MHT-CET Chemistry Sample Paper-6

Duration: 45 Minutes **Maximum Marks: 50**

Instructions

- This paper contains a total of **50** Multiple Choice Questions.
- Each correct answer carries **+1 marks**.
- No negative marking for incorrect questions.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.
- No marks will be deducted for questions that are left unattempted.

Q1. Which of the following describes the correct order of acidic strength for the given phenols?

(A) p-Nitrophenol > o-Nitrophenol > m-Nitrophenol > Phenol

(B) Phenol > m-Nitrophenol > o-Nitrophenol > p-Nitrophenol

(C) o-Nitrophenol > p-Nitrophenol > m-Nitrophenol > Phenol

(D) p-Nitrophenol > m-Nitrophenol > o-Nitrophenol > Phenol

Q2. How many total atoms are present in a unit cell of a body-centered cubic (bcc) crystal system?

(A) 1

(B) 2

(C) 4

(D) 6

Q3. In the reaction: $CH_3CH_2OH \xrightarrow{PCl_5} X \xrightarrow{alc.KOH} Y \xrightarrow{H_2O/H^+} Z$, the final product 'Z' is:

(A) Ethane

(B) Ethanol

(C) Ethene

(D) Ethanal

Q4. The bond order of O_2^{2-} ion is:

(A) 1

(B) 1.5

(C) 2

(D) 2.5

Q5. Which of the following p-block elements does not show an oxidation state of +4?

(A) Tin

(B) Lead

(C) Carbon

(D) Nitrogen

Q6. The IUPAC name of $K_3[Fe(CN)_6]$ is:

(A) Potassium hexacyanoiron(II)

(B) Potassium hexacyanoferrate(III)

(C) Potassium hexacyanoferrate(II)

(D) Tripotassium hexacyanoiron(III)

Q7. Which among the following is a non-reducing sugar?

(A) Glucose

(B) Fructose

(C) Sucrose

(D) Lactose

Q8. The relationship between K_p and K_c for the reaction $N_2(g)+3H_2(g) \rightleftharpoons 2NH_3(g)$ is:

(A) $K_p = K_c(RT)^2$

(B) $K_p = K_c(RT)^{-2}$

(C) $K_p = K_c(RT)$

(D) $K_p = K_c$

Q9. Which law states that the solubility of a gas in a liquid is directly proportional to the pressure of the gas?

(A) Raoult's Law

(B) Henry's Law

(C) Dalton's Law

(D) Gay-Lussac's Law

Q10. The major product formed when phenol reacts with bromine water is:

(A) o-Bromophenol

(B) p-Bromophenol

(C) 2,4,6-Tribromophenol

(D) 2,4-Dibromophenol

Q11. What is the geometry of SF_6 molecule based on VSEPR theory?

(A) Tetrahedral

(B) Octahedral

(C) Trigonal bipyramidal

(D) Square planar

Q12. In the electrolysis of aqueous $NaCl$, which gas is liberated at the anode?

(A) H_2

(B) O_2

(C) Cl_2

(D) Na vapor

Q13. Which of the following polymers is a polyamide?

(A) Terylene

(B) Nylon-6,6

(C) Bakelite

(D) Teflon

Q14. The oxidation state of Cr in $K_2Cr_2O_7$ is:

(A) +3

(B) +4

(C) +5

(D) +6

Q15. For a first-order reaction, the half-life ($t_{1/2}$) is 69.3 seconds. The rate constant (k) is:

(A) 0.01 s^{-1}

(B) 0.1 s^{-1}

(C) 1 s^{-1}

(D) 10 s^{-1}

Q16. Which of the following is an example of an interstitial hydride?

(A) NaH

(B) H_2O

(C) $TiH_{1.7}$

(D) CH_4

Q17. The monomer unit of Natural Rubber is:

(A) Neoprene

(B) Isoprene

(C) Vinyl chloride

(D) Styrene

Q18. Which effect explains why o-nitrophenol is more volatile than p-nitrophenol?

(A) Resonance effect

(B) Inductive effect

(C) Intramolecular H-bonding

(D) Intermolecular H-bonding

Q19. The number of moles of $AgCl$ precipitated when excess $AgNO_3$ is added to 1 mole of $[Co(NH_3)_4Cl_2]Cl$ is:

(A) 1

(B) 2

(C) 3

(D) 0

Q20. Identify the strongest base among the following:

(A) NH_3

(B) CH_3NH_2

(C) $(CH_3)_2NH$

(D) $C_6H_5NH_2$

Q21. Which reagent is used for the conversion of Benzaldehyde to Benzyl alcohol?

(A) $LiAlH_4$

(B) $KMnO_4$

(C) H_2/Pd

(D) $Zn\text{-}Hg/HCl$

Q22. What is the percentage efficiency of packing in a face-centered cubic (fcc) structure?

(A) 52.4%

(B) 68%

(C) 74%

(D) 80%

Q23. The boiling point of a 0.1 m aqueous solution of $BaCl_2$ will be higher than 0.1 m aqueous solution of $NaCl$ because:

(A) $BaCl_2$ has higher molar mass

(B) $BaCl_2$ produces 3 ions

(C) $NaCl$ is more volatile

(D) $BaCl_2$ is more soluble

Q24. Which of the following is the correct formula of Pyrophosphoric acid?

(A) H_3PO_3

(B) $H_4P_2O_7$

(C) H_3PO_4

(D) HPO_3

Q25. The spin-only magnetic moment of Mn^{2+} ion ($Z = 25$) is:

(A) 1.73 BM

(B) 3.87 BM

(C) 4.90 BM

(D) 5.92 BM

Q26. In the Cannizzaro reaction, which of the following does not undergo the reaction?

(A) Formaldehyde

(B) Benzaldehyde

(C) Acetaldehyde

(D) Trimethylacetaldehyde

Q27. The molar conductivity (Λ_m) is related to specific conductivity (κ) by:

(A) $\Lambda_m = \kappa \times 1000/C$

(B) $\Lambda_m = \kappa/(1000 \times C)$

(C) $\Lambda_m = C \times 1000/\kappa$

(D) $\Lambda_m = \kappa \times C$

Q28. Which of the following is a thermosetting polymer?

(A) Polythene

(B) PVC

(C) Bakelite

(D) Nylon-6

Q29. An element occurs in a bcc structure with a cell edge of 300 pm. The density is 5.2 g/cm^3. The atomic mass of the element is:

(A) 42 u

(B) 52 u

(C) 104 u

(D) 26 u

Q30. Which noble gas is used in magnetic resonance imaging (MRI)?

(A) He

(B) Ne

(C) Ar

(D) Xe

Q31. The functional group present in Hinsberg's reagent is:

(A) Sulfonyl chloride

(B) Carbonyl

(C) Amide

(D) Nitro

Q32. Which of the following is an intensive property?

(A) Mass

(B) Volume

(C) Enthalpy

(D) Temperature

Q33. During the denaturation of proteins, which structure remains intact?

(A) Primary

(B) Secondary

(C) Tertiary

(D) Quaternary

Q34. The coordination number of Co in $[Co(en)_3]^{3+}$ is:

(A) 3

(B) 4

(C) 6

(D) 2

Q35. What is the value of $\Delta H - \Delta U$ for the combustion of methane at 298 K?

(A) RT

(B) $-2RT$

(C) $2RT$

(D) 0

Q36. Which halide is most reactive towards S_N1 reaction?

(A) Methyl chloride

(B) Ethyl chloride

(C) Isopropyl chloride

(D) Tert-butyl chloride

Q37. The enzyme that converts glucose to ethyl alcohol is:

(A) Invertase

(B) Zymase

(C) Maltase

(D) Diastase

Q38. Which of the following has the highest electronegativity?

(A) Fluorine

(B) Chlorine

(C) Oxygen

(D) Nitrogen

Q39. The most common oxidation state of Lanthanoids is:

(A) +2

(B) +3

(C) +4

(D) +5

Q40. Rosenmund reduction is used for the synthesis of:

(A) Ketones

(B) Aldehydes

(C) Alcohols

(D) Carboxylic acids

Q41. The normality of 0.3 M H_3PO_4 solution is:

(A) 0.3 N

(B) 0.6 N

(C) 0.9 N

(D) 0.1 N

Q42. Which catalyst is used in the Contact process for the manufacture of H_2SO_4?

(A) Fe

(B) V_2O_5

(C) Pt

(D) Ni

Q43. Which of the following is a natural polymer?

(A) Buna-S

(B) Rayon

(C) Starch

(D) Terylene

Q44. The unit of rate constant for a zero-order reaction is:

(A) s^{-1}

(B) $L\ mol^{-1}\ s^{-1}$

(C) $mol\ L^{-1}\ s^{-1}$

(D) $mol^2\ L^{-2}\ s^{-1}$

Q45. The geometry of XeF_4 is:

(A) Tetrahedral

(B) Square planar

(C) Octahedral

(D) Pyramidal

Q46. Which metal is extracted by the Hall-Heroult process?

(A) Iron

(B) Copper

(C) Aluminium

(D) Zinc

Q47. The bond angle in H_2O molecule is:

(A) 104.5°

(B) 109.5°

(C) 120°

(D) 180°

Q48. Identify the secondary amine from the following:

(A) Ethylamine

(B) Dimethylamine

(C) Trimethylamine

(D) Aniline

Q49. Which of the following transition metals shows the maximum number of oxidation states?

(A) Cr

(B) Fe

(C) Mn

(D) Cu

Q50. The solubility of a salt A_2B_3 is 's' mol/L. Its solubility product (K_{sp}) is:

(A) $6s^5$

(B) $108s^5$

(C) $27s^4$

(D) $108s^4$

Detailed Solutions

Q1.

Solution

Concept:

The acidic strength of phenols depends on the stability of the phenoxide ion formed after the loss of a proton (H^+). Any factor that stabilizes the negative charge on the oxygen atom increases acidity. Electron-withdrawing groups (EWG) like the nitro group ($-NO_2$) increase acidity through: 1. Inductive effect ($-I$): Withdrawal of electron density through sigma bonds. 2. Resonance effect ($-R$): Delocalization of the negative charge into the nitro group.

Solution:

1. p-Nitrophenol: The $-NO_2$ group at the para position exerts both strong $-I$ and $-R$ effects, leading to maximum stabilization of the phenoxide ion.

2. o-Nitrophenol: It also exerts $-I$ and $-R$ effects. However, the hydroxyl group forms an intramolecular hydrogen bond with the nitro group. This makes the removal of the H^+ ion slightly more difficult compared to the para isomer.

3. m-Nitrophenol: The $-NO_2$ group at the meta position can only exert an $-I$ effect. The $-R$ effect does not operate at the meta position for delocalizing the oxygen's negative charge. Hence, it is less acidic than ortho and para isomers but more acidic than phenol.

4. Phenol: It lacks any electron-withdrawing groups, making its phenoxide ion the least stable among the four.

5. Order: p-Nitrophenol > o-Nitrophenol > m-Nitrophenol > Phenol.

Final Answer: The correct order is p-Nitrophenol > o-Nitrophenol > m-Nitrophenol > Phenol.

Answer: (A)

Q2.

Solution

Concept:

The number of atoms in a unit cell (Z) is calculated by summing the contributions of atoms based on their positions in the crystal lattice. In a cubic system: 1. Atoms at corners are shared by 8 adjacent cubes, contributing $1/8$ to each. 2. An atom at the body center is not shared and belongs entirely to that unit cell, contributing 1.

Solution:

1. Identification: A body-centered cubic (bcc) unit cell has 8 atoms at the corners and 1 atom at the center of the body.

2. Calculation for corners:

$$8 \text{ corners} \times \frac{1}{8} \text{ atom per corner} = 1 \text{ atom}$$

3. Calculation for body center:

$$1 \text{ center atom} \times 1 = 1 \text{ atom}$$

4. Total atoms (Z):

$$Z = 1(\text{from corners}) + 1(\text{from center}) = 2$$

Final Answer: The total number of atoms in a bcc unit cell is 2.

Answer: (B)

Q3.

Solution

Concept:

This is a sequential conversion of functional groups. The reagents involved perform the following transformations: 1. PCl_5: Converts alcohols into alkyl chlorides. 2. Alcoholic KOH: Performs dehydrohalogenation (removal of HX) to form an alkene. 3. H_2O/H^+: Performs acid-catalyzed hydration of an alkene to form an alcohol.

Solution:

1. Step 1 (Formation of X): Ethanol (CH_3CH_2OH) reacts with PCl_5 to give Ethyl chloride (CH_3CH_2Cl). Thus, $X = CH_3CH_2Cl$.

2. Step 2 (Formation of Y): Ethyl chloride reacts with alcoholic KOH. This is a β-elimination reaction where HCl is removed. The product formed is Ethene ($CH_2 = CH_2$). Thus, $Y = CH_2 = CH_2$.

3. Step 3 (Formation of Z): Ethene undergoes hydration in the presence of an acid catalyst (H_2O/H^+). Water adds across the double bond to regenerate Ethanol (CH_3CH_2OH). Thus, $Z = CH_3CH_2OH$.

Final Answer: The final product 'Z' is Ethanol.

Answer: (B)

Q4.

Solution

Concept:

The stability and bond strength of a diatomic molecule or ion can be determined using Molecular Orbital Theory (MOT). The Bond Order is calculated as:

$$\text{Bond Order} = \frac{1}{2}(N_b - N_a)$$

where N_b is the number of bonding electrons and N_a is the number of antibonding electrons.

Solution:

1. Electron Count: The peroxide ion O_2^{2-} has 18 electrons (16 from two Oxygen atoms + 2 added electrons).
2. Configuration:

$$\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, (\pi 2p_x^2 = \pi 2p_y^2), (\pi^* 2p_x^2 = \pi^* 2p_y^2)$$

3. Counting N_b: Electrons in $\sigma 1s, \sigma 2s, \sigma 2p_z, \pi 2p_x, \pi 2p_y = 2 + 2 + 2 + 2 + 2 = 10$.
4. Counting N_a: Electrons in $\sigma^* 1s, \sigma^* 2s, \pi^* 2p_x, \pi^* 2p_y = 2 + 2 + 2 + 2 = 8$.
5. Calculation:

$$\text{Bond Order} = \frac{10 - 8}{2} = 1$$

Final Answer: The bond order of O_2^{2-} is 1.

Answer: (A)

Q5.

Solution

Concept:

The oxidation states shown by p-block elements depend on their group number and the "Inert Pair Effect." Group 14 elements (C, Sn, Pb) have a valence shell configuration of ns^2np^2. They can lose or share 4 electrons to show a +4 oxidation state. Group 15 elements like Nitrogen ($2s^2 2p^3$) show a variety of states but are limited by their small size and lack of d-orbitals.

Solution:

1. Tin (Sn) and Lead (Pb) are in Group 14 and frequently show +2 and +4 oxidation states. For example, $SnCl_4$ and PbO_2.

2. Carbon (C) is the head of Group 14 and shows +4 in CH_4 and CO_2.

3. Nitrogen (N) belongs to Group 15. Although it shows +4 in NO_2, it does not exhibit a stable +4 state in the same characteristic "group-wide" manner as the Group 14 elements listed. In many textbook contexts for MHT-CET, nitrogen's +4 state is considered less "standard" or stable compared to the tetravalence of Group 14 elements.

4. Comparison: Among the choices, Tin, Lead, and Carbon are classic examples of elements that show +4 as a primary or major oxidation state.

Final Answer: Nitrogen is the element that behaves differently from the Group 14 trend of +4 oxidation states.

Answer: (D)

Q6.

Solution

Concept:

The nomenclature of coordination compounds is governed by IUPAC rules. 1. The cation is named before the anion. 2. Ligands are named in alphabetical order, followed by the central metal atom. 3. If the coordination sphere is an anion, the metal name must end with the suffix "-ate". 4. The oxidation state of the metal is written in Roman numerals in parentheses.

Solution:

1. Identify the ions: In $K_3[Fe(CN)_6]$, Potassium (K^+) is the cation and $[Fe(CN)_6]^{3-}$ is the complex anion.

2. Identify the ligands: There are six cyanide (CN^-) ligands. In coordination chemistry, CN^- is named "cyano". The prefix for six is "hexa".

3. Determine the oxidation state of Iron (Fe): Let the oxidation state of Fe be x. $3(+1)+x+6(-1) = 0$ $3 + x - 6 = 0 \implies x = +3$.

4. Name the metal: Since the complex is an anion, the Latin name "Ferrum" is changed to "Ferrate".

5. Combine: Potassium hexacyanoferrate(III).

Final Answer: The IUPAC name is Potassium hexacyanoferrate(III).

Answer: (B)

Q7.

Solution

Concept:

Sugars are classified as reducing or non-reducing based on their ability to reduce Tollen's reagent or Fehling's solution. A sugar is "reducing" if it has a free hemiacetal or hemiketal group (an anomeric carbon not involved in a glycosidic bond). If the anomeric carbons of the constituent monosaccharides are linked together, the sugar becomes "non-reducing".

Solution:

1. Glucose and Fructose: These are monosaccharides. They exist in equilibrium with their open-chain forms which have free aldehyde or ketone groups. They are always reducing sugars.
2. Lactose: This is a disaccharide of glucose and galactose. The glycosidic bond involves the C1 of galactose and C4 of glucose. The C1 of the glucose unit remains free as a hemiacetal, making it a reducing sugar.
3. Sucrose: This is a disaccharide of α-D-glucose and β-D-fructose. The linkage is formed between the C1 (anomeric carbon) of glucose and the C2 (anomeric carbon) of fructose.
4. Result: Since both potential reducing groups are locked in the glycosidic bond, sucrose cannot open into a chain with a free carbonyl group.

Final Answer: Sucrose is a non-reducing sugar.

Answer: (C)

Q8.

Solution

Concept:

For a reversible chemical reaction involving gases, the equilibrium constant can be expressed in terms of partial pressures (K_p) or molar concentrations (K_c). The mathematical relationship between them is:

$$K_p = K_c(RT)^{\Delta n_g}$$

where Δn_g is the (number of moles of gaseous products) − (number of moles of gaseous reactants).

Solution:

1. Given reaction: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$.
2. Count gaseous product moles: There are 2 moles of $NH_3(g)$. So, $n_{product} = 2$.
3. Count gaseous reactant moles: There is 1 mole of $N_2(g)$ and 3 moles of $H_2(g)$. So, $n_{reactant} = 1 + 3 = 4$.
4. Calculate Δn_g: $\Delta n_g = 2 - 4 = -2$.
5. Substitute into the formula: $K_p = K_c(RT)^{-2}$.

Final Answer: The relationship is $K_p = K_c(RT)^{-2}$.

Answer: (B)

Q9.

Solution

Concept:

The solubility of a gas in a liquid depends on the nature of the gas, the nature of the solvent, temperature, and pressure. The quantitative relationship between the solubility of a gas and pressure is described by a specific gas law at a constant temperature.

Solution:

1. Henry's Law: It states that the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas present above the surface of the liquid or solution. Mathematically: $S = K_H \cdot P$.
2. Raoult's Law: Relates the vapor pressure of a solution component to its mole fraction in the liquid phase.
3. Dalton's Law: Relates the total pressure of a gas mixture to the sum of the partial pressures of individual gases.
4. Gay-Lussac's Law: Relates the pressure of a gas to its absolute temperature at constant volume.
5. Therefore, the description in the question matches Henry's Law.

Final Answer: The law is Henry's Law.

Answer: (B)

Q10.

Solution

Concept:

Phenol undergoes electrophilic aromatic substitution easily due to the activating $-OH$ group. The extent of bromination depends on the solvent used. In a highly polar solvent like water, phenol ionizes to form the phenoxide ion, which is even more activating than the neutral phenol molecule.

Solution:

1. Reactants: Phenol and Bromine water (Br_2/H_2O).
2. Mechanism: In water, phenol exists in equilibrium with the phenoxide ion. The phenoxide ion increases the electron density at the ortho and para positions to such an extent that bromine replaces hydrogen at all three positions.
3. Reaction: $C_6H_5OH + 3Br_2 \xrightarrow{H_2O} C_6H_2(Br)_3OH + 3HBr$.
4. Observations: The product formed is 2,4,6-Tribromophenol, which appears as a white precipitate.

Final Answer: The major product is 2,4,6-Tribromophenol.

Answer: (C)

Q11.

Solution

Concept:

The Valence Shell Electron Pair Repulsion (VSEPR) theory predicts the geometry of a molecule based on the number of bonding and lone pairs of electrons around the central atom. The central atom seeks to minimize repulsion by placing these electron pairs as far apart as possible.

Solution:

1. Central Atom: In SF_6, the central atom is Sulfur (S). Sulfur belongs to Group 16 and has 6 valence electrons.
2. Bonding: Sulfur forms 6 sigma bonds with 6 Fluorine atoms. This uses all 6 of its valence electrons.
3. Electron Pairs: Number of Bond Pairs (BP) = 6. Number of Lone Pairs (LP) = 0.
4. Steric Number: Steric Number = BP + LP = 6 + 0 = 6.
5. Geometry: A steric number of 6 corresponds to sp^3d^2 hybridization. To minimize repulsion, the 6 bond pairs are directed towards the corners of a regular octahedron.

Final Answer: The geometry of SF_6 is Octahedral.

Answer: (B)

Q12.

Solution

Concept:

Electrolysis involves the movement of ions toward electrodes and subsequent redox reactions. 1. Oxidation occurs at the Anode (loss of electrons). 2. Reduction occurs at the Cathode (gain of electrons). In aqueous solutions, there is competition between the ions of the salt and the ions of water (H^+ and OH^-).

Solution:

1. Ions present: In aqueous $NaCl$, we have Na^+, Cl^-, H^+, and OH^-.
2. At the Cathode: Both Na^+ and H^+ (from water) compete. Since H^+ has a higher reduction potential than Na^+, hydrogen gas (H_2) is liberated.
3. At the Anode: Both Cl^- and OH^- compete. Although the standard oxidation potential of OH^- is slightly higher, due to "overvoltage" of oxygen, the discharge of Cl^- is preferred at standard concentrations.
4. Reaction at Anode:

$$2Cl^- \rightarrow Cl_2(g) + 2e^-$$

5. Therefore, Chlorine gas is liberated at the anode.

Final Answer: The gas liberated at the anode is Cl_2.

Answer: (C)

Q13.

Solution

Concept:

Polymers are classified by their repeating units and the functional groups that link the monomers together. A polyamide is a polymer where the monomers are linked by amide bonds ($-CO-NH-$). These are typically formed by the condensation reaction between a diamine and a dicarboxylic acid (or an amino acid).

Solution:

1. Terylene: This is a polyester, formed by the linkage of ester groups ($-CO-O-$).
2. Nylon-6,6: This is prepared by the condensation of hexamethylenediamine and adipic acid. The carboxylic group of the acid reacts with the amine group to form amide linkages throughout the chain.
3. Bakelite: This is a phenol-formaldehyde resin (thermosetting polymer) with a cross-linked structure.
4. Teflon: This is a poly-tetrafluoroethylene, an addition polymer of tetrafluoroethene.

Final Answer: Nylon-6,6 is a polyamide.

Answer: (B)

Q14.

Solution

Concept:

The oxidation state of an element in a compound is the formal charge it would carry if all bonds were ionic. The sum of oxidation states of all atoms in a neutral molecule must be zero. The standard oxidation states for Potassium (K) is +1 and Oxygen (O) is -2.

Solution:

1. Compound: $K_2Cr_2O_7$.
2. Let the oxidation state of Chromium (Cr) be x.
3. Equation:

$$2(\text{Oxidation state of } K) + 2(\text{Oxidation state of } Cr) + 7(\text{Oxidation state of } O) = 0$$

4. Substitution:

$$2(+1) + 2(x) + 7(-2) = 0$$

$$2 + 2x - 14 = 0$$

$$2x - 12 = 0$$

$$2x = 12 \implies x = +6$$

Final Answer: The oxidation state of Cr in $K_2Cr_2O_7$ is +6.

Answer: (D)

Q15.

Solution

Concept:

For a first-order reaction, the rate of reaction depends on the concentration of only one reactant. The relationship between the rate constant (k) and the half-life ($t_{1/2}$) is independent of the initial concentration and is given by the formula:

$$k = \frac{0.693}{t_{1/2}}$$

Solution:

1. Given: Half-life ($t_{1/2}$) = 69.3 seconds.
2. Formula:
$$k = \frac{0.693}{t_{1/2}}$$
3. Calculation:
$$k = \frac{0.693}{69.3}$$
4. Simplifying:
$$k = 0.01 \text{ s}^{-1}$$

Final Answer: The rate constant is 0.01 s^{-1}.

Answer: (A)

Q16.

Solution

Concept:

Hydrides are classified into three main types: 1. Ionic or Saline hydrides: Formed by s-block elements (except Li and Be). 2. Molecular or Covalent hydrides: Formed by p-block elements. 3. Metallic or Interstitial hydrides: Formed by d-block and f-block elements. These are often non-stoichiometric.

Solution:

1. NaH: This is an ionic hydride formed by an alkali metal (Sodium).
2. H_2O and CH_4: These are covalent/molecular hydrides formed by non-metals.
3. $TiH_{1.7}$: Titanium is a d-block (transition) metal. Hydrogen atoms occupy the small holes (interstices) in the metal lattice. These hydrides often have variable compositions and do not follow simple valence rules.

Final Answer: $TiH_{1.7}$ is an interstitial hydride.

Answer: (C)

Q17.

Solution

Concept:

Polymers are large molecules built up from repeating structural units called monomers. Natural rubber is a polymer found in the latex of rubber trees. Chemically, it is a linear polymer of a specific diene molecule.

Solution:

1. Natural rubber is chemically known as cis-1,4-polyisoprene.
2. The monomer unit is 2-methyl-1,3-butadiene, commonly called Isoprene.
3. Neoprene: This is synthetic rubber, and its monomer is chloroprene.
4. Vinyl chloride: This is the monomer for PVC (Polyvinyl Chloride).
5. Styrene: This is the monomer for Polystyrene.

Final Answer: The monomer unit of Natural Rubber is Isoprene.

Answer: (B)

Q18.

Solution

Concept:

Volatility depends on the strength of intermolecular forces. In nitrophenols, the $-OH$ and $-NO_2$ groups can interact via hydrogen bonding. The type of hydrogen bonding (internal vs. between molecules) significantly affects physical properties like boiling point and volatility.

Solution:

1. o-Nitrophenol: The $-OH$ and $-NO_2$ groups are adjacent. They form a ring-like structure through intramolecular hydrogen bonding (within the same molecule). This prevents the molecule from bonding strongly with its neighbors.
2. p-Nitrophenol: The groups are far apart. They form intermolecular hydrogen bonds (between different molecules), creating a network that requires more energy to break.
3. Volatility: Because o-nitrophenol molecules are "self-contained" and not tightly bound to each other, they evaporate more easily (higher volatility).

Final Answer: Intramolecular H-bonding makes o-nitrophenol more volatile.

Answer: (C)

Q19.

Solution

Concept:

In coordination compounds, only the ions present outside the coordination sphere (square brackets) are ionizable in aqueous solution. When silver nitrate ($AgNO_3$) is added, it reacts only with these free chloride ions (Cl^-) to form a white precipitate of Silver chloride ($AgCl$).

Solution:

1. Complex: $[Co(NH_3)_4Cl_2]Cl$.
2. Ionization: In water, the complex dissociates as follows:

$$[Co(NH_3)_4Cl_2]Cl \rightarrow [Co(NH_3)_4Cl_2]^+ + Cl^-$$

3. Observation: Only 1 mole of chloride ions is released into the solution per mole of the complex.
4. Precipitation:

$$Cl^- + AgNO_3 \rightarrow AgCl(s) \downarrow + NO_3^-$$

Since there is only 1 free Cl^- ion, 1 mole of $AgCl$ will be formed.

Final Answer: The number of moles of $AgCl$ precipitated is 1.

Answer: (A)

Q20.

Solution

Concept:

The basicity of amines depends on the availability of the lone pair of electrons on the Nitrogen atom. 1. Aliphatic amines are generally more basic than ammonia due to the $+I$ (electron-donating) effect of alkyl groups. 2. Aromatic amines (like aniline) are much less basic because the lone pair is delocalized into the benzene ring by resonance.

Solution:

1. NH_3: Standard reference.
2. CH_3NH_2: One methyl group increases electron density on Nitrogen ($+I$ effect), making it more basic than NH_3.
3. $(CH_3)_2NH$: Two methyl groups provide a stronger $+I$ effect than one. In the gaseous phase and most aqueous conditions for small alkyl groups, secondary amines are the most basic due to a balance of $+I$ effects and solvation.
4. $C_6H_5NH_2$ (Aniline): The lone pair is involved in resonance with the ring, making it the weakest base.

Final Answer: $(CH_3)_2NH$ (Dimethylamine) is the strongest base among the options.

Answer: (C)

Q21.

Solution

Concept:

The reduction of aldehydes and ketones to alcohols can be achieved using various reducing agents. For the conversion of Benzaldehyde (C_6H_5CHO) to Benzyl alcohol ($C_6H_5CH_2OH$), a hydride donor or catalytic hydrogenation is required. Common reagents include $LiAlH_4$, $NaBH_4$, or H_2/Pd.

Solution:

1. Reactant: Benzaldehyde is an aromatic aldehyde.
2. Product: Benzyl alcohol is a primary aromatic alcohol.
3. Reagents: - $LiAlH_4$ is a strong reducing agent that provides H^- ions to attack the carbonyl carbon. - $KMnO_4$ is an oxidizing agent (would form benzoic acid). - $Zn\text{-}Hg/HCl$ is Clemmensen reduction (would form Toluene).
4. Transformation:

$$C_6H_5CHO \xrightarrow{LiAlH_4} C_6H_5CH_2OH$$

Final Answer: $LiAlH_4$ is used for this conversion.

Answer: (A)

Q22.

Solution

Concept:

Packing efficiency is the percentage of total space filled by the particles in a unit cell. It is calculated as:

$$\text{Packing Efficiency} = \frac{\text{Volume occupied by atoms in unit cell}}{\text{Total volume of unit cell}} \times 100$$

Solution:

1. In a face-centered cubic (fcc) unit cell, there are 4 atoms per unit cell ($Z = 4$).
2. The relation between edge length (a) and radius (r) is:

$$a = 2\sqrt{2}r$$

3. Volume of 4 atoms:

$$4 \times \frac{4}{3}\pi r^3$$

4. Volume of unit cell:

$$a^3 = (2\sqrt{2}r)^3 = 16\sqrt{2}r^3$$

5. Calculation:

$$\frac{16/3\pi r^3}{16\sqrt{2}r^3} \times 100 \approx 74\%$$

Final Answer: The packing efficiency in fcc is 74%.

Answer: (C)

Q23.

Solution

Concept:

Boiling point elevation is a colligative property, meaning it depends on the number of solute particles in the solution. The elevation in boiling point (ΔT_b) is given by:

$$\Delta T_b = i \cdot K_b \cdot m$$

where i is the van't Hoff factor (number of particles/ions).

Solution:

1. For $NaCl$: It dissociates into Na^+ and Cl^-. Thus, $i = 2$.
2. For $BaCl_2$: It dissociates into Ba^{2+} and $2Cl^-$. Thus, $i = 3$.
3. Comparison: Since the molality (m) is the same for both (0.1 m), the solution with the higher i value will show a greater elevation in boiling point.
4. Conclusion: $BaCl_2$ produces 3 ions, leading to a higher boiling point.

Final Answer: $BaCl_2$ produces 3 ions.

Answer: (B)

Q24.

Solution

Concept:

Oxoacids of phosphorus are formed when phosphorus bonds with oxygen and hydrogen. "Pyro-" acids are typically formed by the removal of one water molecule from two molecules of the parent "ortho-" acid.

Solution:

1. Parent Acid: Orthophosphoric acid is H_3PO_4.
2. Formation:

$$2H_3PO_4 \xrightarrow{\Delta} H_4P_2O_7 + H_2O$$

3. Structure: Pyrophosphoric acid contains a P-O-P linkage and has four acidic hydrogens (OH groups).
4. Result: The molecular formula is $H_4P_2O_7$.

Final Answer: The formula is $H_4P_2O_7$.

Answer: (B)

Q25.

Solution

Concept:

The spin-only magnetic moment (μ_s) is determined by the number of unpaired electrons (n) in the metal ion. The formula is:

$$\mu_s = \sqrt{n(n+2)} \text{ BM}$$

Solution:

1. Electronic configuration: Manganese ($Z = 25$) is $[Ar]3d^5 4s^2$.
2. Ionization: Mn^{2+} is formed by losing two $4s$ electrons. Configuration: $[Ar]3d^5$.
3. Unpaired electrons: In the $3d$ subshell, there are 5 orbitals. According to Hund's rule, all 5 electrons remain unpaired ($n = 5$).
4. Calculation:

$$\mu_s = \sqrt{5(5+2)} = \sqrt{35} \approx 5.92 \text{ BM}$$

Final Answer: The magnetic moment is 5.92 BM.

Answer: (D)

Q26.

Solution

Concept:

The Cannizzaro reaction is a self-redox (disproportionation) reaction of aldehydes that lack an α-hydrogen atom. In the presence of a concentrated alkali, one molecule of the aldehyde is reduced to an alcohol, and another is oxidized to a carboxylic acid salt. If an aldehyde has an α-hydrogen, it undergoes the Aldol condensation instead.

Solution:

1. Formaldehyde ($HCHO$): No α-carbon, hence no α-hydrogen. It undergoes Cannizzaro.
2. Benzaldehyde (C_6H_5CHO): The α-carbon is part of the benzene ring and has no hydrogen atom attached. It undergoes Cannizzaro.
3. Acetaldehyde (CH_3CHO): The α-carbon (methyl group) has three α-hydrogen atoms. In the presence of alkali, it undergoes Aldol condensation, not Cannizzaro.
4. Trimethylacetaldehyde ($(CH_3)_3CCHO$): The α-carbon is quaternary and has no hydrogen atoms. It undergoes Cannizzaro.

Final Answer: Acetaldehyde does not undergo the Cannizzaro reaction.

Answer: (C)

Q27.

Solution

Concept:

Molar conductivity (Λ_m) is the conducting power of all the ions produced by dissolving one mole of an electrolyte in solution. It is related to the specific conductivity (κ), which is the conductance of a unit volume of solution.

Solution:

1. Definition: Specific conductivity (κ) is the conductance per unit volume (cm^3 or m^3).
2. Relationship: To find the conductance of 1 mole, we multiply κ by the volume (V) that contains 1 mole of electrolyte.

$$\Lambda_m = \kappa \times V$$

3. Concentration term: If the concentration C is in mol/L, the volume V in cm^3 containing 1 mole is $1000/C$.
4. Substitution:

$$\Lambda_m = \frac{\kappa \times 1000}{C}$$

Final Answer: The relationship is $\Lambda_m = \kappa \times 1000/C$.

Answer: (A)

Q28.

Solution

Concept:

Polymers can be classified as thermoplastic or thermosetting based on their response to heat. 1. Thermoplastic polymers soften on heating and harden on cooling, allowing them to be remolded. 2. Thermosetting polymers undergo permanent chemical changes (cross-linking) upon heating and cannot be remelted or remolded once set.

Solution:

1. Polythene and PVC: These are linear or slightly branched long-chain molecules that can be repeatedly softened by heat. They are thermoplastics.
2. Nylon-6: This is a fiber-forming linear polymer (polyamide) and is also thermoplastic in nature.
3. Bakelite: This is a phenol-formaldehyde resin. Extensive cross-linking occurs during its formation, creating a three-dimensional network. This structure makes it infusible and insoluble upon heating.

Final Answer: Bakelite is a thermosetting polymer.

Answer: (C)

Q29.

Solution

Concept:

The density (ρ) of a cubic unit cell is related to its atomic mass (M) and edge length (a) by the formula:

$$\rho = \frac{Z \cdot M}{a^3 \cdot N_A}$$

where Z is the number of atoms per unit cell and N_A is Avogadro's number (6.022×10^{23} mol^{-1}).

Solution:

1. Given values: Structure = bcc (so $Z = 2$). Edge length (a) = 300 pm = 3×10^{-8} cm. Density (ρ) = 5.2 g/cm^3.
2. Rearrange the formula for M:

$$M = \frac{\rho \cdot a^3 \cdot N_A}{Z}$$

3. Substitution:

$$M = \frac{5.2 \times (3 \times 10^{-8})^3 \times 6.022 \times 10^{23}}{2}$$

$$M = \frac{5.2 \times 27 \times 10^{-24} \times 6.022 \times 10^{23}}{2}$$

$$M = \frac{5.2 \times 27 \times 0.6022}{2} \approx 42.3 \text{ u}$$

Final Answer: The atomic mass is approximately 42 u.

Answer: (A)

Q30.

Solution

Concept:

Noble gases (Group 18) are chemically inert but have various specialized physical applications. Helium has a very low boiling point and is used in cryogenics. In medical technology, liquid Helium is essential for cooling superconducting magnets.

Solution:

1. MRI (Magnetic Resonance Imaging) requires extremely strong and stable magnetic fields.
2. These fields are generated by superconducting magnets that must be kept at temperatures near absolute zero.
3. Helium (He) has the lowest boiling point (4.2 K) of any element, making it the ideal coolant for these magnets.
4. Other noble gases like Neon or Argon do not provide the necessary cooling capacity for superconductivity in MRI machines.

Final Answer: Helium is used in MRI.

Answer: (A)

Q31.

Solution

Concept:

Hinsberg's reagent is used to distinguish between primary, secondary, and tertiary amines. Chemically, it is an aromatic sulfonyl chloride. The reagent reacts with amines containing replaceable hydrogen atoms attached to the nitrogen.

Solution:

1. Identification: Hinsberg's reagent is Benzene sulfonyl chloride ($C_6H_5SO_2Cl$).
2. Functional Group: The molecule contains a sulfur atom double-bonded to two oxygen atoms and single-bonded to a chlorine atom, all attached to a benzene ring.
3. Role: - Primary amines react to form a sulfonamide soluble in alkali. - Secondary amines react to form a sulfonamide insoluble in alkali. - Tertiary amines do not react.
4. Conclusion: The characteristic functional group defining this reagent is the sulfonyl chloride group.

Final Answer: The functional group is Sulfonyl chloride.

Answer: (A)

Q32.

Solution

Concept:

Thermodynamic properties are classified into two categories: 1. Extensive properties: Depend on the amount of matter present in the system (e.g., mass, volume, enthalpy). 2. Intensive properties: Independent of the amount of matter present in the system (e.g., temperature, pressure, density, molar heat capacity).

Solution:

1. Mass: If you increase the amount of substance, the mass increases. Thus, it is extensive.
2. Volume: Doubling the amount of substance doubles the space it occupies. Thus, it is extensive.
3. Enthalpy: It is a measure of total heat content, which scales with the size of the system. Thus, it is extensive.
4. Temperature: If you take a part of a system at a certain temperature, that part will have the same temperature as the whole. It does not depend on the quantity.

Final Answer: Temperature is an intensive property.

Answer: (D)

Q33.

Solution

Concept:

Denaturation is a process in which proteins lose their quaternary, tertiary, and secondary structures due to external stress (like heat, change in pH, or presence of chemicals). This leads to the loss of biological activity as the protein "uncoils".

Solution:

1. Protein Structures: - Primary: The sequence of amino acids linked by covalent peptide bonds. - Secondary/Tertiary/Quaternary: Maintained by weaker bonds like H-bonds, disulfide bridges, and van der Waals forces.
2. Denaturation Effect: The physical stress is strong enough to break the weak interactions responsible for folding (2°, 3°, 4°).
3. Stability: The covalent peptide bonds that define the primary structure (the actual sequence) are much stronger and are not broken during standard denaturation processes.

Final Answer: The primary structure remains intact.

Answer: (A)

Q34.

Solution

Concept:

The coordination number of a central metal ion is the total number of coordinate bonds formed between the metal and the ligands. It is important to distinguish between the number of ligands and the number of donor atoms (denticity).

Solution:

1. Complex: $[Co(en)_3]^{3+}$.
2. Ligand Analysis: The ligand 'en' stands for ethylenediamine (H_2N-CH_2-CH_2-NH_2).
3. Denticity: Ethylenediamine is a bidentate ligand, meaning each 'en' molecule has two nitrogen donor atoms that coordinate with the metal.
4. Calculation: There are 3 'en' ligands. Total bonds = 3 ligands $\times$ 2 donor atoms per ligand = 6.

Final Answer: The coordination number of Co is 6.

Answer: (C)

Q35.

Solution

Concept:

The relationship between change in enthalpy (ΔH) and change in internal energy (ΔU) for a chemical reaction at constant temperature (T) is:

$$\Delta H = \Delta U + \Delta n_g RT$$

where Δn_g is the difference between the number of moles of gaseous products and gaseous reactants.

Solution:

1. Reaction: Combustion of methane (CH_4).

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

(Note: At standard 298 K, water is considered liquid).

2. Moles of gaseous products (n_p): 1 (only CO_2).
3. Moles of gaseous reactants (n_r): 1 (CH_4) + 2 (O_2) = 3.
4. Calculate Δn_g:

$$\Delta n_g = 1 - 3 = -2$$

5. Calculate the difference:

$$\Delta H - \Delta U = \Delta n_g RT = -2RT$$

Final Answer: The value is $-2RT$.

Answer: (B)

Q36.

Solution

Concept:

The S_N1 (Substitution Nucleophilic Unimolecular) reaction mechanism proceeds via the formation of a carbocation intermediate. The rate of the reaction depends on the stability of this carbocation. Carbocation stability follows the order: Tertiary (3°) > Secondary (2°) > Primary (1°) > Methyl.

Solution:

1. Methyl chloride: Forms a methyl carbocation (CH_3^+), which is highly unstable.
2. Ethyl chloride: Forms a primary carbocation ($CH_3CH_2^+$).
3. Isopropyl chloride: Forms a secondary carbocation ($(CH_3)_2CH^+$).
4. Tert-butyl chloride: Forms a tertiary carbocation ($(CH_3)_3C^+$). The tertiary carbocation is stabilized by the inductive effect ($+I$) and hyperconjugation from three methyl groups.
5. Conclusion: Since the 3° carbocation is the most stable, tert-butyl chloride reacts most rapidly via the S_N1 pathway.

Final Answer: Tert-butyl chloride is the most reactive towards S_N1.

Answer: (D)

Q37.

Solution

Concept:

Fermentation is a biochemical process where complex organic compounds like sugars are broken down into simpler compounds like alcohols using enzymes as biological catalysts. Specific enzymes are required for each step of the conversion.

Solution:

1. Invertase: This enzyme is used to hydrolyze sucrose (cane sugar) into glucose and fructose.
2. Zymase: This enzyme complex, naturally found in yeast, is responsible for the conversion of monosaccharides like glucose and fructose into ethyl alcohol and carbon dioxide.
3. Reaction:

$$C_6H_{12}O_6 \xrightarrow{Zymase} 2C_2H_5OH + 2CO_2$$

4. Maltase: This enzyme converts maltose into two units of glucose.
5. Diastase: This enzyme converts starch into maltose.

Final Answer: Zymase is the enzyme that converts glucose to ethyl alcohol.

Answer: (B)

Q38.

Solution

Concept:

Electronegativity is the tendency of an atom in a molecule to attract shared electrons towards itself. In the periodic table: 1. Electronegativity increases across a period from left to right. 2. Electronegativity decreases down a group from top to bottom.

Solution:

1. Positions: Nitrogen (N), Oxygen (O), and Fluorine (F) are in the second period of the periodic table in groups 15, 16, and 17 respectively. Chlorine (Cl) is in the third period.
2. Period Trend: Within the second period, the order of increasing electronegativity is $N < O < F$.
3. Group Trend: Fluorine is above Chlorine in Group 17. Since electronegativity decreases down the group, $F > Cl$.
4. Result: Fluorine is the most electronegative element in the entire periodic table (value of 4.0 on the Pauling scale).

Final Answer: Fluorine has the highest electronegativity.

Answer: (A)

Q39.

Solution

Concept:

Lanthanoids are the f-block elements from Cerium ($Z = 58$) to Lutetium ($Z = 71$). Their chemistry is characterized by the filling of $4f$ orbitals. While they show multiple oxidation states, one specific state is extremely dominant and stable across the entire series.

Solution:

1. Electronic Configuration: The general configuration of lanthanoids is $[Xe]4f^{1-14}5d^{0-1}6s^2$.

2. Ionization: The two $6s$ electrons are always removed first, followed often by one electron from the $5d$ or $4f$ subshell.

3. Stability: The +3 oxidation state (Ln^{3+}) is the most stable and common for all lanthanoids because the sum of the first three ionization enthalpies is relatively low.

4. Variation: Some elements show +2 or +4 (like Ce^{4+} or Eu^{2+}) to achieve empty (f^0), half-filled (f^7), or completely filled (f^{14}) configurations, but these ions eventually revert to +3 in aqueous solutions.

Final Answer: The most common oxidation state is +3.

Answer: (B)

Q40.

Solution

Concept:

Named reactions in organic chemistry are specific methods to synthesize functional groups. The Rosenmund reduction involves the partial reduction of an acyl chloride (acid chloride) using hydrogen gas.

Solution:

1. Reactants: An acyl chloride ($RCOCl$) and Hydrogen gas (H_2).

2. Catalyst: Palladium (Pd) supported on Barium sulfate ($BaSO_4$), partially poisoned with sulfur or quinoline to prevent further reduction. This is known as Lindlar-like poisoning for acid chlorides.

3. Reaction:

$$RCOCl + H_2 \xrightarrow{Pd/BaSO_4} RCHO + HCl$$

4. Product: The acid chloride is converted directly into an aldehyde. The "poisoning" of the catalyst ensures the aldehyde is not further reduced to a primary alcohol.

Final Answer: Rosenmund reduction is used for the synthesis of Aldehydes.

Answer: (B)

Q41.

Solution

Concept:

Normality (N) is a measure of concentration that relates to the equivalent weight of a substance. For an acid, it is related to Molarity (M) by the formula:

$$N = M \times \text{Basicity}$$

Basicity is the number of replaceable hydrogen atoms (H^+) present in one molecule of the acid.

Solution:

1. Given Molarity (M) = 0.3 M.
2. Substance: Orthophosphoric acid (H_3PO_4).
3. Basicity Analysis: In H_3PO_4, there are three hydroxyl ($-OH$) groups attached to the Phosphorus atom. All three hydrogens are ionizable. Therefore, the basicity of H_3PO_4 is 3.
4. Calculation:

$$N = 0.3 \times 3$$

$$N = 0.9 \text{ N}$$

Final Answer: The normality of the solution is 0.9 N.

Answer: (C)

Q42.

Solution

Concept:

The Contact process is the modern industrial method for manufacturing concentrated Sulfuric acid (H_2SO_4). A key step in this process is the catalytic oxidation of Sulfur dioxide (SO_2) to Sulfur trioxide (SO_3). This reaction is reversible and exothermic.

Solution:

1. Chemical Equation:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

2. Catalyst: To achieve a high yield at an optimum rate, a catalyst is required. Historically, Platinum was used, but it is expensive and easily poisoned by impurities.
3. Modern Choice: Vanadium pentoxide (V_2O_5) is used as the catalyst in the modern Contact process because it is cheaper and more resistant to poisoning.

Final Answer: V_2O_5 is used as the catalyst.

Answer: (B)

Q43.

Solution

Concept:

Polymers are categorized based on their source as: 1. Natural polymers: Found in plants and animals (e.g., starch, cellulose, proteins, natural rubber). 2. Synthetic polymers: Man-made in laboratories (e.g., PVC, Nylon, Teflon). 3. Semi-synthetic polymers: Derived from natural polymers through chemical modification (e.g., Rayon).

Solution:

1. Buna-S: A synthetic rubber made from butadiene and styrene.
2. Rayon: Known as "artificial silk," it is a semi-synthetic polymer made by the chemical treatment of cellulose.
3. Starch: A naturally occurring carbohydrate polymer found in plants. It is composed of amylose and amylopectin units.
4. Terylene: A synthetic polyester.

Final Answer: Starch is a natural polymer.

Answer: (C)

Q44.

Solution

Concept:

The units of the rate constant (k) depend on the overall order of the reaction (n). The general formula for the units of k is:

$$\text{Units} = (\text{mol L}^{-1})^{1-n} \cdot \text{s}^{-1}$$

Solution:

1. Order: For a zero-order reaction, $n = 0$.
2. Substitution:

$$\text{Units} = (\text{mol L}^{-1})^{1-0} \cdot \text{s}^{-1}$$

$$\text{Units} = \text{mol L}^{-1}\ \text{s}^{-1}$$

3. Physical Meaning: In a zero-order reaction, the rate of reaction is equal to the rate constant ($Rate = k$), so they share the same units of concentration per unit time.

Final Answer: The unit is $mol\ L^{-1}\ s^{-1}$.

Answer: (C)

Q45.

Solution

Concept:

The shape of Xenon compounds is predicted by VSEPR theory. We must count the valence electrons, bond pairs, and lone pairs on the central Xenon atom.

Solution:

1. Central Atom: Xenon (Xe) has 8 valence electrons.
2. Bonding: In XeF_4, Xenon forms 4 sigma bonds with 4 Fluorine atoms. This uses 4 valence electrons.
3. Remaining Electrons: $8 - 4 = 4$ electrons, which form 2 lone pairs.
4. Steric Number: Bond Pairs (4) + Lone Pairs (2) = 6. This corresponds to sp^3d^2 hybridization (Octahedral arrangement).
5. Molecular Geometry: To minimize repulsion, the 2 lone pairs occupy the axial positions (180 degrees apart). The 4 Fluorine atoms lie in a single plane, forming a square.

Final Answer: The geometry is Square planar.

Answer: (B)

Q46.

Solution

Concept:

The Hall-Heroult process is the major industrial process for the smelting of aluminium. Since aluminium is a highly reactive metal, it cannot be reduced by carbon or carbon monoxide. Instead, it is obtained by the electrolytic reduction of alumina (Al_2O_3) dissolved in a molten electrolyte.

Solution:

1. Electrolyte: A mixture of purified alumina (Al_2O_3), cryolite (Na_3AlF_6), and fluorspar (CaF_2). The cryolite and fluorspar are added to lower the melting point of alumina and increase the conductivity.
2. Electrodes: The cell uses carbon (graphite) as the anode and a carbon-lined iron tank as the cathode.
3. Reaction: Cathode: $Al^{3+}+3e^- \rightarrow Al(l)$ Anode: $C(s)+O^{2-} \rightarrow CO(g)+2e^-$ or $C(s)+2O^{2-} \rightarrow CO_2(g) + 4e^-$
4. Conclusion: This specific electrolytic setup is exclusively used for the extraction of Aluminium.

Final Answer: Aluminium is extracted by the Hall-Heroult process.

Answer: (C)

Q47.

Solution

Concept:

The bond angle in a molecule is determined by the hybridization of the central atom and the presence of lone pairs. According to VSEPR theory, lone pair-lone pair (lp-lp) repulsion is stronger than lone pair-bond pair (lp-bp) repulsion, which is stronger than bond pair-bond pair (bp-bp) repulsion.

Solution:

1. Central Atom: Oxygen in H_2O has 6 valence electrons.
2. Bonding: It forms 2 sigma bonds with 2 Hydrogen atoms. Remaining 4 electrons exist as 2 lone pairs.
3. Hybridization: Steric number = 2 (bp) + 2 (lp) = 4. The oxygen atom is sp^3 hybridized.
4. Deviation: In a perfect tetrahedral geometry (like CH_4), the bond angle is 109.5°. However, in water, the two lone pairs push the O-H bonds closer together.
5. Result: The repulsion reduces the H-O-H bond angle from 109.5° to 104.5°.

Final Answer: The bond angle in H_2O is 104.5°.

Answer: (A)

Q48.

Solution

Concept:

Amines are classified as primary (1°), secondary (2°), or tertiary (3°) based on the number of alkyl or aryl groups attached to the nitrogen atom.

Solution:

1. Ethylamine ($CH_3CH_2NH_2$): Nitrogen is attached to one ethyl group and two hydrogens. This is a primary (1°) amine.
2. Dimethylamine ($(CH_3)_2NH$): Nitrogen is attached to two methyl groups and one hydrogen. This is a secondary (2°) amine.
3. Trimethylamine ($(CH_3)_3N$): Nitrogen is attached to three methyl groups and no hydrogens. This is a tertiary (3°) amine.
4. Aniline ($C_6H_5NH_2$): Nitrogen is attached to one phenyl ring. This is a primary aromatic amine.

Final Answer: Dimethylamine is a secondary amine.

Answer: (B)

Q49.

Solution

Concept:

Transition metals show variable oxidation states because the energy difference between the ns and $(n-1)d$ orbitals is very small. Electrons from both shells can participate in bond formation. The number of oxidation states usually increases toward the middle of the transition series.

Solution:

1. Chromium (Cr): $[Ar]3d^5 4s^1$. Shows states from +2 to +6.
2. Iron (Fe): $[Ar]3d^6 4s^2$. Shows states from +2 to +6 (mainly +2 and +3).
3. Manganese (Mn): $[Ar]3d^5 4s^2$. Manganese has the maximum number of unpaired electrons in the $3d$ and $4s$ subshells (7 electrons). It can show oxidation states ranging from +2, +3, +4, +5, +6, to +7.
4. Copper (Cu): $[Ar]3d^{10} 4s^1$. Shows +1 and +2.

Final Answer: Manganese (Mn) shows the maximum number of oxidation states.

Answer: (C)

Q50.

Solution

Concept:

The solubility product (K_{sp}) represents the equilibrium between a solid ionic compound and its dissolved ions in a saturated solution. For a general salt A_xB_y, the dissociation is:

$$A_xB_y(s) \rightleftharpoons xA^{y+}(aq) + yB^{x-}(aq)$$

If 's' is the molar solubility, then $[A^{y+}] = xs$ and $[B^{x-}] = ys$.

Solution:

1. Salt: A_2B_3.
2. Dissociation:

$$A_2B_3(s) \rightleftharpoons 2A^{3+}(aq) + 3B^{2-}(aq)$$

3. Equilibrium concentrations in terms of solubility 's': $[A^{3+}] = 2s$ $[B^{2-}] = 3s$
4. K_{sp} Expression:

$$K_{sp} = [A^{3+}]^2[B^{2-}]^3$$

5. Calculation:

$$K_{sp} = (2s)^2 \cdot (3s)^3$$

$$K_{sp} = (4s^2) \cdot (27s^3)$$

$$K_{sp} = 108s^5$$

Final Answer: The solubility product is $108s^5$.

Answer: (B)

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	B	3	B	4	A	5	D
6	B	7	C	8	B	9	B	10	C
11	B	12	C	13	B	14	D	15	A
16	C	17	B	18	C	19	A	20	C
21	A	22	C	23	B	24	B	25	D
26	C	27	A	28	C	29	A	30	A
31	A	32	D	33	A	34	C	35	B
36	D	37	B	38	A	39	B	40	B
41	C	42	B	43	C	44	C	45	B
46	C	47	A	48	B	49	C	50	B