rgpvprep.in



**Program: B.Tech**

**Subject Name: Chemistry**

**Subject Code: BT101**

**Semester: 1st(set-A) & 2nd(set-B)**

**QUE 1- What is the hardness of water and what are the causes of hardness? (Answer)**

**Summary -** Water hardness refers to the concentration of dissolved minerals like calcium and magnesium. It's measured in parts per million (ppm) or grains per gallon (gpg). Hardness arises from geological formations, such as limestone, which leach minerals into water, or from human activities like industrial runoff and sewage discharges.

**QUE 2- How can the hardness of water be determined using N/50 HCl? (Answer)**

**Summary -** The hardness of water can be determined using N/50 HCl by titration with a known volume of water sample and measuring the volume of HCl required to neutralize the alkalinity. The endpoint is reached when a color change occurs due to the reaction between HCl and the alkaline ions present.

**QUE 3- Explain the process of softening water with the help of chemical agents. (Answer)**

**Summary -** Softening water with chemical agents typically involves the use of substances like sodium carbonate or sodium hexametaphosphate. These agents work by binding to the minerals responsible for water hardness, such as calcium and magnesium ions, forming soluble compounds that can be easily removed through filtration or precipitation, resulting in softer water.



**QUE 4- Define the various units of water hardness and discuss their relationships. (Answer)**

**Summary -** Water hardness is measured in different units, primarily in parts per million (ppm), milligrams per liter (mg/L), or grains per gallon (gpg). These units reflect the concentration of dissolved minerals, predominantly calcium and magnesium. Conversion factors exist between units: 1 ppm = 1 mg/L = 0.0584 gpg, facilitating inter-unit comparisons.

**QUE 5- What is the principle behind the EDTA method for determining water hardness? (Answer)**

**Summary -** The principle behind the EDTA method for determining water hardness relies on the chelation reaction between ethylenediaminetetraacetic acid (EDTA) and metal ions, particularly calcium and magnesium, present in the water. EDTA forms stable complexes with these ions, and the concentration of EDTA required for complexation indicates the water's hardness.

**QUE 6- Discuss the corrosion theories and provide examples of how corrosion can be prevented. (Answer)**

**Summary -** Corrosion theories propose electrochemical, chemical, or physical mechanisms for metal deterioration. Examples include galvanic corrosion, where dissimilar metals in contact lead to degradation, and pitting corrosion, forming localized holes. Prevention methods include coatings like paint or plating, cathodic protection systems, and alloying metals to enhance resistance.

**QUE 7- Explain the molecular orbital concept of bond formation. (Answer)**
**Summary -** In the molecular orbital concept, atomic orbitals combine to form molecular orbitals, influencing bond formation. When atomic orbitals overlap constructively, bonding orbitals form, lowering energy and stabilizing the molecule. Conversely, when they overlap destructively, anti-bonding orbitals result, raising energy. This model explains bond strength and electron distribution in molecules.

**QUE 8- Differentiate between ionic and covalent bonds. (Answer)**
**Summary -** Ionic bonds form between ions of opposite charges, transferring electrons from one atom to another. Covalent bonds occur when atoms share electrons to achieve stability. Ionic bonds typically involve a metal and a nonmetal, while covalent bonds occur between two nonmetals. Ionic bonds are often stronger than covalent bonds.



**QUE 9- Define Kohlrausch's law and its applications. (Answer)**
**Summary -** Kohlrausch's Law states that the molar conductivity of an electrolyte at infinite dilution is the sum of the individual molar conductivities of its constituent ions. It's applied in understanding electrolytic conductivity, determining the degree of dissociation of electrolytes, and studying the behavior of solutions at high dilution.

**QUE 10- Discuss the order and molecular nature of hard water in boilers. (Answer)**
**Summary -** Hard water in boilers contains dissolved minerals, primarily calcium and magnesium ions. When heated, these ions form insoluble scale deposits, reducing efficiency and potentially causing damage. The order of hardness refers to the concentration of these ions. Molecularly, they form compounds like calcium carbonate and magnesium hydroxide, precipitating as scale.

**QUE 11- What is the significance of carbon residue and aniline point in lubrication? (Answer)**
**Summary -**Carbon residue indicates the amount of carbonaceous material left after evaporation, indicating lubricant thermal stability. Aniline point measures the solubility of lubricants in aromatic hydrocarbons, reflecting their compatibility with rubber seals. Both

are critical for selecting lubricants suitable for high-temperature operations and compatibility with sealing materials in machinery.

**QUE 12- Explain the zeolite method of water softening. (Answer)**
**Summary -** Carbon residue indicates the tendency of lubricants to form deposits under high temperatures, affecting engine performance and longevity. Aniline point measures the solvency of the lubricant, indicating its ability to dissolve other substances, crucial for effective lubrication and preventing engine wear. Both parameters ensure optimal lubricant functionality and engine protection.

**QUE 13- Define colloids and discuss their electrical, mechanical, and optical properties. (Answer)**
**Summary - C**olloids are heterogeneous mixtures where particles are dispersed in a continuous medium. They exhibit unique properties:
1. Electrical: Colloids can conduct electricity due to charged particles, facilitating applications in electronics.
2. Mechanical: They resist gravitational settling, crucial in stabilizing emulsions and suspensions.
3. Optical: Colloids scatter light, enabling applications in paints, inks, and photonic materials.



**QUE 14- Classify various types of organic reactions and provide examples. (Answer)**
**Summary -** Organic reactions encompass substitution, addition, elimination, and rearrangement. Substitution, like SN1 and SN2, involves replacing one group with another, such as halogenation of alkanes. Addition reactions, like hydration of alkenes, add atoms to double or triple bonds. Elimination, such as E1 and E2, removes groups, seen in dehydrohalogenation. Rearrangement, like the Wagner-Meerwein shift, alters the connectivity of atoms within a molecule.

**QUE 15- Discuss addition reactions in detail with appropriate examples. (Answer)**
**Summary -** Addition reactions involve the addition of atoms or groups to a molecule, typically to unsaturated compounds like alkenes or alkynes. For instance, in the hydrogenation of ethene, hydrogen adds across the double bond to form ethane. Similarly, halogenation of ethene yields a dihaloalkane. These reactions are fundamental in organic synthesis.

**QUE 16- Explain homolytic and heterolytic cleavage and discuss electrophilic substitution reactions of Benzene. (Answer)**

**Summary -** Homolytic cleavage splits a chemical bond evenly, with each atom retaining one electron. Heterolytic cleavage results in uneven distribution, with one atom gaining both electrons. In electrophilic substitution reactions of benzene, an electrophile replaces a hydrogen atom, forming a new aromatic compound. These reactions maintain benzene's stability.

**QUE 17- Describe the general principles involved in ore concentration and the electro-refining of copper. (Answer)**
**Summary -** Ore concentration involves separating valuable minerals from gangue through processes like crushing, grinding, and flotation, exploiting differences in physical and chemical properties. Electro-refining of copper involves passing an electric current through a copper solution, causing copper ions to migrate to the cathode, where they plate out as pure copper, while impurities collect at the anode.

**QUE 18- What are the disadvantages of hard water and how is it removed using ion-exchange methods? (Answer)**
**Summary -** Hard water can cause limescale buildup, decrease soap lathering, and leave residue on surfaces. Ion-exchange methods remove hardness ions like calcium and magnesium by passing water through a resin bed where these ions are exchanged for sodium ions. This process effectively softens the water, reducing its negative effects.



**QUE 19- How is the hardness of water expressed in various units? (Answer)**
**Summary -** Hard water in boilers causes scale buildup, reducing efficiency and heat transfer. It leads to increased energy consumption and maintenance costs. Scale deposits can also lead to overheating and boiler failure, decreasing lifespan. Additionally, hard water can corrode boiler components, compromising safety and reliability, necessitating frequent repairs.

**QUE 20- Discuss the harmful effects of hard water in boilers. (Answer)**
**Summary -** Hard water contains dissolved minerals like calcium and magnesium, leading to scale buildup in boilers. This reduces efficiency, increases energy consumption, and shortens equipment lifespan. Scale can also obstruct pipes and valves, causing costly repairs and downtime. Regular maintenance and water treatment are essential to mitigate these detrimental effects.

**QUE 21- Explain the principle, instrumentation, and applications of vibrational spectroscopy. (Answer)**
**Summary -** Vibrational spectroscopy analyzes molecular vibrations, providing insight into molecular structure and composition. Instruments like infrared (IR) and Raman spectrometers measure vibrational frequencies. IR detects absorption of IR radiation,

correlating with bond vibrations, while Raman detects scattered light changes. Applications include chemical analysis, material characterization, and pharmaceutical identification.

**QUE 22- What is corrosion and how can it be prevented? (Answer)**
**Summary -** Corrosion is the gradual deterioration of materials, commonly metals, due to chemical reactions with their environment. Prevention methods include coating metals with protective layers (e.g., paint, galvanization), using corrosion-resistant alloys, controlling environmental conditions (e.g., humidity, pH), and employing cathodic protection techniques like sacrificial anodes.

**QUE 23- Discuss the determination of hardness by the EDTA method and caustic embrittlement. (Answer)**
**Summary -** The determination of hardness by the EDTA method involves titrating a solution containing calcium and magnesium ions with ethylenediaminetetraacetic acid (EDTA) until the metal ions form stable complexes. Caustic embrittlement, a form of corrosion, occurs in boilers due to excessive alkalinity leading to metal embrittlement and failure.

**QUE 24- Define the various units of water hardness and their relationships. (Answer)**

**Summary -** Water hardness is typically measured in milligrams per liter (mg/L) or parts per million (ppm) of calcium carbonate ($CaCO_3$). It's categorized as soft (0-60 mg/L), moderately hard (61-120 mg/L), hard (121-180 mg/L), and very hard (>180 mg/L). These units denote the concentration of minerals dissolved in water, affecting its quality.

**QUE 25- Discuss the principle of the EDTA method for determining water hardness. (Answer)**
**Summary -** The EDTA method for determining water hardness relies on the principle of complexometric titration, where ethylenediaminetetraacetic acid (EDTA) reacts with metal ions in hard water, particularly calcium and magnesium, forming stable complexes. The endpoint is detected using a metal ion indicator, such as Eriochrome Black T, which changes color upon metal ion depletion.

**QUE 26- Explain the lime soda process for softening water. (Answer)**
**Summary -** The lime soda process involves adding lime (calcium hydroxide) and soda ash (sodium carbonate) to hard water. This forms calcium carbonate and magnesium hydroxide precipitates, which settle out, removing hardness ions. The water is then filtered to remove the precipitates, resulting in softened water suitable for various applications.

**QUE 27- Define the significance of carbon residue and aniline point in lubrication. (Answer)**

**Summary -** Carbon residue indicates the amount of carbonaceous material left after evaporation, reflecting oil's thermal stability and potential for deposit formation. Aniline point measures oil's solvency and compatibility with rubber seals. Both parameters guide lubricant formulation, ensuring efficient performance, reduced wear, and prolonged machinery lifespan.

**QUE 28- Discuss the disadvantages of hard water and its removal using ion-exchange methods. (Answer)**

**Summary -** Hard water poses issues such as scale buildup in pipes, reduced soap lathering, and appliance damage. Ion-exchange methods for its removal involve replacing calcium and magnesium ions with sodium ions through resin beads. However, this method adds sodium to the water, which may not be suitable for individuals on low-sodium diets.

**QUE 29- Explain the mechanism of lubrication. (Answer)**

**Summary -** Lubrication involves applying a fluid or semi-fluid substance between surfaces in relative motion to reduce friction and wear. It functions by forming a thin film that separates the surfaces, preventing direct contact and distributing the load evenly. This film also dissipates heat, enhancing efficiency and prolonging the lifespan of machinery.



**QUE 30- Define colloids and discuss their properties. (Answer)**

**Summary -** Colloids are mixtures where particles, typically between 1-1000 nanometers, are dispersed throughout a continuous medium. Their properties include stable dispersion, exhibiting the Tyndall effect (light scattering), and Brownian motion. Colloids don't settle out, have large surface areas, and can display unique optical, electrical, and mechanical properties.

**QUE 31- Classify organic reactions and provide examples. (Answer)**

**Summary -** Organic reactions are classified based on the type of transformation they cause. Major categories include substitution (e.g., SN1, SN2), addition (e.g., Markovnikov addition), elimination (e.g., E1, E2), oxidation-reduction (e.g., alcohol to aldehyde), and rearrangement (e.g., Wagner-Meerwein rearrangement). Example: SN2 reaction of methyl bromide with cyanide ion.

**QUE 32- Discuss addition reactions in organic chemistry. (Answer)**

**Summary -** Addition reactions in organic chemistry involve the joining of two or more molecules to form a single product. They often occur with unsaturated compounds like alkenes and alkynes, where the π bond is broken and new σ bonds are formed. Examples include hydration, hydrogenation, and halogenation, altering molecular structure.

**QUE 33- Explain homolytic and heterolytic cleavage in chemical reactions. (Answer)**
**Summary -** Homolytic cleavage involves the breaking of a chemical bond with each atom retaining one of the electrons from the bond. It results in the formation of free radicals. Heterolytic cleavage splits a bond unevenly, with one atom taking both electrons, forming ions. It's common in polar covalent bonds.

**QUE 34- Describe electrophilic substitution reactions of Benzene. (Answer)**
**Summary -** Electrophilic substitution reactions of benzene involve the replacement of a hydrogen atom with an electrophile, forming a new substituted product. Key examples include nitration, sulfonation, halogenation, and Friedel-Crafts acylation/alkylation. These reactions proceed via an intermediate carbocation and are governed by the electron-rich nature of benzene's pi electrons.



**QUE 35- Discuss the general principles of ore concentration. (Answer)**
**Summary -** Ore concentration involves separating valuable minerals from gangue using physical or chemical methods. General principles include crushing and grinding to liberate minerals, followed by gravity separation, flotation, or magnetic separation to concentrate the desired mineral. The process aims to increase the ore's economic value by reducing impurities and increasing the mineral content.

**QUE 36- Describe the electro-refining of copper. (Answer)**
**Summary -** Electro-refining of copper involves electrolysis of impure copper anodes in a bath of copper sulfate solution, where cathodes are pure copper sheets. When electric current passes through, copper ions migrate to the cathode, forming a pure copper deposit. Impurities settle as sludge or remain in solution.

**QUE 37- Explain the process of softening water with chemical agents. (Answer)**
**Summary -** Softening water with chemical agents typically involves the use of substances like lime, soda ash, or ion-exchange resins. These agents react with calcium and magnesium ions in hard water, precipitating them out or exchanging them with sodium ions, resulting in softened water. This process reduces scale buildup and improves soap effectiveness.

**QUE 38- Discuss scales and sludges in water treatment. (Answer)**
**Summary -** Scales and sludges are common issues in water treatment. Scales form when minerals precipitate out of water, leading to pipe blockages and equipment damage. Sludges result from suspended solids settling in water, causing contamination and reduced efficiency. Both require treatment methods like filtration, chemical additives, or pH adjustment for removal.

**QUE 39- Define the various units of water hardness. (Answer)**
**Summary -** Water hardness is measured in milligrams per liter (mg/L) or parts per million (ppm) of calcium carbonate (CaCO3). Units include:

1. **Grains per gallon (gpg)**: Common in the United States.
2. **French degrees (°fH)**: Widely used in Europe.
3. **German degrees (°dH)**: Common in Germany.
4. **Parts per million (ppm)**: A universal unit of measurement.

**QUE 40- Discuss the determination of alkalinity in water samples.(Answer)**
**Summary -** Alkalinity in water is determined by titration with a standard acid solution to a pH endpoint. The commonly used method is the Gran method, where phenolphthalein indicates the endpoint for weakly alkaline samples, and methyl orange for strongly alkaline ones. Alkalinity is expressed as milligrams per liter of calcium carbonate.



**QUE 41- Explain the principle of vibrational spectroscopy. (Answer)**
**Summary -** Vibrational spectroscopy relies on the interaction between electromagnetic radiation and the vibrational modes of molecules. When molecules absorb infrared radiation, their vibrational modes are excited, leading to characteristic absorption spectra. By analyzing these spectra, one can deduce molecular structure, functional groups, and chemical bonds present within a sample.

**QUE 42- Define corrosion and its prevention methods. (Answer)**
**Summary -** Corrosion is the gradual deterioration of materials, usually metals, due to chemical reactions with their environment. Prevention methods include coatings like paint or plating, cathodic protection where a sacrificial metal is used, inhibitors that interfere with the corrosion process, and proper material selection for the environment.

**QUE 43- Discuss the molecular orbital concept of bond formation. (Answer)**
**Summary -** Ionic bonds involve the transfer of electrons from one atom to another, creating ions with opposite charges that attract each other. Covalent bonds involve the sharing of electrons between atoms to achieve a stable electron configuration. Ionic

bonds typically form between metals and nonmetals, while covalent bonds form between nonmetals.

**QUE 44- Differentiate between ionic and covalent bonds. (Answer)**
**Summary -** Ionic bonds form between atoms when one atom transfers electrons to another, resulting in the formation of ions with opposite charges that attract each other. Covalent bonds occur when atoms share electrons, resulting in the formation of stable electron pairs between the atoms, typically seen in nonmetals.

**QUE 45- Define Kohlrausch's law and its applications. (Answer)**
**Summary -** Kohlrausch's law states that the molar conductivity of an electrolyte at infinite dilution is the sum of the individual ions' contributions. This law finds application in determining the degree of dissociation of electrolytes, calculating equivalent conductivity, and understanding conductivity behavior in solutions, aiding in various fields like chemistry and electrochemistry.

**QUE 46- Discuss the order and molecular nature of hard water in boilers. (Answer)**
**Summary -** Hard water in boilers forms calcium and magnesium deposits due to their high concentrations. Initially, calcium carbonate precipitates as scale on heating surfaces. With prolonged heating, magnesium silicate deposits form. These deposits reduce efficiency and damage equipment. Treating with water softeners or chemicals prevents scaling, ensuring optimal boiler performance.



**QUE 47- Explain the significance of carbon residue and aniline point in lubrication.(Answer)**
**Summary -** Carbon residue indicates the amount of carbonaceous deposits formed during lubricant combustion, reflecting its thermal stability. Aniline point measures a lubricant's solvency and compatibility with rubber seals. Both parameters are crucial in assessing lubricant performance, ensuring minimal residue buildup and optimal compatibility for efficient machinery operation.

**QUE 48- Describe the zeolite method of water softening. (Answer)**
**Summary -** The zeolite method of water softening involves passing hard water through a bed of zeolite resin beads. These beads contain sodium ions, which exchange places with the calcium and magnesium ions in the water, effectively softening it. Periodically, the zeolite resin is regenerated with a salt solution.

**QUE 49- Discuss the harmful effects of hard water in boilers. (Answer)**

**Summary -** Hard water in boilers causes scale buildup, reducing efficiency and increasing energy consumption. Scale deposits insulate heat transfer surfaces, leading to overheating, corrosion, and ultimately, equipment failure. Additionally, hard water can hinder soap lathering, resulting in inefficient cleaning processes. Regular descaling and water treatment are necessary to mitigate these detrimental effects.

**QUE 50- Explain the principle, instrumentation, and applications of vibrational spectroscopy. (Answer)**

**Summary -** Vibrational spectroscopy analyzes molecular vibrations. Instruments like FTIR and Raman spectroscopy measure molecular vibrations' absorption or scattering of light. It's applied in chemistry for molecular identification, structural elucidation, and analyzing chemical reactions. In materials science, it's used for quality control, identifying polymorphs, and studying surface chemistry.