Zinc Ⓒ Silver **Ⓓ Arsenic**

40. The minimum amount of energy required to convert reactants into product is called:

Ⓐ Activated state Ⓑ Activated complex
**Ⓒ Energy of activation** Ⓓ Energy barrier

41. The reaction may be:

Ⓐ $2^{nd}$ order Ⓑ 1st order Ⓒ Forth order **Ⓓ Third order**

42. The main function of a catalyst is to:

Ⓐ Decrease pressure Ⓑ Decrease temp **Ⓒ Decrease Ea** Ⓓ Increase Ea

43. ..... are called biocatalysts.

**Ⓐ Enzymes** Ⓑ Organic bases Ⓒ All of these Ⓓ Organic acids

44. With increases in 100 $^0$C temperature, the rate of reaction doubles . This increase in rate of reaction is due to:

Ⓐ Increase in activation energy of reaction.
Ⓑ Increase in number of effective collisions.
Ⓒ Decrease in the number of collisions between reactant molecules.
Ⓓ Decrease in activation energy of reaction.

45. The rate of reaction:
Ⓐ May decrease or increase as the reaction
Ⓑ Remains the same as the reactions procee
Ⓒ Decreases as the reaction proceeds
Ⓓ Increase as the reaction proceeds

## Fill in the blanks

Q1: The rate of an endothermic reaction ..... with the increase in temperature.
Q2: All radioactive disintegration nuclear is of ..... order.
Q3: For a fast reaction the rate constant is relatively ..... and half - life is ..... .
Q4: The second order reaction becomes ..... if one of the reactants is in large excess.
Q5: Arrhenius equation can be used to find out ..... of a reaction.

## Answers

| | | |
|---|---|---|
| 1. **Increases** | 2. **First** | 3. **large , small** |
| 4. **First order** | 5. **Energy of activation** | |

## Chapter : 11 Reaction Kinetics



### Subjective

Q1: **What do you mean by chemical kinetics?**

Ans: **Chemical kinetics:**

"The branch of chemistry which deals with the study of rate of chemical reactions and the factors that affect the rates of chemical reactions is called chemical kinetics".

These studies also throw light on the mechanisms of the reactions.

- The rates of reactions and their control are very important in industry. They might be the deciding factor that determines whether a certain chemical reactions may be used economically or not.

Q2: **How does a catalyst affect the reversible chemical reaction?**

Ans: A catalyst does not affect the equilibrium position or the equilibrium constant of a reversible reaction. It increases the rates of both forward and backward reactions and thus reduces the time to attain the state of equilibrium. Actually a catalyst lowers the energy of activation of both forward and reverse steps by giving new path to the reaction.

Q3: **Rate of chemical reaction is an ever changing parameter under the given conditions.**

Ans: According to Law of mass action:

- "The rate of a reaction is directly proportional to concentration of reactants."
- As the concentration of reactants is maximum at start the rate is fast. As the time passes, the concentration of reactants decreases and rate of reaction also slows down.

- During the progress of reaction, the rate of reaction slows down every moment with the decreasing concentration of reactants. Hence, it is ever changing parameter.

Q4: **The reaction rate decreases every moment but rate constant 'k' of the reaction is a constant quantity, under the given conditions.**

Ans: As, rate of a chemical reaction depend upon the concentration of the reactants, the rate of reaction decreases every moment with decreasing concentration of reactants.

For rate constant (k), consider the following hypothetical reaction.

$$A + B \longrightarrow C + D$$

$$\text{Rate} = K[A][B]$$

**Or**

$$K = \frac{\text{Rate}}{[A][B]}$$

From above equation, it is clear that rate constant "K" is the ratio of rate of reaction and concentration of reactants. As the concentration of reactants decreases, rate of reaction also decreases but the ratio remains constant. Hence, rate constant "K" is constant quantity.

Q5: **50% of a hypothetical first order reaction completes in one hour. The remaining 50% needs more than one hour to complete.**

Ans: For 1st order reaction, the half-life period is independent of the initial concentration of the reactants. So, whatever the initial concentration, the half-life remains constant.

Now if half-life of a hypothetical reaction is one hour, then 50% of 1 kg of the reactant will be converted into products in one hour.

After one hour the initial concentration is 0.5 kg. Now 50% of this amount (i.e. 0.25 kg of the reactants), will be converted into products in next hour. Similarly in the next hour, 0.125 kg of the reactant is converted into products.

Hence proved that remaining 50% of product requires more than one hour to complete.

Q6: **The radioactive decay is always a first order reaction.**

Ans: "Those reaction in which the rate of a reaction depend upon the concentration of a single reactant (specie) are called 1st" order reactions."

In the disintegration of a radioactive element, only a single specie is involved in the rate determining step. Hence a radioactive decay is always a first order reaction. e.g.

The disintegration of radioactive $^{235}_{92}U$ has a half-life of 710 million years. If 1 kg of $^{235}_{92}U$ disintegrates, then 0.5 kg of it is converted into daughter element in 710 million years. Out of 0.5 kg, 0.25 kg will decay in next 710 million years.

Q7: **The unit of rate constant of a second order reaction is $dm^3\ mole^{-1}\ s^{-1}$, but the unit of rate of reaction is $dm^{-1}\ mole\ s^{-1}$.**

Ans: Equation for rate of reaction is:

$$\text{Rate} = \frac{\triangle C}{\triangle T} = \frac{\text{Change in conc}}{\text{Change in time}}$$

$$\text{Rate} = \frac{dm^{-3}\ moles}{s^{-1}}$$

$$\textbf{Rate} = \textbf{dm}^{-3}\ \textbf{moles. S}^{-1}$$

For a second order reaction:

$$A + B \longrightarrow C + D$$

$$\text{Rate} = K[A][B]$$

$$K = \frac{\text{Rate}}{[A][B]}$$

$$K = \frac{dm^{-3}\ moles.s^{-1}}{dm^{-3}\ moles \times dm^{-3}\ moles}$$

$$\mathbf{K = dm^{-3}\ moles.\ S^{-1}}$$

Q8: **Briefly describe the following with examples.**

1. **A finely divided catalyst may prove more effective.**
2. **A very small amount of a catalyst may prove sufficient to carry out a reaction.**
3. **Change of physical state of a catalyst at the end of a reaction.**

Ans: **A finely divided catalyst may prove more effective:**

A catalyst is more effective in finely divided form. It is because increase in surface area increases the efficiency of a catalyst and rate of reaction increases.

**Examples:**

- In the hydrogenation of vegetable oils finely divided nickel is used.
- A big piece of Pt, have much less catalyst activity than colloidal Pt.

**A very small amount of a catalyst may prove sufficient to carry out a reaction:**

Sometimes only a trace of a metal catalyst is used to affect very large amount of reactants.

**Examples:**

- Thousands of $dm^3$ of $H_2O_2$ can be decomposed in the presence of 1 g of colloidal platinum.
- 1 mg of fine platinum powder can convert 2.5 $dm^3$ of $H_2$ and 1.25 $dm^3$ of $O_2$ to water.

**Change of physical state of a catalyst at the end of a reaction:**

The physical state of a catalyst may be changed at the end of reaction.

**Examples:**

- In many cases shining surfaces of the solid catalyst become dull.
- For the decomposition of $KClO_3$, $MnO_2$ is added in the form of granules. It is converted to fine powder at the end of reaction.

Q9: **The order of a reaction is obtained from the rate expression of a reaction and the rate expression is obtained from the experiment.**

Ans: "The order of a reaction is equal to the sum of exponents to which the concentrations are raised in the rate equation of a chemical reaction".

Many reactions take place in more than one step. For such reactions the overall rate of the reaction is determined by the slowest step of the reaction. This step is called the rate determining step and it is determined experimentally. As the rate of reaction depends on this step, the rate equation of the reaction is written on the basis of slowest step.

**Example:**

Oxidation of CO takes place in two steps.

$$\text{Fast} \quad NO_3 + CO \longrightarrow NO_2 + CO_2$$
$$\text{Slow} \quad NO_2 + NO_2 \longrightarrow NO_3 + NO$$

So, the rate equation is written as:

$$\text{Rate} = K[NO_2]^2$$

Q10: **How the physical state of a catalyst alters at the end of a reaction.**

Ans: A catalyst remains unchanged in chemical composition at the end of the reaction, but may not remain in the same physical state.

**Examples:**

- ❖ Shining surface of Pt is made dull, when it is used as catalyst for hydrogenation of vegetable oil.
- ❖ Granular catalyst ($MnO_2$) for the decomposition of $KClO_3$ is converted into powder form.

Q11: **A very small amount of a catalyst may prove sufficient to carry out a reaction.**

Ans: Since, catalyst itself is not consumed in the reaction, so a very small amount of catalyst is sufficient to catalyze very large amount of reactants.

**Examples:**

- ❖ Thousands of $dm^3$ of $H_2O_2$ can decompose in the presence of 1 g of colloidal platinum.
- ❖ 1 g of Pt can catalyse a reaction between 2.5 $dm^3$ of $H_2$ and 1.25 $dm_3$ of $O_2$ to form water.

$$2H_2 + O_2 \longrightarrow 2H_2O$$

Q12: **A finely divided catalyst may prove more effective.**

Ans: When a catalyst is used in finely divided form, it has greater surface area and hence is more effective in colloidal form.

**Examples:**

- ❖ For hydrogenation of vegetable oils, finely divided Nickel is used.
- ❖ Colloidal platinum has far more catalytic activity than lump of Pt.

Q13: **Equilibrium constant of a reversible reaction is not changed in the presence of a catalyst.**

Ans: When catalyst is added at the equilibrium position of a reversible reaction, it equally speeds up the rate of forward and backward reaction. Hence, equilibrium is not disturbed and equilibrium constant remains constant.

**Example:**

$$2SO_2 + O_2 \overset{V_2O_2}{\rightleftharpoons} 2SO_3$$

Equilibrium constant (Kc) of the above reaction remains same whether the reaction is carried out in the presence or absence of a catalyst.

Q14: **A catalyst is specific in its action. Justify?**

Ans: When a particular catalyst works for one reaction, it may not necessarily work for any other reaction. If different catalysts are used for same reactants then the product may change.

**Example:**

$$HCOOH \xrightarrow{Al_2O_3} H_2O + CO$$

$$HCOOH \xrightarrow{Cu} H_2 + CO_2$$

So for the preparation of CO and $H_2O$ from HCOOH, $Al_2O_3$ must be used as catalyst.

Q15: **What is negative catalyst?**

Ans: "When the rate of reaction is retarded by adding a substance, then it is said to be a negative catalyst". It is also known as inhibitor.

**Example:**

To save petrol from pre-ignition, tetraethyl lead is added to petrol.

Q16: **What is specific rate constant or velocity constant? OR**

**Define specific rate constant. What is the effect of temperature on it?**

Ans: It can be defined as "Specific rate constant of a chemical reaction is the rate of reaction when the concentrations of the reactants are unity".

- ❖ Under given conditions it remains constant.
- ❖ It changes with change in temperature and vice versa.

Q17: **Differentiate between homogeneous catalysis and heterogeneous catalysis. OR**

**Define heterogeneous catalysis with example. OR**

**Define homogenous catalysis with two examples.**

Ans: Difference between homogeneous catalysis and heterogeneous catalysis:

**Homogeneous catalysis:**

In this process, the catalyst and the reactant are in the same phase and the reacting system is homogeneous throughout. The catalyst is distributed uniformly throughout the system. Mostly liquids and gases are used as homogeneous catalysis.

**Example**:

$$2SO_2 + O_2 \xrightarrow{NO(g)} 2SO_3$$

Both the reactants and the catalyst are in same phase i.c. gas phase.

**Heterogeneous catalysis:**

In this catalyst, reactants and catalyst are in the different phases. In this the system remains heterogeneous during the reaction. Mostly the catalysts are in solid phase and reactants are in gaseous or liquid phase.

**Example**:

$$H_2C{=}{=}CH_2(g) + H_{2(g)} \xrightarrow{Ni(s)} CH_3 - CH_{3(g)}$$

Here the Ni (Nickle) is in solid state while all the others are in gaseous state.

Q18: **Differentiate between instantaneous and average rate of reaction.**

Ans: Difference between instantaneous and average rate of reaction:

| Instantaneous rate of reaction | Average rate of reaction |
|---|---|
| ❖ The rate at any one instant during the interval is called the instantaneous rate of reaction. | ❖ While the rate of reaction between two specific time intervals is called average rate of reaction. |
| ❖ The average rate and instantaneous rate are equal for only one instant in any time interval. | ❖ At first the instantaneous rate is higher than the average rate but at the end the instantaneous rate becomes slower than the average rate. |

Q19: **How light affects the rate of a reaction?**

Ans: Light consist of photons having definite amount of energies depending upon their frequencies. When light falls on reactants, this energy becomes available to them and rate of reaction is enhanced.

**For example:**

Reaction of $H_2$ and $Cl_2$ requires light. The reaction is negligible in darkness between $H_2$ and $Cl_2$. Slow in day light, but explosive in sun light. Similarly reaction between $CH_4$ and $Cl_2$ requires light, light plays vital role in the process of photosynthesis.

Q20: **Give two characteristics of enzyme catalysis.**

Ans: The role of enzyme is like inorganic heterogeneous catalyst. They are unique, highly efficient and specific in their action. They have following characteristics.

- ❖ They lower the energy of activation.

- ❖ They have maximum rate of reaction at an optimum temperature.
- ❖ Their catalytic property is greatly enhanced by the presence of a co-enzyme or activator.
- ❖ They are highly specific in their action.

Q21: **Compare molecularity and order of reaction.**

Ans: Compare molecularity and order of reaction:

| Molecularity | Order of reaction |
|---|---|
| ❖ It is the number of atoms, ions or molecules that must collide with one another simultaneously as a result chemical reaction takes place.<br>❖ It is always a whole number.<br>❖ The overall molecularity of a complex reaction has no significance. It is only slowest step whose molecularity has significance for the overall reaction.<br>❖ It can be calculated by simply adding the molecules of the slowest step. | ❖ It is sum of the concentration terms on which the rate of reaction actually depends.<br>❖ It may be zero, in fraction or whole number.<br>❖ It is for the overall reaction and no separate steps are written to obtain it.<br>❖ It can be determined experimentally only and cannot be calculated by looking at reaction equation. |

Q22: **Describe two characteristics of a catalyst.**

Ans: The two characteristics of a catalyst:

- ❖ A catalyst is more effective in finely divided form. It is because increase in surface area increases the efficiency of a catalyst and rate of reaction increases e.g. a big piece of Pt have much less catalytic activity than colloidal Pt.
- ❖ Sometimes only a trace of a metal catalyst is used to affect very large amount of reactants e.g. thousands of $dm^3$ of $H_2O_2$ can be decomposed in the presence of 1 g of colloidal platinum.

Q23: **Write a note on auto-catalyst. OR**

**What is auto-catalyst? Give one example.**

Ans: **Auto-catalyst:**

"In some of the reactions, a product formed acts as a catalyst. It is called auto-catalyst and this phenomenon is called auto-catalysis.

**For example:**

When copper is allowed to react with nitric acid, the reaction is slow in the start.

It gains speed gradually and finally becomes very fast. This happens due to the formation of nitrous acid during the reaction which acts as auto-catalyst and accelerates the process.

Q24: **How surface area affect the rate of reaction give example.**

Ans: With increase in surface area of reactants, the possibility of atoms and molecules of reactants to come in contact with each other is increases.

So rate of reaction is increases e.g. $CaCO_3$ in the powder form reacts with dilute $H_2SO_4$ more efficiently than its big pieces.

Q25: **Define instantaneous rate.**

Ans: The rate of reaction at any one instant during the interval is called instantaneous rate.

Q26: **How higher temperature increases the rate of reaction?**

Ans: At low temperature molecules possess average energy and only small fraction of molecules have necessary activation energy (Ea) and rate of reaction is low. When temperature rises the fraction of high energy molecules increases and rate of reaction increases.

When the temperature is raised 10K, the fraction of molecule with more energy than (Ea) roughly doubles and so the reaction rate is also doubled so higher temperature increases the rate of reaction.

Q27: **What is zero order reaction? Give one example.**

Ans: When the reaction is independent of the concentration of reactants, it is known as zero order reaction.

**Example**:
Photochemical reactions are usually zero order reactions.

Q28: **Write a note promoter.**

Ans: Such a substance which promotes the activity of a catalyst is called a promoter or activator. It is also called "catalyst for a catalyst".

**For example:**
Hydrogenation of vegetable oils is accelerated by nickel. The catalytic activity of nickel can be increased by using copper.

Q29: **Define the term activation of a catalyst.**

Ans: Such a substance which promotes the activity of a catalyst is called a promoter or activator. It is also called "catalyst for a catalyst". This whole process is known as activation of a catalyst.

**For example:**
Hydrogenation of vegetable oils is accelerated by nickel. The catalytic activity of nickel can be increased by using copper.

Q30: **Define transpiration.**

Ans: The loss of water from the surface of the plant in the form of water vapors is known as transpiration.

Q31: **Define order of reaction.**

Ans: The order of reaction may be defined as "The number of reacting molecules, whose concentrations alter as a result of the chemical change. It is given by the sum of all the exponents to which the concentrations in the rate equation are raised."

Q32: **Differentiate between slow step and fast step.**

Ans: Difference between slow step and fast step:

| Slow step | Fast step |
|---|---|
| It is the rate determining step in the reaction mechanism. | In the reaction mechanism, the rate does not depend upon this step. |

Q33: **Define rate law.**

Ans: The experimental relationship between a reaction rate and the concentration of the reactants is known as the rate law or the rate equation for that reaction.

Q34: **Define activation energy and activated complex.**

Ans: The minimum amount of energy which is required to start a chemical reaction is called activation energy.

While activated complex is an unstable combination of all the atoms involved in the reaction for which the energy is maximum. It is short lived species and decomposes into products immediately.

Q35: **Differentiate between enthalpy change of a reaction and energy of activation of a reaction.**

Ans: Difference between enthalpy change of a reaction and energy of activation of a reaction:

| Enthalpy change of a reaction | Energy of activation |
|---|---|
| Enthalpy change is the name given to the amount of heat evolved or absorbed in a reaction carried out at constant pressure. It is shown by the symbol AH, read as "delta H". | Energy of activation is the minimum amount of energy which is required to start a chemical reaction. It is shown by the symbol "Ea". |

Q36: **The sum of the coefficients of a balanced chemical equation is not necessarily important to give the order of a reaction.**

Ans: The order of a chemical reaction is an experimentally determined value and is equal to the sum of the exponents to which concentrations are raised in the rate equation of a reaction.

**Example:**

Consider a chemical reaction.

$$2NO_{(g)} + 2H_{2(g)} \longrightarrow 2H_2O_{(g)} + N_{2(g)}$$

The sum of coefficients of the above equation is 2 +2 =4.

The mechanism of the reaction shows that reaction is completed in two steps.

$$\text{Fast} \quad 2H_2O_{(g)} + H_{2(g)} \longrightarrow 2H_2O_{(g)}$$

$$\text{Slow} \quad 2NO_{(g)} + H_{2(g)} \longrightarrow N_{2(g)} + 2H_2O_{(g)}$$

Step (2) is the rate determining step, hence the rate equation of the reaction is written as:

$$\text{Rate} = K[NO]^2[H_2]$$

So, the order of the reaction is 2 +1 =3.

## Chapter : 11 Reaction Kinetics

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### Imp.Long Questions

Q1: Give four characteristics of enzyme catalysis. (v.imp)

Q2: Discuss different factors which affect the rate of reactions.

Q3: Explain effect of concentration of reaction on rate of reaction.

Q4: How light and surface area affect the rate of reactions? (v.imp)

Q5: Define catalysis. Give its types and describe one type with an example.

Q6: How does Arrhenius equation help us to calculate the energy of activation of a reaction? (v.imp)

Q7: Define half-life period and order of reaction. Describe half-life method to determine the order or reaction. (v.imp)

Q8: What are enzymes? Give example in which they act as catalyst. Mention the. Characteristics of enzymes?

Q9: Write a comprehensive note on activation energy.

Q10: Define enzyme catalysis. Write three characteristics of enzyme catalysis.

Q11: Write down any four characteristics of a catalyst. (v.imp)

Q12: What is Catalysis? Differentiate Between Homogeneous and Heterogeneous catalysis with one example in each?. (v.imp)

Q13: Define these terms: (i) Rate of reaction (ii) Order of reaction.

Q14: Name various factors affecting rate of reactions. Explain any one in detail?

Q15: What is energy of activation? Discuss collision theory of reaction rate?

Q16: Describe Energy of Activation of a Reaction. How is it described for Exothermic, Reaction. And Endothermic reaction.