NEET-UG Chemistry Sample Paper-16

Duration: 1 Hour **Maximum Marks: 180**

Instructions

- This paper contains a total of 45 Multiple Choice Questions.
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries **-1 mark**.
- No negative marking for unattempted questions.

Q1. A compound contains 40% carbon, 6.7% hydrogen and rest oxygen. Its empirical formula is:

(A) CH_2O

(B) $C_2H_4O_2$

(C) CHO

(D) $C_3H_6O_3$

Q2. The wavelength of an electron in the third orbit of hydrogen atom is:

(A) $3\lambda_1$

(B) $\frac{\lambda_1}{3}$

(C) $9\lambda_1$

(D) $\frac{\lambda_1}{9}$

Q3. The number of radial nodes in 4d orbital is:

(A) 0

(B) 1

(C) 2

(D) 3

Q4. Which molecule has maximum bond angle?

(A) NH_3

(B) H_2O

(C) BF_3

(D) CH_4

Q5. The hybridization of central atom in XeF_4 is:

(A) sp^3

(B) sp^3d

(C) sp^3d^2

(D) sp^2

Q6. Which species has highest bond order?

(A) O_2

(B) O_2^+

(C) O_2^-

(D) O_2^{2-}

Q7. Which has zero dipole moment?

(A) NH_3

(B) CO_2

(C) H_2O

(D) SO_2

Q8. For an exothermic reaction, the sign of ΔH and ΔS for spontaneous reaction at low temperature is:

(A) ΔH +ve, ΔS +ve

(B) ΔH −ve, ΔS −ve

(C) ΔH −ve, ΔS +ve

(D) ΔH +ve, ΔS −ve

Q9. At equilibrium, ΔG is:

(A) Positive

(B) Negative

(C) Zero

(D) Infinite

Q10. Which solution shows positive deviation from Raoult's law?

(A) Acetone + chloroform

(B) Benzene + toluene

(C) Ethanol + water

(D) HNO_3 + water

Q11. Van't Hoff factor for K_2SO_4 (complete dissociation) is:

(A) 1

(B) 2

(C) 3

(D) 4

Q12. Increasing pressure shifts equilibrium toward:

(A) More moles

(B) Fewer moles

(C) No change

(D) Depends on catalyst

Q13. For weak acid, degree of dissociation increases with:

(A) Concentration increase

(B) Dilution

(C) Temperature decrease

(D) Pressure increase

Q14. Standard EMF of cell is positive when:

(A) ΔG positive

(B) ΔG negative

(C) ΔG zero

(D) ΔH zero

Q15. Which is strongest oxidizing agent?

(A) Zn^{2+}

(B) Cu^{2+}

(C) Fe^{3+}

(D) Ag^{+}

Q16. Units of rate constant for first order reaction are:

(A) mol L^{-1} s^{-1}

(B) s^{-1}

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

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

Q17. Half-life of first order reaction depends on:

(A) Initial concentration

(B) Temperature only

(C) Rate constant

(D) Pressure

Q18. Highest electron affinity is of:

(A) F

(B) Cl

(C) O

(D) N

Q19. Which oxide is amphoteric?

(A) CO_2

(B) SO_2

(C) Al_2O_3

(D) P_2O_5

Q20. Shape of ClF_3 is:

(A) Trigonal planar

(B) T-shaped

(C) Linear

(D) Tetrahedral

Q21. Inert pair effect is maximum in:

(A) Carbon

(B) Silicon

(C) Tin

(D) Lead

Q22. Highest oxidation state of Mn is:

(A) +5

(B) +6

(C) +7

(D) +8

Q23. Lanthanide contraction is due to:

(A) Shielding effect

(B) Poor shielding of f-electrons

(C) Nuclear repulsion

(D) Ionization

Q24. Which is colored?

(A) Sc^{3+}

(B) Ti^{3+}

(C) Zn^{2+}

(D) Ca^{2+}

Q25. Coordination number of Fe in $[Fe(CN)_6]^{4-}$ is:

(A) 4

(B) 6

(C) 2

(D) 8

Q26. Which shows geometrical isomerism?

$Ni(CO)_4$

$Pt(NH_3)_2Cl_2$

$Fe(CN)_6 \; ^{3-}$

$Cu(NH_3)_4 \; ^{2+}$

Q27. Strong field ligand is:

(A) Cl^-

(B) H_2O

(C) CN^-

(D) F^-

Q28. Which method separates liquids with close boiling points?

(A) Simple distillation

(B) Fractional distillation

(C) Sublimation

(D) Chromatography

Q29. Stability of carbocation is highest in:

(A) 1°

(B) 2°

(C) 3°

(D) Methyl

Q30. Which group shows −I effect?

(A) $-CH_3$

(B) $-OH$

(C) $-NO_2$

(D) $-OCH_3$

Q31. Electrophile is:

(A) Electron donor

(B) Electron acceptor

(C) Neutral species

(D) Radical

Q32. Major product of Markovnikov addition is:

(A) Less substituted

(B) More substituted

(C) Equal mixture
(D) Anti-product

Q33. Benzene undergoes:

(A) Addition
(B) Substitution
(C) Elimination
(D) Oxidation only

Q34. Which is aromatic?

(A) Cyclobutadiene
(B) Benzene
(C) Cyclooctatetraene
(D) Cyclopentane

Q35. SN1 reaction is favored by:

(A) Primary halide
(B) Secondary
(C) Tertiary
(D) Methyl

Q36. Which is most reactive?

(A) CH_3Cl
(B) CH_3Br
(C) CH_3I
(D) CH_3F

Q37. Aldehydes give:

(A) Fehling's test

(B) Tollen's test

(C) Both

(D) None

Q38. Phenol is acidic due to:

(A) Inductive effect

(B) Resonance stabilization

(C) Hybridization

(D) Size

Q39. Boiling point is highest for:

(A) Ether

(B) Alcohol

(C) Alkane

(D) Alkene

Q40. Product of oxidation of primary alcohol is:

(A) Ketone

(B) Aldehyde

(C) Acid

(D) Ester

Q41. Basicity order is:

(A) $NH_3 > RNH_2 > R_2NH$

(B) $R_2NH > RNH_2 > NH_3$

(C) $RNH_2 > R_2NH > NH_3$

(D) $NH_3 > R_2NH > RNH_2$

Q42. Diazonium salts are stable at:

(A) 25°C

(B) 0–5°C

(C) 50°C

(D) 100°C

Q43. Glucose is:

(A) Ketose

(B) Aldose

(C) Acid

(D) Ester

Q44. Protein structure is stabilized by:

(A) Covalent bonds only

(B) Hydrogen bonding

(C) Ionic only

(D) Metallic

Q45. pH of neutral solution at 25°C is:

(A) 0

(B) 5

(C) 7

(D) 14

Detailed Solutions

Q1.

Solution

Concept: The empirical formula of a compound represents the simplest whole-number ratio of atoms of each element in the compound. It can be determined from the mass percentage composition.

Solution: To find the empirical formula, we follow these steps:

(a) Assume a 100 g sample of the compound. The percentages can then be treated as masses in grams.

- Mass of Carbon (C) = 40 g
- Mass of Hydrogen (H) = 6.7 g
- Mass of Oxygen (O) = 100 g - 40 g - 6.7 g = 53.3 g

(b) Convert the mass of each element to moles by dividing by its atomic mass (C $\approx$ 12 g/mol, H $\approx$ 1 g/mol, O $\approx$ 16 g/mol).

- Moles of C = $\frac{40 \text{ g}}{12 \text{ g/mol}} = 3.33$ mol
- Moles of H = $\frac{6.7 \text{ g}}{1 \text{ g/mol}} = 6.7$ mol
- Moles of O = $\frac{53.3 \text{ g}}{16 \text{ g/mol}} = 3.33$ mol

(c) Divide the mole value of each element by the smallest mole value (3.33) to find the simplest ratio.

- For C: $\frac{3.33}{3.33} = 1$
- For H: $\frac{6.7}{3.33} \approx 2$
- For O: $\frac{3.33}{3.33} = 1$

The simplest whole-number ratio of C:H:O is 1:2:1. Therefore, the empirical formula is CH_2O.

Final Answer : The empirical formula is CH_2O.

Answer: (A)

Q2.

Solution

Concept: According to de Broglie's hypothesis as applied to Bohr's model, the circumference of a stable electron orbit must be an integral multiple of the electron's wavelength ($2\pi r_n = n\lambda_n$). The radius of the n-th orbit is given by $r_n = n^2 r_1$.

Solution: For an electron in the n-th orbit of a hydrogen atom, the condition for a stable orbit is: $2\pi r_n = n\lambda_n$ where r_n is the radius of the n-th orbit, n is the principal quantum number, and λ_n is the de Broglie wavelength of the electron in that orbit.

For the first orbit (n=1): $2\pi r_1 = (1)\lambda_1 \implies \lambda_1 = 2\pi r_1$

For the third orbit (n=3): $2\pi r_3 = 3\lambda_3$

The radius of the n-th orbit (r_n) is related to the first orbit radius (r_1) by the formula $r_n = n^2 r_1$. So, for the third orbit: $r_3 = 3^2 r_1 = 9r_1$

Now substitute this expression for r_3 into the equation for the third orbit: $2\pi(9r_1) = 3\lambda_3$ $9(2\pi r_1) = 3\lambda_3$

Since we know that $\lambda_1 = 2\pi r_1$, we can substitute λ_1 into the equation: $9\lambda_1 = 3\lambda_3$

Finally, solve for λ_3: $\lambda_3 = \frac{9\lambda_1}{3} = 3\lambda_1$

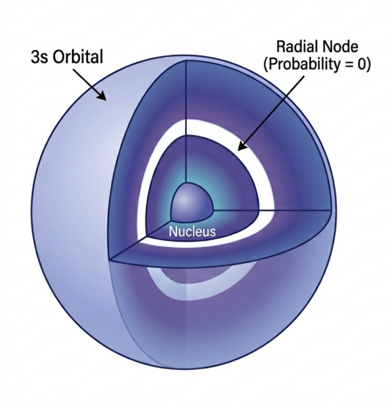
Final Answer : The wavelength of an electron in the third orbit of hydrogen atom is $3\lambda_1$.

Answer: (A)

Q3.

Solution

Concept: A radial node is a spherical surface where the probability of finding an electron is zero. The number of radial nodes for any given orbital is calculated using the formula: Number of radial nodes = n - l - 1.



Solution: The number of radial nodes depends on the principal quantum number (n) and the azimuthal quantum number (l).

- For the 4d orbital, the principal quantum number (n) is the number in front, so n = 4.
- The azimuthal quantum number (l) is determined by the orbital type (s=0, p=1, d=2, f=3). For a 'd' orbital, l = 2.

Now, apply the formula: Number of radial nodes = n - l - 1 Number of radial nodes = 4 - 2 - 1 = 1. **Final Answer : The number of radial nodes in a 4d orbital is 1.**

Answer: (B)

Q4.

Solution

Concept: The Valence Shell Electron Pair Repulsion (VSEPR) theory helps predict molecular geometry and bond angles. Electron pairs (both bonding and lone pairs) around a central atom arrange themselves to be as far apart as possible, minimizing repulsion. Lone pairs repel more strongly than bonding pairs.

Solution: Let's analyze the geometry and bond angles of each molecule:

- **NH_3**: The central N atom has 3 bonding pairs and 1 lone pair. The electron geometry is tetrahedral, but the molecular geometry is trigonal pyramidal. The lone pair repels the bonding pairs, compressing the H-N-H bond angle to approximately 107°.
- **H_2O**: The central O atom has 2 bonding pairs and 2 lone pairs. The electron geometry is tetrahedral, but the molecular geometry is bent. The two lone pairs exert even greater repulsion, compressing the H-O-H bond angle to approximately 104.5°.
- **BF_3**: The central B atom has 3 bonding pairs and 0 lone pairs. The three electron pairs arrange themselves symmetrically in a plane to maximize distance. This results in a trigonal planar geometry with F-B-F bond angles of exactly 120°.
- **CH_4**: The central C atom has 4 bonding pairs and 0 lone pairs. The four electron pairs arrange themselves symmetrically in a tetrahedral geometry, resulting in H-C-H bond angles of 109.5°.

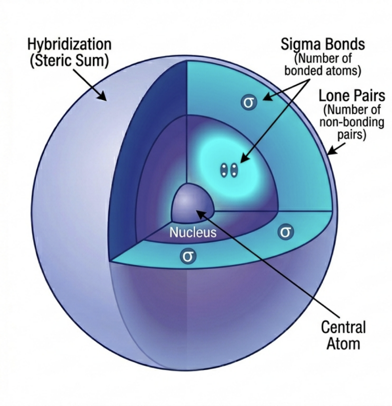
Comparing the angles: 120° (BF_3) > 109.5° (CH_4) > 107° (NH_3) > 104.5° (H_2O).
Final Answer : BF_3 has the maximum bond angle (120°).

$\boxed{\textbf{Answer: (C)}}$

Q5.

Solution

Concept: The hybridization of a central atom can be determined by calculating its steric number, which is the sum of the number of atoms bonded to it (sigma bonds) and the number of lone pairs it has.



Solution: To find the hybridization of Xenon (Xe) in XeF_4:

(a) **Valence Electrons:** Xenon (Xe) is a noble gas (Group 18), so it has 8 valence electrons.

(b) **Bonds Formed:** Xe forms single bonds with 4 Fluorine (F) atoms. This uses 4 of its valence electrons.

(c) **Lone Pair Electrons:** The number of remaining electrons on Xe is 8 (valence) - 4 (bonding) = 4 electrons.

(d) **Number of Lone Pairs:** Since electrons exist in pairs, these 4 electrons form 2 lone pairs.

(e) **Steric Number:** The steric number is the sum of sigma bonds and lone pairs. Steric Number = (4 sigma bonds) + (2 lone pairs) = 6.

(f) **Hybridization:** The hybridization corresponding to the steric number is:

- Steric Number 2 $\longrightarrow$ sp
- Steric Number 3 $\longrightarrow$ sp^2
- Steric Number 4 $\longrightarrow$ sp^3
- Steric Number 5 $\longrightarrow$ sp^3d
- Steric Number 6 $\longrightarrow$ sp^3d^2

A steric number of 6 corresponds to sp^3d^2 hybridization.

Final Answer : The hybridization of the central atom in XeF_4 is sp^3d^2.

Answer: (C)

Q6.

Solution

Concept: Bond order is a measure of the number of chemical bonds between two atoms. According to Molecular Orbital Theory (MOT), it is calculated as: Bond Order = $\frac{1}{2}$ (Number of electrons in bonding MOs - Number of electrons in antibonding MOs).

Solution: Let's calculate the bond order for each species. Oxygen has 8 electrons.

- **O_2**: Total electrons = 16. MO configuration is $(\sigma_{2s})^2(\sigma^*_{2s})^2(\sigma_{2p_z})^2(\pi_{2p_x})^2(\pi_{2p_y})^2(\pi^*_{2p_x})^1(\pi^*_{2p_y})^1$. Bonding e^- = 10. Antibonding e^- = 6. Bond Order = $\frac{1}{2}(10-6) = 2.0$.
- **O_2^+**: Total electrons = 15. One electron is removed from the highest occupied molecular orbital (an antibonding π^* orbital). Bonding e^- = 10. Antibonding e^- = 5. Bond Order = $\frac{1}{2}(10-5) = 2.5$.
- **O_2^-**: Total electrons = 17. One electron is added to a half-filled antibonding π^* orbital. Bonding e^- = 10. Antibonding e^- = 7. Bond Order = $\frac{1}{2}(10-7) = 1.5$.
- **O_2^{2-}**: Total electrons = 18. Two electrons are added, filling the antibonding π^* orbitals. Bonding e^- = 10. Antibonding e^- = 8. Bond Order = $\frac{1}{2}(10-8) = 1.0$.

Comparing the values, $2.5 > 2.0 > 1.5 > 1.0$. Therefore, O_2^+ has the highest bond order.

Final Answer : O_2^+ has the highest bond order.

Answer: (B)

Q7.

Solution

Concept: The net dipole moment of a molecule depends on both the polarity of its bonds and its overall molecular geometry. A molecule with polar bonds can be nonpolar if its geometry is symmetrical, causing the individual bond dipoles to cancel each other out.

Solution: Let's analyze the structure of each molecule:

- **NH_3**: Ammonia has a trigonal pyramidal shape. The N-H bonds are polar, and due to the asymmetrical shape and the lone pair on nitrogen, the bond dipoles do not cancel, resulting in a net dipole moment.
- **CO_2**: Carbon dioxide is a linear molecule (O=C=O). The C=O bond is polar, with oxygen being more electronegative. However, the molecule is symmetrical, with two bond dipoles of equal magnitude pointing in exactly opposite directions. They cancel each other out, resulting in a net dipole moment of zero.
- **H_2O**: Water has a bent or V-shape. The O-H bonds are highly polar. Because of the bent geometry, the two bond dipoles do not cancel and result in a large net dipole moment.
- **SO_2**: Sulfur dioxide has a bent shape similar to water. The S=O bonds are polar, and the bent geometry prevents the bond dipoles from canceling, resulting in a net dipole moment.

Only CO_2 has a symmetrical structure that allows for the complete cancellation of its bond dipoles.

Final Answer : CO_2 has zero dipole moment.

$\boxed{\textbf{Answer: (B)}}$

Q8.

Solution

Concept: The spontaneity of a process is determined by the Gibbs free energy change, $\Delta G = \Delta H - T\Delta S$. A reaction is spontaneous if ΔG is negative.

Solution: We are given the following conditions:

- The reaction is **exothermic**, which means it releases heat. Therefore, the change in enthalpy, ΔH, is negative ($\Delta H < 0$).
- The reaction is **spontaneous**, which means the change in Gibbs free energy, ΔG, must be negative ($\Delta G < 0$).
- The reaction occurs at **low temperature**, so the value of T is small.

Let's analyze the Gibbs equation: $\Delta G = \Delta H - T\Delta S$. We need ΔG to be negative. We know ΔH is negative. $\Delta G = (\text{negative value}) - T\Delta S$ For the reaction to be spontaneous specifically at low temperatures, the negative ΔH term must dominate the equation. This happens when the $T\Delta S$ term does not favor spontaneity or is less favorable. If ΔS were positive, the $-T\Delta S$ term would be negative, and the reaction would be spontaneous at all temperatures. However, if ΔS is negative, the $-T\Delta S$ term becomes positive. The equation becomes: $\Delta G = (\text{negative value}) + (\text{positive value})$ In this case, for ΔG to be negative, the magnitude of ΔH must be greater than the magnitude of $T\Delta S$ ($|\Delta H| > |T\Delta S|$). This condition is most likely to be met at low temperatures, where the $T\Delta S$ term is small. Thus, for an exothermic reaction to be spontaneous only at low temperatures, both ΔH and ΔS must be negative.

Final Answer : For the reaction to be spontaneous, ΔH must be negative and ΔS must be negative.

Answer: (B)

Q9.

Solution

Concept: Gibbs free energy change (ΔG) is the thermodynamic potential that measures the maximum reversible work that may be performed by a thermodynamic system at a constant temperature and pressure. It determines the direction of a spontaneous process.

Solution: The sign of the Gibbs free energy change (ΔG) indicates the spontaneity of a chemical reaction under constant temperature and pressure:

- If $\Delta G < 0$ (negative), the forward reaction is spontaneous and will proceed to form products.
- If $\Delta G > 0$ (positive), the forward reaction is non-spontaneous. The reverse reaction is spontaneous.
- If $\Delta G = 0$, the system is at equilibrium. The rate of the forward reaction equals the rate of the reverse reaction, and there is no net change in the concentrations of reactants and products. The system has no further potential to do work.

Therefore, at equilibrium, the Gibbs free energy change is zero.
Final Answer : At equilibrium, ΔG is zero.

Answer: (C)

Q10.

Solution

Concept: Raoult's law applies to ideal solutions. Positive deviation occurs when the total vapor pressure of a mixture is greater than what is predicted for an ideal solution. This happens when the intermolecular forces between the solute and solvent molecules (A-B interactions) are weaker than the forces between the molecules of the pure components (A-A and B-B interactions).

Solution: Let's examine the intermolecular forces in each mixture:

- **Acetone + chloroform:** Chloroform ($CHCl_3$) and acetone ($(CH_3)_2CO$) can form a hydrogen bond with each other. This creates new, strong A-B interactions, causing the vapor pressure to be lower than predicted (negative deviation).
- **Benzene + toluene:** Both are nonpolar, aromatic molecules with similar structures and sizes. The intermolecular forces are very similar, and the solution behaves almost ideally.
- **Ethanol + water:** Both pure liquids exhibit strong hydrogen bonding. When mixed, the ethanol molecules get between the water molecules, disrupting the extensive hydrogen-bonding network present in pure water. The new ethanol-water interactions are, on average, weaker than the original water-water and ethanol-ethanol hydrogen bonds. This weakening of forces allows molecules to escape into the vapor phase more easily, leading to a higher vapor pressure than predicted (positive deviation).
- **HNO_3 + water:** Nitric acid ionizes in water and forms strong hydrogen bonds. These are very strong A-B interactions, leading to a significant negative deviation.

The ethanol and water mixture shows positive deviation due to the disruption of strong hydrogen bonds.

Final Answer : Ethanol + water shows positive deviation from Raoult's law.

$\boxed{\textbf{Answer: (C)}}$

Q11.

Solution

Concept: The Van't Hoff factor (i) represents the number of discrete particles (ions or molecules) produced in solution from one formula unit of a solute. For strong electrolytes that dissociate completely, it is equal to the number of ions formed upon dissociation.

Solution: The solute is potassium sulfate, K_2SO_4, which is a strong electrolyte. We need to write the dissociation equation to see how many ions are produced per formula unit. When K_2SO_4 dissolves in water, it dissociates completely into its constituent ions: $K_2SO_4(s) \xrightarrow{\text{water}} 2K^+(aq) + SO_4^{2-}(aq)$ From the balanced equation, we can see that one formula unit of K_2SO_4 produces:

- 2 potassium cations (K^+)
- 1 sulfate anion (SO_4^{2-})

The total number of ions produced is 2 + 1 = 3. Since complete dissociation is assumed, the Van't Hoff factor (i) is equal to this number. i = 3.

Final Answer : The Van't Hoff factor for K_2SO_4 (complete dissociation) is 3.

Answer: (C)

Q12.

Solution

Concept: Le Chatelier's principle states that if a dynamic equilibrium is disturbed by changing the conditions, the position of equilibrium moves to counteract the change. For changes in pressure, the system counteracts an increase in pressure by reducing the number of gas molecules.

Solution: Pressure in a container is caused by the collisions of gas molecules with the walls. The pressure is directly proportional to the number of moles of gas present (at constant volume and temperature).

- **Stress:** The pressure on the system is increased.
- **Response:** According to Le Chatelier's principle, the system will try to reduce the pressure.
- **Shift:** To reduce the pressure, the system must reduce the total number of gas molecules. Therefore, the equilibrium will shift in the direction of the reaction (forward or reverse) that has fewer moles of gaseous substances.

For example, in the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, the reactant side has 4 moles of gas, and the product side has 2 moles. Increasing the pressure would shift the equilibrium to the right, towards the side with fewer moles.

Final Answer : Increasing pressure shifts the equilibrium toward the side with fewer moles.

Answer: (B)

Q13.

Solution

Concept: Ostwald's Dilution Law describes the behavior of weak electrolytes. It states that the degree of dissociation (α) of a weak acid is inversely proportional to the square root of its molar concentration (C), i.e., $\alpha \propto \frac{1}{\sqrt{C}}$.

Solution: According to Ostwald's Dilution Law, the degree of dissociation, α, is given by $\alpha = \sqrt{\frac{K_a}{C}}$, where K_a is the acid dissociation constant and C is the concentration.

- As concentration (C) increases, the value of α decreases.
- Dilution means decreasing the concentration (C). As C decreases, the value of the fraction $\frac{K_a}{C}$ increases, and therefore α increases.
- A decrease in temperature generally disfavors dissociation (which is often endothermic), thus decreasing α.
- Pressure has a negligible effect on the dissociation of acids in aqueous solutions.

Therefore, the degree of dissociation increases with dilution.
Final Answer : The degree of dissociation increases with dilution.

Answer: (B)

Q14.

Solution

Concept: The relationship between the standard Gibbs free energy change (ΔG°) and the standard cell potential (E°_{cell}) is given by the equation: $\Delta G^\circ = -nFE^\circ_{\text{cell}}$.

Solution: In the equation $\Delta G^\circ = -nFE^\circ_{\text{cell}}$:

- n is the number of moles of electrons transferred in the balanced redox reaction (always a positive number).
- F is the Faraday constant (approximately 96485 C/mol, a positive constant).

For an electrochemical cell to be spontaneous under standard conditions, its standard EMF (E°_{cell}) must be positive. If E°_{cell} is positive, then the entire term $-nFE^\circ_{\text{cell}}$ will be negative. This means that a positive standard EMF corresponds to a negative standard Gibbs free energy change (ΔG°).
Final Answer : The standard EMF of a cell is positive when ΔG is negative.

Answer: (B)

Q15.

Solution

Concept: An oxidizing agent is a species that accepts electrons and gets reduced. The strength of an oxidizing agent is measured by its standard reduction potential ($E°$). The higher (more positive) the standard reduction potential, the stronger the oxidizing agent.

Solution: We need to compare the standard reduction potentials ($E°$) for the given ions:

- $Zn^{2+} + 2e^- \rightarrow Zn$; $E°$ = -0.76 V
- $Cu^{2+} + 2e^- \rightarrow Cu$; $E°$ = +0.34 V
- $Fe^{3+} + e^- \rightarrow Fe^{2+}$; $E°$ = +0.77 V
- $Ag^+ + e^- \rightarrow Ag$; $E°$ = +0.80 V

The species with the highest positive value of $E°$ has the greatest tendency to be reduced and is therefore the strongest oxidizing agent. Comparing the values, +0.80 V is the highest.
Final Answer : Ag^+ is the strongest oxidizing agent.

Answer: (D)

Q16.

Solution

Concept: The units of the rate constant (k) for a reaction of order 'n' can be determined from the general rate law. The units are $(\text{concentration})^{1-n}\ \text{time}^{-1}$.

Solution: The rate law for a first-order reaction is Rate = $k[A]^1$. The units are: Unit of Rate = (Unit of k) × (Unit of [A]) mol L^{-1} s^{-1} = (Unit of k) × (mol L^{-1}) To find the unit of k, we rearrange the equation: Unit of $k = \frac{\text{mol } L^{-1} s^{-1}}{\text{mol } L^{-1}} = s^{-1}$.
Alternatively, using the general formula for a first-order reaction, n=1: Units of $k = (\text{mol } L^{-1})^{1-1}\ s^{-1} = (\text{mol } L^{-1})^0\ s^{-1} = s^{-1}$.
Final Answer : The units of the rate constant for a first-order reaction are s^{-1}.

Answer: (B)

Q17.

Solution

Concept: The half-life ($t_{1/2}$) of a reaction is the time required for the concentration of a reactant to decrease to half of its initial value. For a first-order reaction, it is given by a specific formula.

Solution: The integrated rate law for a first-order reaction leads to the formula for its half-life: $t_{1/2} = \frac{\ln(2)}{k}$ or $t_{1/2} = \frac{0.693}{k}$ where k is the rate constant. From this formula, it is clear that the half-life of a first-order reaction:

- Is independent of the initial concentration of the reactant.
- Is inversely proportional to the rate constant (k).

Since the rate constant k is dependent on temperature (as per the Arrhenius equation), the half-life also depends on temperature, but its most direct and fundamental dependency is on the rate constant itself.

Final Answer : The half-life of a first-order reaction depends on the rate constant.

Answer: (C)

Q18.

Solution

Concept: Electron affinity is the energy released when a neutral gaseous atom accepts an electron to form a negative ion. Generally, it increases across a period and decreases down a group, with some notable exceptions.

Solution: We are comparing the electron affinities of F, Cl, O, and N.

- Halogens (Group 17, F and Cl) have higher electron affinities than chalcogens (Group 16, O) and pnictogens (Group 15, N) because they are one electron short of a stable noble gas configuration.
- Nitrogen (N) has a stable half-filled p-subshell, so adding an electron is energetically unfavorable, resulting in a very low electron affinity.
- The most important comparison is between Fluorine and Chlorine. Although electron affinity generally decreases down a group, Chlorine has a higher electron affinity than Fluorine. This is because Fluorine's small size and high electron density in the 2p orbital cause significant electron-electron repulsion when an extra electron is added. Chlorine, being larger, accommodates the incoming electron in its 3p orbital with less repulsion.

Thus, Chlorine has the highest electron affinity among the given elements.

Final Answer : Highest electron affinity is of Cl.

Answer: (B)

Q19.

Solution

Concept: Amphoteric oxides are chemical compounds that can act as either an acid or a base. They react with both strong acids and strong bases. They are typically formed by metalloids and some metals like Al, Zn, Sn, and Pb.

Solution: Let's analyze the nature of each oxide:

- CO_2 and SO_2 are oxides of non-metals (carbon and sulfur) and are acidic in nature. They react with bases to form salts (carbonates and sulfites, respectively).
- Al_2O_3 (aluminum oxide) is a classic example of an amphoteric oxide. It reacts with acids to form aluminum salts and with strong bases to form aluminates. Reaction as a base: $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$ Reaction as an acid: $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2Na[Al(OH)_4]$
- P_2O_5 (phosphorus pentoxide) is an oxide of a non-metal and is strongly acidic. It reacts with water to form phosphoric acid.

Final Answer : Al_2O_3 is an amphoteric oxide.

$\boxed{\textbf{Answer: (C)}}$

Q20.

Solution

Concept: The shape of a molecule is predicted using the Valence Shell Electron Pair Repulsion (VSEPR) theory, which considers the arrangement of both bonding pairs and lone pairs of electrons around the central atom.

Solution: To determine the shape of ClF_3:

(a) Central Atom: Chlorine (Cl).

(b) Valence Electrons of Cl (Group 17): 7.

(c) Electrons from bonding atoms: 3 Fluorine atoms contribute 1 electron each, for a total of 3.

(d) Total valence electrons: 7 + 3 = 10.

(e) Total electron pairs: 10 / 2 = 5 pairs.

(f) Bonding Pairs: Cl is bonded to 3 F atoms, so there are 3 bonding pairs.

(g) Lone Pairs: Total pairs - Bonding pairs = 5 - 3 = 2 lone pairs.

The arrangement of 5 electron pairs (3 bonding, 2 lone) corresponds to an AX_3E_2 type. The electron geometry is trigonal bipyramidal. To minimize repulsion, the 2 lone pairs occupy the equatorial positions. This results in the three fluorine atoms being arranged in a shape resembling the letter 'T'.
Final Answer : The shape of ClF_3 is T-shaped.

Answer: (B)

Q21.

Solution

Concept: The inert pair effect is the reluctance of the outermost s-electrons to participate in bonding. This effect becomes more prominent for heavier elements at the bottom of the p-block groups (like Groups 13, 14, 15) due to poor shielding by inner d and f electrons.

Solution: The elements given (Carbon, Silicon, Tin, Lead) all belong to Group 14. As we move down Group 14, the inert pair effect increases.

- Carbon and Silicon predominantly show a +4 oxidation state.
- Tin (Sn) shows both +2 and +4 oxidation states, but +4 is more stable.
- Lead (Pb), the heaviest element in the group, shows both +2 and +4 states, but the inert pair effect is so strong that the +2 state is significantly more stable than the +4 state. The $6s^2$ electrons in lead tend to remain 'inert'.

Therefore, the inert pair effect is maximum in Lead.
Final Answer : The inert pair effect is maximum in Lead.

Answer: (D)

Q22.

Solution

Concept: For many transition metals, the highest possible oxidation state is achieved when the atom loses all its valence electrons from both the outer 's' and the inner 'd' subshells.

Solution: Manganese (Mn) has the atomic number 25. Its ground-state electron configuration is [Ar] $3d^5$ $4s^2$. The valence electrons are the 2 electrons in the 4s orbital and the 5 electrons in the 3d orbital. Total number of valence electrons = 2 (from 4s) + 5 (from 3d) = 7. By losing all 7 of its valence electrons, Manganese can attain its highest oxidation state of +7. This is famously observed in the permanganate ion (MnO_4^-), where the oxidation state of Mn is calculated as x + 4(-2) = -1, which gives x = +7.
Final Answer : The highest oxidation state of Mn is +7.

Answer: (C)

Q23.

Solution

Concept: Lanthanide contraction refers to the steady decrease in the size of the atoms and ions of the lanthanide series (elements 57-71) with increasing atomic number. This effect is caused by the properties of the 4f orbitals.

Solution: In the lanthanide series, as we move from one element to the next, a proton is added to the nucleus and an electron is added to the 4f subshell. The 4f orbitals have a very diffuse shape and are located deep inside the atom. Consequently, they are very poor at shielding the outer shell electrons (e.g., in the 6s orbital) from the increasing positive charge of the nucleus. This ineffective shielding causes the outer electrons to be pulled more strongly towards the nucleus, resulting in a contraction of the atomic and ionic radii across the series.
Final Answer : Lanthanide contraction is due to the poor shielding of f-electrons.

Answer: (B)

Q24.

Solution

Concept: The color of transition metal ions in solution is typically due to d-d electron transitions. For this to occur, the ion must have a partially filled d-subshell (i.e., contain one or more unpaired d-electrons). Ions with an empty (d^0) or completely filled (d^{10}) d-subshell are generally colorless.

Solution: Let's examine the electron configurations of the d-orbitals for each ion:

- **Sc^{3+}**: Scandium (Z=21) has the configuration [Ar] $3d^1$ $4s^2$. Sc^{3+} loses all three valence electrons, resulting in the configuration [Ar] $3d^0$. It has no d-electrons and is colorless.
- **Ti^{3+}**: Titanium (Z=22) has the configuration [Ar] $3d^2$ $4s^2$. Ti^{3+} loses two 4s and one 3d electron, resulting in the configuration [Ar] $3d^1$. It has one unpaired d-electron, which can undergo d-d transitions, making it colored (purple).
- **Zn^{2+}**: Zinc (Z=30) has the configuration [Ar] $3d^{10}$ $4s^2$. Zn^{2+} loses the two 4s electrons, resulting in the configuration [Ar] $3d^{10}$. The d-subshell is completely full, so no d-d transitions can occur. It is colorless.
- **Ca^{2+}**: Calcium (Z=20) is not a transition metal. Its configuration is [Ar] $4s^2$. Ca^{2+} has the configuration [Ar]. It has no d-electrons and is colorless.

Final Answer : Ti^{3+} is colored.

Answer: (B)

Q25.

Solution

Concept: The coordination number of a central metal ion in a coordination complex is the number of ligand donor atoms to which the metal is directly bonded.

Solution: In the complex ion $[Fe(CN)_6]^{4-}$, the central metal ion is Iron (Fe). The ligands are the cyanide ions (CN^-). There are six cyanide ions surrounding the central iron ion. The cyanide ion is a monodentate ligand, meaning each CN^- ion forms one coordinate bond with the Fe ion through its carbon atom. Therefore, the total number of bonds from the ligands to the central metal is 6.

Final Answer : The coordination number of Fe is 6.

Answer: (B)

Q26.

Solution

Concept: Geometrical isomerism (cis-trans isomerism) occurs in coordination compounds that have the same chemical formula but different spatial arrangements of ligands. It is common in square planar (e.g., MA_2B_2) and octahedral (e.g., MA_4B_2) complexes.

Solution: Let's analyze the given complexes:

- **$[Ni(CO)_4]$**: This complex has a tetrahedral geometry with four identical ligands (MA_4 type). Tetrahedral complexes do not show geometrical isomerism.
- **$[Pt(NH_3)_2Cl_2]$**: This is a square planar complex of the type MA_2B_2. The two Cl^- ligands can be placed adjacent to each other (cis-isomer) or opposite to each other (trans-isomer). Thus, it exhibits geometrical isomerism.
- **$[Fe(CN)_6]^{3-}$**: This is an octahedral complex with six identical ligands (MA_6 type). It does not show geometrical isomerism.
- **$[Cu(NH_3)_4]^{2+}$**: This is a square planar complex with four identical ligands (MA_4 type). It does not show geometrical isomerism.

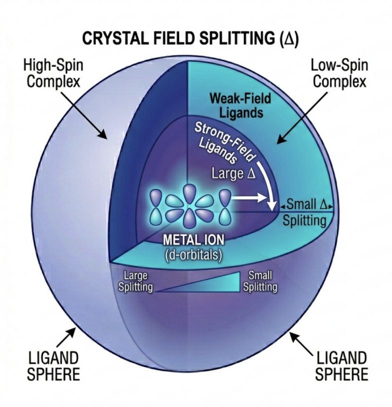
Final Answer : $[Pt(NH_3)_2Cl_2]$ shows geometrical isomerism.

Answer: (B)

Q27.

Solution

Concept: The spectrochemical series is an empirically determined list of ligands ordered by their ability to cause crystal field splitting in the d-orbitals of a metal ion. Ligands causing a large splitting are called strong-field ligands.



Solution: The general order of the spectrochemical series is: $I^- < Br^- < S^{2-} < SCN^- < \mathbf{Cl}^- < NO_3^- < N_3^- < \mathbf{F}^- < OH^- < C_2O_4^{2-} < \mathbf{H_2O} < ... < \mathbf{CN}^- < CO$ From this series, we can see that halide ions like Cl^- and F^- are weak-field ligands. Water (H_2O) is a relatively weak-field ligand. Cyanide (CN^-), on the other hand, is high up in the series and is a classic example of a strong-field ligand.

Final Answer : CN^- is a strong field ligand.

$\boxed{\textbf{Answer: (C)}}$

Q28.

Solution

Concept: Different distillation techniques are used to separate liquid mixtures based on the difference in their boiling points.

Solution:

- **Simple distillation:** This method is effective for separating liquids with a large difference in boiling points (typically $> 25^\circ$C) or for separating a volatile liquid from a non-volatile solid.
- **Fractional distillation:** This technique is specifically designed to separate a mixture of liquids whose boiling points are close to each other. It uses a fractionating column, which provides a large surface area for repeated cycles of vaporization and condensation, allowing for a more efficient separation of the components.
- **Sublimation:** This is a process for separating solids, where one component can turn directly from a solid to a gas.
- **Chromatography:** This is a set of techniques for separating mixtures based on the differential distribution of components between a stationary and a mobile phase, not directly on boiling points.

Final Answer : Fractional distillation is used to separate liquids with close boiling points.

$\boxed{\textbf{Answer: (B)}}$

Q29.

Solution

Concept: The stability of a carbocation increases with the number of alkyl groups attached to the positively charged carbon atom. This is due to the electron-donating inductive effect and hyperconjugation.

Solution: The stability of carbocations is determined by how well the positive charge can be dispersed or stabilized.

- **Inductive Effect (+I):** Alkyl groups are electron-donating, pushing electron density toward the carbocation center and reducing the positive charge.
- **Hyperconjugation:** The sigma electrons from adjacent C-H bonds can overlap with the empty p-orbital of the carbocation, delocalizing the positive charge.

The order of stability based on these effects is: Tertiary (3°) carbocation (most stable, 3 alkyl groups) > Secondary (2°) carbocation (2 alkyl groups) > Primary (1°) carbocation (1 alkyl group) > Methyl carbocation (least stable, no alkyl groups).

Final Answer : The stability is highest in a 3° carbocation.

Answer: (C)

Q30.

Solution

Concept: The inductive effect is the transmission of charge through a chain of atoms in a molecule. A group that withdraws electron density from the chain is said to have a negative inductive effect (−I). This is typically caused by atoms that are more electronegative than carbon.

Solution: Let's analyze the groups:

- **$-CH_3$**: The methyl group is an alkyl group, which is electron-donating and shows a positive inductive effect (+I).
- **$-OH$**: Oxygen is more electronegative than carbon, so it withdraws electron density from the carbon chain, showing a −I effect.
- **$-NO_2$**: The nitro group is a very strong electron-withdrawing group due to the high electronegativity of oxygen and the formal positive charge on nitrogen. It exhibits a very strong −I effect.
- **$-OCH_3$**: Similar to −OH, the oxygen atom makes this group exhibit a −I effect.

Among the given options, $-CH_3$ is the only one with a +I effect. The other three all show a −I effect. The $-NO_2$ group has the strongest −I effect.

Final Answer : $-NO_2$ shows a strong −I effect.

Answer: (C)

Q31.

Solution

Concept: An electrophile, which translates to "electron-loving," is a chemical species that is attracted to electrons and participates in a chemical reaction by accepting an electron pair.

Solution: Electrophiles are electron-deficient species. They can be positively charged ions (like H^+ or NO_2^+) or neutral molecules with an electron-deficient center (like BF_3 or SO_3). In a chemical reaction, they seek out electron-rich centers (nucleophiles) and form a new bond by accepting a pair of electrons from the nucleophile. Therefore, an electrophile is an electron pair acceptor, which is the definition of a Lewis acid.

Final Answer : An electrophile is an electron acceptor.

Answer: (B)

Q32.

Solution

Concept: Markovnikov's rule describes the regioselectivity of electrophilic addition reactions of unsymmetrical alkenes. It is based on the formation of the most stable carbocation intermediate.

Solution: When an unsymmetrical reagent like H-X adds across the double bond of an unsymmetrical alkene, the reaction proceeds in two steps. The first step is the addition of the electrophile (H^+) to one of the double-bonded carbons. This addition occurs in a way that forms the most stable carbocation. The stability of carbocations is $3° > 2° > 1°$. A more substituted carbon atom will form a more stable carbocation. In the second step, the nucleophile (X^-) attacks this more stable carbocation. The result is that the H adds to the carbon with more hydrogens, and X adds to the carbon with fewer hydrogens (the more substituted carbon).

Final Answer : The major product is the more substituted one.

Answer: (B)

Q33.

Solution

Concept: The characteristic chemical reactions of benzene and other aromatic compounds are driven by the desire to preserve the special stability of the aromatic ring.

Solution: Benzene possesses a delocalized π-electron system, which gives it significant aromatic stability.

- **Addition** reactions would require breaking the double bonds, which would disrupt the delocalized π system and destroy the aromaticity. This is energetically unfavorable and only occurs under harsh conditions.
- **Substitution** reactions (specifically, electrophilic aromatic substitution) allow the ring to react while preserving the aromatic system. An electrophile replaces one of the hydrogen atoms on the ring, keeping the stable delocalized system intact. This is the characteristic reaction of benzene.

Final Answer : Benzene undergoes substitution reactions.

Answer: (B)

Q34.

Solution

Concept: Aromaticity is a property of cyclic, planar, conjugated molecules that exhibit enhanced stability. According to Hückel's rule, an aromatic compound must have $(4n + 2)$ π electrons, where n is a non-negative integer (0, 1, 2, ...).

Solution: Let's apply Hückel's rule to the options:

- **Cyclobutadiene:** Is cyclic, planar, and conjugated, but has 4 π electrons. This follows the 4n rule, making it anti-aromatic and highly unstable.
- **Benzene:** Is cyclic, planar, and fully conjugated. It has 6 π electrons. This fits the $(4n + 2)$ rule with n=1 $(4(1)+2 = 6)$. Therefore, benzene is aromatic.
- **Cyclooctatetraene:** Is cyclic and conjugated with 8 π electrons (4n rule). To avoid being anti-aromatic, it adopts a non-planar, tub-like shape. It is non-aromatic.
- **Cyclopentane:** Is cyclic but is a saturated alkane with no π electrons or conjugation. It is non-aromatic.

Final Answer : Benzene is aromatic.

Answer: (B)

Q35.

Solution

Concept: The SN1 (Substitution Nucleophilic Unimolecular) reaction proceeds through a two-step mechanism, with the formation of a carbocation intermediate being the rate-determining step.

Solution: The rate of an SN1 reaction is directly related to the stability of the carbocation intermediate formed in the first step. Rate $\propto$ Stability of carbocation. The stability of alkyl carbocations follows the order: Tertiary (3°) > Secondary (2°) > Primary (1°) > Methyl Therefore, a tertiary alkyl halide, which can form a stable tertiary carbocation, will undergo the SN1 reaction most readily. Primary and methyl halides are too unstable to form carbocations and typically react via the SN2 mechanism.

Final Answer : The SN1 reaction is favored by a tertiary halide.

Answer: (C)

Q36.

Solution

Concept: The reactivity of alkyl halides in nucleophilic substitution reactions (both SN1 and SN2) is heavily influenced by the ability of the halogen to act as a leaving group. A better leaving group is the conjugate base of a strong acid.

Solution: The rate-determining step of both SN1 and SN2 reactions involves the breaking of the carbon-halogen (C-X) bond. A weaker C-X bond breaks more easily, and a more stable halide ion (X^-) is a better leaving group.

- **Bond Strength:** The C-X bond strength decreases down the group: C-F > C-Cl > C-Br > C-I. The C-I bond is the longest and weakest.
- **Leaving Group Ability:** The stability of the halide anion (the conjugate base) increases down the group: $I^- > Br^- > Cl^- > F^-$. This is because the negative charge is dispersed over a larger volume.

Both factors indicate that iodide (I^-) is the best leaving group. Therefore, methyl iodide (CH_3I) is the most reactive of the given methyl halides.

Final Answer : CH_3I is the most reactive.

Answer: (C)

Q37.

Solution

Concept: Aldehydes are easily oxidized by mild oxidizing agents, a property that distinguishes them from ketones (which are generally resistant to oxidation).

Solution: The aldehyde functional group contains a hydrogen atom directly bonded to the carbonyl carbon. This C-H bond is susceptible to oxidation.

- **Fehling's test:** Uses a basic solution of copper(II) ions (Cu^{2+}), which is a mild oxidizing agent. Aldehydes reduce the blue Cu^{2+} to a red precipitate of copper(I) oxide (Cu_2O) while being oxidized themselves to a carboxylate ion.
- **Tollen's test:** Uses ammoniacal silver nitrate solution, $[Ag(NH_3)_2]^+$, also a mild oxidizing agent. Aldehydes reduce the Ag^+ ions to metallic silver, which forms a characteristic "silver mirror" on the inside of the test tube.

Since aldehydes give a positive result for both of these classic tests, they are used to confirm the presence of an aldehyde group.
Final Answer : Aldehydes give a positive result for both Fehling's and Tollen's tests.

$\boxed{\textbf{Answer: (C)}}$

Q38.

Solution

Concept: The acidity of a compound is determined by the stability of its conjugate base formed after donating a proton.

Solution: When phenol (C_6H_5OH) acts as an acid, it loses a proton (H^+) to form the phenoxide ion ($C_6H_5O^-$). This phenoxide ion is the conjugate base. The stability of this ion is significantly enhanced because the negative charge on the oxygen atom is not localized; it is delocalized into the π-electron system of the benzene ring through resonance. The negative charge is spread over the ortho and para positions of the ring. This delocalization and spreading of the charge stabilizes the phenoxide ion, making it more favorable to form. A more stable conjugate base corresponds to a stronger acid.
Final Answer : Phenol is acidic due to the resonance stabilization of its conjugate base, the phenoxide ion.

$\boxed{\textbf{Answer: (B)}}$

Q39.

Solution

Concept: Boiling points of molecular substances are determined by the strength of their intermolecular forces. Stronger forces require more energy to overcome, resulting in higher boiling points.

Solution: Let's compare the intermolecular forces of the given classes of compounds (of similar molecular mass):

- **Alkane/Alkene:** These are nonpolar molecules. The only intermolecular forces are weak London dispersion forces.
- **Ether:** Ethers (R-O-R) are polar, so they have dipole-dipole interactions in addition to dispersion forces. However, they lack a hydrogen atom bonded to oxygen, so they cannot form hydrogen bonds with themselves.
- **Alcohol:** Alcohols (R-O-H) have a hydrogen atom bonded to a highly electronegative oxygen atom. This allows them to form strong intermolecular hydrogen bonds with each other.

Hydrogen bonding is significantly stronger than dipole-dipole interactions or London dispersion forces. Therefore, alcohols have considerably higher boiling points than ethers, alkanes, or alkenes of comparable molecular weight.
Final Answer : The boiling point is highest for alcohols due to strong intermolecular hydrogen bonding.

$\boxed{\textbf{Answer: (B)}}$

Q40.

Solution

Concept: The oxidation of a primary alcohol can yield either an aldehyde or a carboxylic acid, depending on the strength of the oxidizing agent used.

Solution: A primary alcohol has the structure R-CH_2-OH.

- **Mild Oxidation:** Using a mild or controlled oxidizing agent, such as pyridinium chlorochromate (PCC), the oxidation stops at the aldehyde stage. $\text{R-CH}_2\text{-OH} \xrightarrow{\text{PCC}} \text{R-CHO}$ (Aldehyde)
- **Strong Oxidation:** Using a strong oxidizing agent, such as potassium permanganate ($KMnO_4$) or potassium dichromate ($K_2Cr_2O_7$), the primary alcohol is first oxidized to an aldehyde, which is then immediately oxidized further to a carboxylic acid. $\text{R-CH}_2\text{-OH} \xrightarrow{\text{KMnO}_4} \text{R-COOH}$ (Carboxylic Acid)

Since aldehyde is a possible product and is listed as an option, it is a correct answer representing the initial stage of oxidation.

Final Answer : The product of oxidation of a primary alcohol is an aldehyde (under mild conditions).

Answer: (B)

Q41.

Solution

Concept: The basicity of amines in aqueous solution is determined by a combination of the electron-donating inductive effect (+I) of alkyl groups, the stabilization of the conjugate acid by solvation (hydrogen bonding with water), and steric hindrance.

Solution:

- **Inductive Effect:** Alkyl groups (R) push electron density onto the nitrogen atom, increasing the availability of its lone pair to accept a proton. This effect alone would suggest the order 3° > 2° > 1° > NH_3.
- **Solvation:** The protonated amine (conjugate acid) is stabilized by hydrogen bonding with water. The more hydrogen atoms on the nitrogen, the better the solvation. This effect favors the order NH_3 > 1° > 2° > 3°.
- **Steric Hindrance:** Bulky alkyl groups can block the lone pair, making it difficult for a proton to approach. This effect is most significant for tertiary amines.

The interplay of these factors in an aqueous solution for small alkyl groups (like methyl or ethyl) results in secondary amines being the most basic, as they have a good balance of inductive effects and solvation. The generally accepted order is: Secondary amine (R_2NH) > Primary amine (RNH_2) > Ammonia (NH_3).

Final Answer : The basicity order is $R_2NH > RNH_2 > NH_3$.

Answer: (B)

Q42.

Solution

Concept: Aryldiazonium salts are thermally unstable intermediates used in organic synthesis. Their stability is highly temperature-dependent.

Solution: Aryldiazonium salts are formed by the diazotization of primary aromatic amines with nitrous acid (generated from $NaNO_2$ and a strong acid like HCl). The resulting diazonium ion ($Ar\text{-}N_2^+$) is a useful synthetic intermediate but is prone to decomposition, where the $-N_2^+$ group leaves as stable nitrogen gas (N_2). This decomposition reaction is rapid at room temperature. To prevent this and allow for subsequent reactions (e.g., Sandmeyer reaction, azo coupling), the diazotization reaction must be carried out and the resulting solution must be kept at a low temperature, typically in an ice bath. The standard temperature range for maintaining the stability of diazonium salts is 0-5°C.

Final Answer : Diazonium salts are stable at 0–5°C.

Answer: (B)

Q43.

Solution

Concept: Monosaccharides (simple sugars) are classified based on the type of carbonyl functional group they contain.

Solution: Monosaccharides can be categorized as either an aldose or a ketose.

- An **aldose** is a monosaccharide that contains an aldehyde group (-CHO) as its most oxidized functional group.
- A **ketose** is a monosaccharide that contains a ketone group (C=O) as its most oxidized functional group.

Glucose is a six-carbon sugar (a hexose). When its structure is drawn in the open-chain form, the carbonyl group is located at the end of the chain (the C-1 position), which defines it as an aldehyde. Therefore, glucose is classified as an aldose (specifically, an aldohexose).
Final Answer : Glucose is an aldose.

Answer: (B)

Q44.

Solution

Concept: The complex three-dimensional structure of a protein is maintained by a variety of chemical bonds and intermolecular forces.

Solution: The structure of a protein is organized into several levels, each stabilized by different forces.

- Primary structure is the sequence of amino acids linked by covalent peptide bonds.
- Secondary structure (e.g., α-helices and β-sheets) is formed and stabilized primarily by hydrogen bonds between the carbonyl oxygen and amide hydrogen of the peptide backbone.
- Tertiary and quaternary structures are stabilized by a combination of interactions between the R-groups of the amino acids, including hydrogen bonds, ionic bonds (salt bridges), hydrophobic interactions, and covalent disulfide bonds.

Among the given options, hydrogen bonding is a crucial and pervasive force responsible for stabilizing the secondary, tertiary, and quaternary levels of protein structure.
Final Answer : Protein structure is stabilized by hydrogen bonding.

Answer: (B)

Q45.

Solution

Concept: The pH scale is based on the autoionization of water. A neutral solution is defined as one where the concentration of H^+ ions is equal to the concentration of OH^- ions.

Solution: Water undergoes autoionization: $H_2O \rightleftharpoons H^+ + OH^-$. The ion-product constant for water, $K_w = [H^+][OH^-]$, is temperature-dependent. At a standard temperature of 25°C, $K_w = 1.0 \times 10^{-14}$. In a neutral solution, by definition, $[H^+] = [OH^-]$. Substituting this into the K_w expression: $[H^+][H^+] = [H^+]^2 = 1.0 \times 10^{-14}$ Taking the square root of both sides: $[H^+] = 1.0 \times 10^{-7}$ M. The pH is calculated using the formula: pH = -log[H^+]. pH = -log(1.0×10^{-7}) = 7. Therefore, at 25°C, a neutral solution has a pH of exactly 7.

Final Answer : The pH of a neutral solution at 25°C is 7.

Answer: (C)

Answer Key

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