Previous IPE

SOLVED PAPERS

MARCH -2025(AP)

PREVIOUS PAPERS

IPE: MARCH-2025(AP)

Time : 3 Hours **SR. CHEMISTRY** Max.Marks : 60

SECTION-A

I. Answer all questions : $10 \times 2 = 20$

1. Name two most familiar antioxidants used as food additives.
2. What are antacids? Give example.
3. What is PHBV? How is it useful to man?
4. What are the repeating monomeric units of Nylon 6 and Nylon 6,6?
5. State Raoult's law.
6. What is the difference between a mineral and an ore?
7. State Faraday's first law of electrolysis.
8. Write the reactions of F_2 and Cl_2 with water.
9. What happens when Cl_2 reacts with dry slaked lime?
10. Aqueous Cu^{2+} ions are blue in colour, whereas Aqueous Zn^{2+} ions are colourless.

SECTION-B

II. Answer any six of the following Questions. $6 \times 4 = 24$

11. How are XeF_2 and XeF_4 prepared? Give their structures.
12. What are different types of adsorption? Give any four differences between characteristics of these different types.
13. Derive Bragg's equation.
14. A solution of glucose in water is labeled as 10% w/w. What would be the molality of the solution ?
15. Explain briefly the extraction of aluminium from bauxite.
16. Explain Werner's theory of coordination compounds with suitable examples.
17. What are hormones? Give one example for each.
    (i) steroid hormones (ii) Poly peptide hormones and (iii) amino acid derivatives.
18. Explain the mechanism of nucleophilic bimolecular substitution (S_N2) reaction with one example.

SECTION-C

III. Answer any two of the following Questions: $2 \times 8 = 16$

19. a) Write the chemical reactions that occur in the manufacture of nitirc acid.
    b) How is ozone prepared from oxygen? Explain its reaction with (a) C_2H_4 (b) KI
20. a) Describe the salient features of the collision theory of reaction rates of bimolecular reactions.
    b) State and explain Kohlrausch's law of independent migration of ions.
21. Describe the following :
    a) Carbylamine reaction b) Gattermann reaction c) HVZ reaction d) Aldol condensation

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IPE AP MARCH-2025
SOLUTIONS

SECTION-A

1. Name two most familiar antioxidants used as food additives.

A: Butylated hydroxy toluene (BHT) and

Butylated hydroxy anisole (BHA).

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2. What are antacids? Give example.

A: **1) Antacids:** These are the drugs used 'to remove the excess acid' in the stomach and maintain the normal P^H level .

2) Ex: Omeprazole, Lansoprazole.

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3. What is PHBV? How is it useful to man?

A: **1) PHBV:** Poly β-hydroxy butyrate –co–β–hydroxy valerate .

2) This biogdegradable polymer is useful to man in the following ways

(i) manufacture of capsules (ii) packing of orthopaedic devices.

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4. What are the repeating monomeric units of Nylon 6 and Nylon 6, 6?

A: **1) Nylon 6:** Caprolactum

2) Nylon 6, 6: Hexamethylene diamine and adipic acid

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5. State Raoult's law.

A: **Raoult's law:** The **R**elative **L**owering of **V**apour **P**ressure of a dilute solution containing 'non- volatile solute' is equal to 'mole fraction(X)of the solute'.

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6. What is the difference between a mineral and an ore?

A: The naturally occurring chemical substances in the form of which metals occur in the earth's crust along with impurities are called minerals. The mineral from which the metal can be extracted conveniently and profitably is called an ore. Thus, all ores are minerals but all minerals are not ores.

For example, aluminium occurs in earth's crust in the form of two minerals, namely Bauxite ($Al_2O_3.xH_2O$) and Clay ($Al_2O_3.2SiO_2.\ 2H_2O$). Out of these two minerals, 'Al' can be conveniently and economically extracted from bauxite. Therefore bauxite is the ore of aluminium.

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7. State Faraday's first law of electrolysis.

A: **1) Electrolysis** is the chemical decomposition of an electrolyte by using electric current.

2) Faraday's first law: "The 'amount of substance deposited or liberated' at the electrode is directly proportional to the 'quantity of current' passing through the electrolyte".

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8. Write the reactions of F_2 and Cl_2 with water.

A: 1) F_2 oxidises H_2O to O_2 and O_3.

$$2F_{2(g)} + 2H_2O_{(l)} \longrightarrow 4HF_{(aq)} + O_{2(g)} ;$$
$$3F_{2(g)} + 3H_2O_{(l)} \longrightarrow 6HF_{(aq)} + O_{3(g)}$$

2) Cl_2 reacts with H_2O to form hydrochloric acid and hypochlorous acid.

$$Cl_{2(g)} + H_2O_{(l)} \longrightarrow HCl_{(aq)} + HOCl_{(aq)}$$

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9. What happens when Cl_2 reacts with dry slaked lime?

A: 1) When Cl_2 reacts with dry slaked lime 'bleaching powder' is obtained.

2) $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$

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10. Aqueous Cu^{2+} ions are blue in colour, where as Aqueous Zn^{2+} ions are colourless. Why?

A: Electronic configuration of Cu^{+2} is[Ar] $4s^0 3d^9$.
It contains one unpaired electron. Hence it exhibits blue colour in aqueous solution.

Electronic configuration of Zn^{+2} is [Ar]$4s^0 3d^{10}$.
It contains no unpaired electron, hence it is colourless in aqueous solution.

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SECTION-B

11. How are XeF_2 , XeF_4 prepared? Give their structures.

A: Preparation :

1) Preparation of XeF_2:

A mixture of Xenon and Fluorine is heated in the molar ratio of 2:1 to form XeF_2.

$$Xe_{(g)} + F_{2(g)} \xrightarrow{673K,\ 1\ bar} XeF_{2(s)}$$

2) Preparation of XeF_4 :

A mixture of Xenon and Fluorine is heated in the molar ratio of 1:5 to form XeF_4 .

$$Xe_{(g)} + 2F_{2(g)} \xrightarrow{873K,\ 7\ bar} XeF_{4(s)}$$

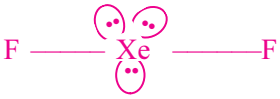
Structures:

1) Structure of XeF_2:

i) In XeF_2, the central atom Xe undergoes sp^3d hybridisation and forms five sp^3d hybrid orbitals.

ii) It forms two σ bonds with two fluorine atoms

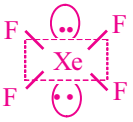
iii) It has two bond pairs and three lone pair.



iv) As per VSEPR theory, the shape of XeF_2 is linear.

2) Structure of XeF_4:

i) In XeF_4, the central atom Xe undergoes sp^3d^2 hybridisation and forms six sp^3d^2 hybrid orbitals.



ii) It forms four σ bonds with four fluorine atoms.

iii) It has four bond pair and two lone pairs.

iv) As per VSEPR theory, the shape of XeF_4 is square planar.

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12. What are different types of adsorption? Give any four differences between characteristics of these different types.

A: There are mainly two types of adsorption.

The adsorption in which accumulation of gas on the surface of a solid occurs on account of weak van der Waals forces, is called as Physical adsorption or Physisorption.

When the gas molecules or atoms are held to the solid surface by chemical bonds, the adsorption is termed as Chemical adsorption or chemisorption.

Comparison of Physisorption and Chemisorption:

Physisorption:

1) It arises because of van der Waals forces
2) It is not specific in nature
3) It is reversible in nature
4) It depends on the nature of gas. Easily liquefiable gases are adsorbed readily.
5) Enthalpy of adsorption is low (20-40 kJ mol^{-1})
6) Low temperature is favourable for adsorption. It decreases with increase of temperature.
7) No appreciable activation energy is needed.
8) It is multilayered.

Chemisorption:

1) It is caused by chemical bond formation.
2) It is highly specific in nature
3) It is irreversible
4) It also depends on the nature of gas. Gases which can react with the adsorbent show chemisorption.
5) Enthalpy of adsorption is high (40-400 kJ mol^{-1})
6) High temperature is favourable for adsorption. It increases with the increase of temperature.
7) High activation energy is sometimes needed.
8) It is unlilayered.

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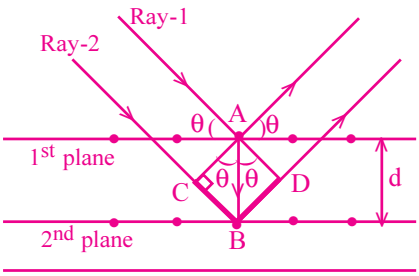
13. Derive Bragg's equation.

A: 1) Suppose two X-rays of wavelength λ are incident on **two parallel planes** of a crystal surface.



2) They both undergo **diffraction**.

3) First x-ray is diffracted from point 'A' in the first plane. Second ray is diffracted from 'B' in the second plane.

4) Here, the second X-ray travels some **extra distance** than the first X-ray. The extra distance (path difference) travelled by the second X-ray = CB + BD

5) When two waves undergo constructive interference then according to Bragg, the path difference must be an **integral multiple of the wave length(λ)**.

$\therefore$ CB + BD = nλ .....(i). Here n = 1, 2, 3…. is known as order of diffraction.

6) If **θ is the angle of incidence** and 'd' be the distance between the parallel planes then

from ΔABC, $\sin\theta = \frac{CB}{AB} = \frac{CB}{d} \Rightarrow CB = d\sin\theta$.....(ii)

In ΔABD, $\sin\theta = \frac{BD}{AB} = \frac{BD}{d} \Rightarrow BD = d\sin\theta$.....(iii)

$\therefore$ from (ii) & (iii), CB+BD = dsinθ + dsinθ = 2dsinθ

$\therefore$ from (i), **nλ = 2dsinθ**

This is known as Bragg's equation.

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14. A solution of glucose in water is labeled as 10% w/w. What would be the molality of the solution ?

A: 10% w/w glucose solution means 10gm of glucose dissolved in 100gm of solution.

Weight of Glucose (w) = 10 gm

Weight of solution (w) = 100 gm

Weight of solvent (w_0) = 100–10 = 90gm

GMW of glucose = 180

Molality = ?

$$m = \frac{w}{GMW} \times \frac{1000}{w_0\ (gm)}$$

$$= \frac{10}{180} \times \frac{1000}{90} = 0.617m$$

Molality of solution = 0.617m

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15. Explain briefly the extraction of Aluminium from Bauxite.

A: Extraction of Aluminium from Bauxite($Al_2O_3.2H_2O$):

1) Concentration: First, Bauxite ore is powdered and then concentrated with a solution of NaOH at 473-523K

Then, Sodium aluminate is formed.

$$Al_2O_{3(s)} + 2NaOH_{(aq)} + 3H_2O_{(l)} \rightarrow 2Na[Al(OH)_4]_{(aq)}$$

2) Passing through CO_2 gas: The alkaline Sodium aluminate is neutralised by passing through CO_2 gas.

Then, hydrated Al_2O_3 is formed.

$$2Na[Al(OH)_4]_{(aq)} + CO_{2(g)} \rightarrow Al_2O_3.xH_2O_{(s)} + 2NaHCO_{3(aq)}$$

3) Heating at 1470K: The insoluble hydrated Al_2O_3 is then filtered, dried and heated at 1470K. Then, pure alumina is formed.

$$Al_2O_3.xH_2O_{(s)} \xrightarrow{1470K} Al_2O_{3(s)} + xH_2O_{(g)}$$

4) Electrolytic refining: Pure alumina on electrolysis gives pure aluminium metal.

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16. Explain Werner's theory of coordination compounds with suitable examples.

A: 1) Werner's theory: This theory explains the structures of 'coordination compounds'.

In co-ordination compounds the central metal atom shows two types of valencies,

a) Primary valency b) Secondary valency.

2) Primary Valency:

i) It is equal to the oxidation number of the central atom.

ii) It is satisfied only by the negative ions.

iii) It is ionisable.

iv) It is non-directional and it is represented by dotted lines.

3) Secondary Valency:

i) It is equal to the co-ordination number of the central atom.

ii) It is satisfied by negative ions, neutral molecues and rarely by positive ions.

iii) It is non-ionisable.

iv) It is directional and it is represented by solid lines. It exhibits isomerism.

4) Example: Hexaammine cobalt (III) chloride-$[Co(NH_3)_6]Cl_3$:

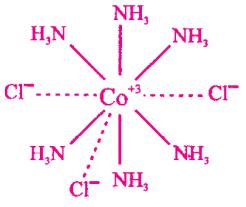
i) Here, primary valency of Co is 3.

It is satisfied by 3 Cl^- ions.

ii) Secondary valency of Co is 6.

It is satisfied by 6 NH_3 molecules.

iii) Shape of complex is Octahedral.



$[Co(NH_3)_6]Cl_3$

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17. What are hormones? Give an example for each of the following:

a) Steroid hormones b) Polypeptide hormones c) Amino acid derivatives

A: **1) Hormones :** These are the molecules which act as intracellular messengers. They transfer biological information from one group of cells to distant tissues (or) target organs. These are produced by Endocrine glands. They are directly released into blood.

2) On the basis of their chemical nature, hormones are classified into three types.

i) Steroid hormones. Ex: Estrogens, androgens.

ii) Protein hormones. Ex: Insulin, endorphins

iii) Amino acid derivatives.

Ex: Thyroxine, epinephrine, norepinephrine

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18. Explain the mechanism of nucleophilic bimolecular substitution (S_N2) reaction with one example.

A: Bimolecular nucleophilic substitution reactions are known as S_N2 reactions. In these reactions, the rate of reaction depends on the concentrations of both alkyl halide and nucleophile.

$$\therefore \text{Rate} \propto [RX]\,[Nu^-]$$

So, these are second order reactions.

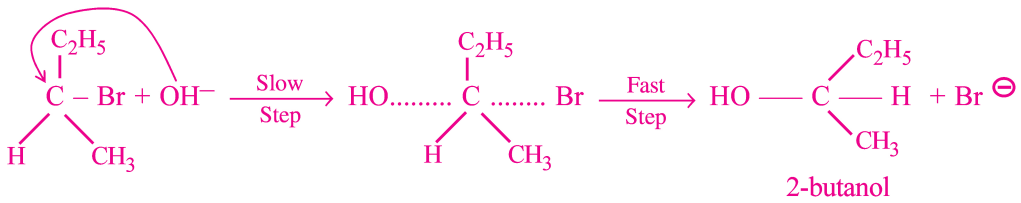
Explanation: It involves only one step. The nucleophile approaches the carbon from the opposite side of the halogen atom to form transition state. It is the slowest step. The transition state is dissociated to form substituted product and halide ion . i.e, Rate depends on concentration of both alkylhalide and nucleophilic. Hence the reaction is known as SN^2 reaction.

In these reactions the configuration of the compound is completely inverted like an inverted umbrella. This change of configurations is called 'Walden inversion'.

Ex: 2-Bromo butane undergoes hydrolysis in aqueous KOH to form 2-butanol.

$$C_2H_5{-}CH(CH_3){-}Br + KOH \xrightarrow{(aq)} C_2H_5{-}CH(CH_3){-}OH + KBr$$

Mechanism:



SECTION-C

19. a) Write the chemcial reactions, that occur in the manufacture of nitric acid.

b) How is ozone prepared from oxygen? Explain its reaction with (a) C_2H_4 (b) KI

A: a) On a large scale HNO_3 is prepared mainly by Ostwald's process. The chemical reactions involved are

$$4NH_{3(g)} + 5O_{2(g)} \xrightarrow[500K, 9\,bar]{Pt/Rh\ gauge\ catalyst} 4NO_{(g)} + 6H_2O_{(g)}$$

$$2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$$

$$3NO_{2(g)} + H_2O_{(l)} \rightarrow 2HNO_{3(aq)} + NO_{(g)}$$

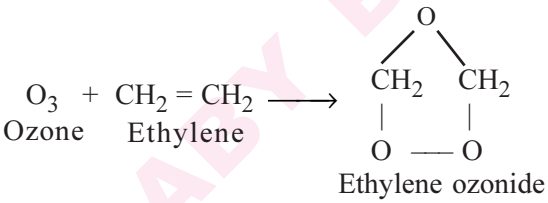
b) Preparation of Ozone from Oxygen:

Ozone is prepared when a slow dry stream of pure, cold oxygen is subjected to a **silent electrical discharge** in ozonizer.

$3O_2 \rightarrow 2O_3$; $\Delta H = +142\ kJ\ mol^{-1}$.

Reactions of Ozone:

a) Ozone reacts with Ethylene to give **Ethylene ozonide.**



b) **Ozone** oxidises moist Potassium Iodide to **Iodine.**

$$O_3 + 2KI + H_2O \longrightarrow 2KOH + I_2 + O_2$$

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20. a) Describe the salient features of the collision theory of reaction rates of bimolecular reactions.

b) State and explain Kohlrausch's law of independent migration of ions.

A: a) Collision Theory:

1) It is based on **kinetic theory** of gases.

2) All collisions do not lead to the formation of products.

3) A reaction takes place only when **reactant molecules collide with 'proper orientation'**.

4) The colliding molecules should posses a **minimum energy** to produce products. Such minimum energy is called **'Threshold energy' (E_T)**

5) Molecules having threshold energy are called **activated molecules.**

6) The difference between the threshold energy (E_T) and the energy of the molecules in the normal state(E_R) is called **'activation energy'(E_a).** $E_a = E_T - E_R$.

7) **Activated collisions only** lead to the formation of products.

8) Collision frequency $Z = \pi\sigma_{AB}^2\sqrt{\frac{8KT}{\pi\mu}}n_A n_B$, σ_{AB} = Collision diameter, μ= reduced mass

9) Specific rate $k=A.e^{-Ea/RT}$

b) 1) Kohlrausch law: The limiting molar conductivity (Λ_m^0) of an electrolyte is equal to the sum of the limiting molar conductivities of cations (λ_+^0) and anions (λ_-^0) of the electrolyte, at infinite dilution.

2) Formula: $\Lambda_m^0 = \lambda_+^0 + \lambda_-^0$

3) Ex: For the electrolyte NaC*l*, we have $\Lambda^o_{(NaCl)} = \lambda^0_{Na^+} + \lambda^0_{Cl^-}$

4) Applications: Kohlrausch's law is used to calculate the following

i) Limiting molar conductivities (Λ^0) of weak electrolytes.

ii) Degree of dissociation (α) of weak electrolytes $\alpha = \frac{\Lambda_m}{\Lambda_m^o}$

iii) Dissociation constant (K) of weak electrolytes $K = \frac{C\alpha^2}{1-\alpha}$

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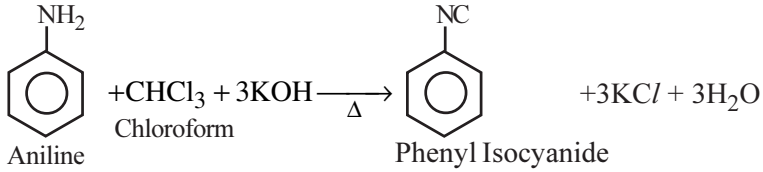
21. Describe the following :

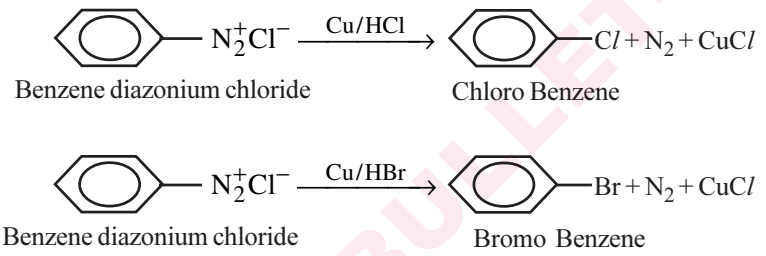
a) Carbylamine reaction **b) Gattermann reaction**

c) HVZ reaction **d) Aldol condensation**

A: a) Carbylamine reaction: **Aniline** is heated with Chloroform in the presence of alc. KOH to form **Phenyl Isocyanide.**

Ex: 

b) Gattermann's reaction: Benzene diazonium chloride is treated with Cu/HCl (or) Cu/HBr to form Chloro Benzene (or) Bromo Benzene

Ex: 

c) HVZ Reaction: Carboxylic Acid is treated with Halogens (Cl (or) Br) in the presence of red phosphorus undergo Halogenation to form α-Halo Carboxylic Acid.

Ex: $R-CH_2-COOH + X_2 \xrightarrow[\text{Halogenation}]{\text{Red phosphorus}} R-\underset{\displaystyle X=Cl,Br}{\underset{|}{CH}}-COOH$

d) Aldol Condensation Reaction: Acetaldehyde 'undergo condensation' in the presence of dilute NaOH to form Aldol.

Ex: $\underset{\text{Acetaldehyde}}{2CH_3CHO} \underset{\text{Condensation}}{\overset{\text{dil NaOH}}{\rightleftharpoons}} \underset{\text{Aldol}}{CH_3-\overset{\displaystyle OH}{\overset{|}{CH}}-CH_2-CHO}$

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