NEET-UG Chemistry Sample Paper-15

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, 6.67% hydrogen, and 53.33% oxygen. If its molar mass is 60 g/mol, determine its molecular formula and explain the relation between empirical and molecular formula.

(A) CH_2O

(B) $C_2H_4O_2$

(C) $C_3H_6O_3$

(D) CH_3O

Q2. Calculate de Broglie wavelength of an electron moving with velocity 2×10^6 m/s. Explain significance of wave-particle duality in atomic structure.

(A) 3.6×10^{-10} m

(B) 6.6×10^{-10} m

(C) 1.8×10^{-10} m

(D) 9.1×10^{-10} m

Q3. Explain quantum numbers and determine possible number of orbitals for $n = 3$. Discuss their significance in describing electron distribution.

(A) 3

(B) 6

(C) 9

(D) 18

Q4. Explain VSEPR theory and predict the shape of SF_4. Also explain distortion due to lone pairs.

(A) Trigonal bipyramidal

(B) Seesaw

(C) Tetrahedral

(D) Octahedral

Q5. Discuss hybridisation and geometry of CO_2 molecule. Explain why it is non-polar.

(A) Linear

(B) Bent

(C) Tetrahedral

(D) Trigonal planar

Q6. Explain hydrogen bonding and its types. Why does water have higher boiling point compared to H_2S?

(A) Due to hydrogen bonding

(B) Due to larger size

(C) Due to weaker bonds

(D) Due to no polarity

Q7. Compare ionic and covalent bonds and explain factors affecting bond strength. Which bond is strongest?

(A) Ionic bond

(B) Covalent bond

(C) Metallic bond

(D) Hydrogen bond

Q8. Calculate enthalpy change for a reaction if heat absorbed is 200 J at constant pressure. Explain relation between heat and enthalpy.

(A) $+200\,J$

(B) $-200\,J$

(C) 0

(D) $100\,J$

Q9. Explain spontaneity using Gibbs free energy and predict whether a reaction with $\Delta H > 0$ and $\Delta S > 0$ is spontaneous at high temperature.

(A) Spontaneous at high temperature

(B) Spontaneous at low temperature

(C) Never spontaneous

(D) Always equilibrium

Q10. Calculate molarity of a solution prepared by dissolving 5.85 g NaCl in 500 mL solution. Explain difference between molarity and molality.

(A) 0.1 M

(B) 0.2 M

(C) 0.05 M

(D) 0.5 M

Q11. Explain colligative properties and calculate boiling point elevation if molality is 1 m and $K_b = 0.52$.

(A) $0.52°C$

(B) $1.04°C$

(C) $0.26°C$

(D) $2.0°C$

Q12. For the reaction $H_2 + I_2 \rightleftharpoons 2HI$, explain dynamic equilibrium and factors affecting equilibrium position.

(A) Rate forward = rate backward

(B) Reaction stops

(C) Only forward occurs

(D) Only backward occurs

Q13. Calculate pH of a solution with $[H^+] = 1 \times 10^{-3}$ M and explain concept of pH scale.

(A) 3

(B) 7

(C) 1

(D) 10

Q14. Balance the redox reaction in acidic medium: $\mathrm{MnO_4^-} + \mathrm{Fe^{2+}} \longrightarrow \mathrm{Mn^{2+}} + \mathrm{Fe^{3+}}$ using ion-electron method. Also explain the concept of oxidising and reducing agents.

(A) $5\mathrm{Fe^{2+}} + \mathrm{MnO_4^-} + 8\mathrm{H^+} \to 5\mathrm{Fe^{3+}} + \mathrm{Mn^{2+}} + 4\mathrm{H_2O}$

(B) $3\mathrm{Fe^{2+}} + \mathrm{MnO_4^-} \to \mathrm{Fe^{3+}} + \mathrm{Mn^{2+}}$

(C) $\mathrm{MnO_4^-} + \mathrm{Fe^{2+}} \to \mathrm{MnO_2} + \mathrm{Fe^{3+}}$

(D) $\mathrm{Fe^{2+}} + \mathrm{MnO_4^-} \to \mathrm{Fe^{3+}}$ only

Q15. Calculate standard emf of a cell composed of $\mathrm{Ag/Ag^+}$ and $\mathrm{Cu/Cu^{2+}}$ electrodes. Given $E^\circ_{Ag^+/Ag} = +0.80V$ and $E^\circ_{Cu^{2+}/Cu} = +0.34V$. Also explain spontaneity of electrochemical reactions.

(A) $0.46V$

(B) $1.14V$

(C) $-0.46V$

(D) $0.80V$

Q16. For a first-order reaction, half-life is 693 s. Calculate rate constant and explain characteristics of first-order reactions.

(A) $1.0 \times 10^{-3} s^{-1}$

(B) $2.0 \times 10^{-3} s^{-1}$

(C) $5.0 \times 10^{-4} s^{-1}$

(D) $1.0 \times 10^{-2} s^{-1}$

Q17. Explain Arrhenius equation and calculate activation energy if rate constant doubles when temperature increases from 300 K to 310 K.

(A) $52\, kJ/mol$

(B) $10\, kJ/mol$

(C) $100\, kJ/mol$

(D) $25\, kJ/mol$

Q18. Explain trend of ionization energy across a period and down a group. Which element has highest ionization energy among N, O, F, and Ne?

(A) N

(B) O

(C) F

(D) Ne

Q19. Explain inert pair effect and its consequences in heavier p-block elements. Why is Tl^+ more stable than Tl^{3+}?

(A) Due to inert pair effect

(B) Due to increase in size

(C) Due to decrease in nuclear charge

(D) Due to resonance

Q20. Describe structure of XeF_4 and explain hybridisation and shape using VSEPR theory.

(A) Square planar

(B) Tetrahedral

(C) Trigonal bipyramidal

(D) Octahedral

Q21. Compare acidic strength of oxoacids of chlorine: $HClO$, $HClO_2$, $HClO_3$, $HClO_4$ and explain trend.

(A) $HClO_4 > HClO_3 > HClO_2 > HClO$

(B) $HClO > HClO_2 > HClO_3 > HClO_4$

(C) $HClO_2 > HClO_3 > HClO_4 > HClO$

(D) All equal

Q22. Explain variable oxidation states in transition elements and why Mn shows maximum oxidation states among 3d series.

(A) Due to involvement of 3d and 4s electrons

(B) Due to only 4s electrons

(C) Due to only 3d electrons

(D) Due to no valence electrons

Q23. Discuss magnetic properties of transition metals and calculate magnetic moment of Fe^{2+} ion.

(A) $4.9\,BM$

(B) $2.8\,BM$

(C) $1.7\,BM$

(D) $0\,BM$

Q24. Explain the magnetic behavior of transition metal ions using crystal field theory. Calculate the number of unpaired electrons in Fe^{3+} in high spin octahedral complex and predict its magnetic nature.

(A) 5 unpaired electrons, paramagnetic

(B) 3 unpaired electrons, diamagnetic

(C) 0 unpaired electrons, paramagnetic

(D) 2 unpaired electrons, diamagnetic

Q25. Explain isomerism in coordination compounds. Which type of isomerism is shown by $[Co(NH_3)_5Br]SO_4$ and $[Co(NH_3)_5SO_4]Br$?

(A) Ionisation isomerism

(B) Linkage isomerism

(C) Geometrical isomerism

(D) Coordination isomerism

Q26. Determine oxidation state, coordination number, and geometry of $[Cr(H_2O)_4Cl_2]^+$. Explain crystal field splitting in octahedral complexes.

(A) +3, 6, octahedral

(B) +2, 4, tetrahedral

(C) +3, 4, square planar

(D) +2, 6, octahedral

Q27. Explain chelation effect in coordination compounds. Why is EDTA a strong chelating agent?

(A) Due to multiple bonding sites

(B) Due to single donor atom

(C) Due to ionic nature only

(D) Due to weak coordination

Q28. Explain chromatography as a purification technique and differentiate between adsorption and partition chromatography. Which factor mainly controls separation?

(A) Differential adsorption/partition

(B) Boiling point only

(C) Molecular weight only

(D) Density only

Q29. Explain inductive effect and compare stability of carbocations: tertiary, secondary, and primary. Which is most stable?

(A) Tertiary carbocation

(B) Primary carbocation

(C) Methyl carbocation

(D) All equal

Q30. Explain resonance effect and identify most stable species: benzyl carbocation, allyl carbocation, or ethyl carbocation.

(A) Benzyl carbocation

(B) Allyl carbocation

(C) Ethyl carbocation

(D) All equal

Q31. Explain hyperconjugation and predict order of stability of alkenes: ethene, propene, and but-2-ene.

(A) But-2-ene > propene > ethene

(B) Ethene > propene > but-2-ene

(C) Propene > ethene > but-2-ene

(D) All equal

Q32. Explain mechanism of electrophilic addition in alkenes. Predict major product when HBr is added to propene in presence of peroxide.

(A) 1-bromopropane

(B) 2-bromopropane

(C) Propanol

(D) Propane

Q33. Explain aromaticity using Huckel's rule. Which of the following is aromatic: benzene, cyclobutadiene, or cyclooctatetraene?

(A) Benzene

(B) Cyclobutadiene

(C) Cyclooctatetraene

(D) All are aromatic

Q34. Explain Friedel–Crafts alkylation of benzene. Why does polyalkylation occur?

(A) Due to activating alkyl group

(B) Due to deactivating group

(C) Due to absence of catalyst

(D) Reaction stops after first substitution

Q35. Explain SN1 and SN2 mechanisms in haloalkanes. Which of the following reacts fastest via SN1 mechanism: CH_3Cl, C_2H_5Cl, $(CH_3)_3CCl$?

(A) $(CH_3)_3CCl$

(B) C_2H_5Cl

(C) CH_3Cl

(D) All equal

Q36. Explain Wurtz reaction and its limitation. Predict the major product when CH_3Br and C_2H_5Br react with Na in dry ether.

(A) Mixture of ethane, propane, and butane

(B) Only propane

(C) Only ethane

(D) Only butane

Q37. Explain acidity of alcohols and phenols. Which is more acidic and why: phenol or ethanol?

(A) Phenol

(B) Ethanol

(C) Both equal

(D) Neither acidic

Q38. Explain nucleophilic addition reaction of aldehydes. Predict product when formaldehyde reacts with HCN.

(A) $HO–CH_2–CN$

(B) CH_3CN

(C) CH_3CHO

(D) CH_3OH

Q39. Explain Cannizzaro reaction and identify products formed when benzaldehyde reacts with strong base.

(A) Benzyl alcohol and benzoate ion

(B) Benzene and CO_2

(C) Phenol only

(D) Toluene only

Q40. Explain esterification reaction. What is formed when acetic acid reacts with ethanol in presence of acid catalyst?

(A) Ethyl acetate

(B) Methane

(C) Ethene

(D) Acetone

Q41. Explain diazotization of aniline. Why are diazonium salts stable only at low temperature?

(A) Due to instability at high temperature

(B) Due to strong covalent bonding

(C) Due to resonance only

(D) Due to high stability

Q42. Explain basicity of amines. Which is most basic in aqueous solution: NH_3, CH_3NH_2, or $(CH_3)_3N$?

(A) CH_3NH_2

(B) NH_3

(C) $(CH_3)_3N$

(D) All equal

Q43. Classify carbohydrates and identify reducing sugars. Which of the following is a reducing sugar: glucose, sucrose, or fructose?

(A) Glucose and fructose

(B) Sucrose only

(C) All are reducing

(D) None are reducing

Q44. Explain structure of DNA and RNA. What type of bond holds nucleotides together in DNA?

(A) Phosphodiester bond

(B) Ionic bond

(C) Hydrogen bond only

(D) Metallic bond

Q45. Explain chromatography as a method of purification. What is the principle behind separation in TLC (Thin Layer Chromatography)?

(A) Differential adsorption

(B) Boiling point difference

(C) Density difference

(D) Molecular weight difference

Detailed Solutions

Q1.

Solution

Concept: Empirical formula gives simplest whole number ratio of atoms, while molecular formula is actual number of atoms in a molecule and is an integer multiple of empirical formula. It is obtained using molar mass comparison. This concept is important in stoichiometry for determining composition of compounds.

Solution: Given: C = 40%, H = 6.67%, O = 53.33%Moles:

$$C = \frac{40}{12} = 3.33, \quad H = \frac{6.67}{1} = 6.67, \quad O = \frac{53.33}{16} = 3.33$$

Divide by smallest:

$$C : H : O = 1 : 2 : 1$$

Empirical formula = CH_2O Empirical mass = 12 + 2 + 16 = 30Molar mass = 60

$$n = \frac{60}{30} = 2$$

Molecular formula = $(CH_2O)_2$ = $C_2H_4O_2$

Final Answer: $\boxed{C_2H_4O_2}$

Answer: (B)

Q2.

Solution

Concept: According to de Broglie hypothesis, every moving particle has wave nature with wavelength:

$$\lambda = \frac{h}{mv}$$

where h is Planck's constant, m is mass, and v is velocity. This explains wave-particle duality, which is fundamental in quantum theory and atomic structure.

Solution: Given:

$$v = 2 \times 10^6\, m/s, \quad m_e = 9.1 \times 10^{-31}\, kg, \quad h = 6.626 \times 10^{-34}$$

$$\lambda = \frac{6.626 \times 10^{-34}}{9.1 \times 10^{-31} \times 2 \times 10^6}$$

$$\lambda = \frac{6.626 \times 10^{-34}}{1.82 \times 10^{-24}} = 3.64 \times 10^{-10}\, m$$

Final Answer: $\boxed{3.6 \times 10^{-10}\, m}$

Answer: (A)

Q3.

Solution

Concept: Quantum numbers describe the complete state of an electron in an atom. The principal quantum number n defines the main energy level. The azimuthal quantum number l defines subshells, and magnetic quantum number m_l defines orbitals. The number of orbitals in a shell is given by n^2, which determines the maximum possible electron distribution in that energy level.

Solution: For $n = 3$,

$$\text{Number of orbitals} = n^2 = 3^2 = 9$$

Thus, the third shell contains:- 1 s orbital - 3 p orbitals - 5 d orbitals Total = 9 orbitals.These orbitals describe the spatial distribution of electrons and help in determining electronic configuration and chemical properties of elements.

Final Answer: $\boxed{9}$

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

Q4.

Solution

Concept: VSEPR theory states that molecular shape is determined by repulsion between electron pairs around the central atom. SF_4 has 5 electron domains (4 bond pairs + 1 lone pair), giving a trigonal bipyramidal electron pair geometry. Lone pairs occupy equatorial positions to minimize repulsion, leading to distortion in geometry.

Solution: In SF_4:- Central atom S has 6 valence electrons - Forms 4 S–F bonds and has 1 lone pair - Total steric number = 5 Electron pair geometry = trigonal bipyramidal Due to one lone pair in equatorial position, molecular shape becomes seesaw.Lone pair–bond pair repulsion is stronger than bond pair–bond pair repulsion, causing bond angle distortion from ideal values.

Final Answer: $\boxed{\text{Seesaw}}$

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

Q5.

Solution

Concept: Hybridisation explains the mixing of atomic orbitals to form equivalent hybrid orbitals. In VSEPR theory, molecular shape depends on the number of electron pairs around the central atom. Polarity depends on both bond polarity and molecular geometry. If bond dipoles cancel due to symmetry, the molecule becomes non-polar.

Solution: In CO_2, the central carbon atom forms two double bonds with oxygen atoms. Carbon undergoes sp hybridisation, forming two sp hybrid orbitals arranged at 180°. These form sigma bonds with oxygen, while remaining p orbitals form pi bonds.Thus, CO_2 has linear geometry:

$$\mathrm{O = C = O}$$

Although C–O bonds are polar, the molecule is symmetrical. The two equal and opposite bond dipoles cancel each other, making CO_2 a non-polar molecule.

Final Answer: $\boxed{\text{Linear}}$

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

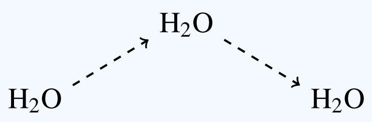
Q6.

Solution

Concept: Hydrogen bonding is a strong intermolecular force of attraction formed when hydrogen is bonded to highly electronegative atoms like N, O, or F and is attracted to lone pairs on nearby molecules.Types of hydrogen bonding:

- **Intermolecular hydrogen bonding:** Between different molecules (e.g., water).
- **Intramolecular hydrogen bonding:** Within the same molecule.

Solution: Water (H_2O) shows extensive hydrogen bonding due to high electronegativity of oxygen and presence of lone pairs. Each water molecule forms multiple hydrogen bonds, creating a strong network.H_2S does not form hydrogen bonding because sulfur is less electronegative and larger in size, resulting in weaker dipole interaction.Thus, water has a much higher boiling point.



Hydrogen bonding network

Final Answer: $\boxed{\text{Due to hydrogen bonding}}$

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

Q7.

Solution

Concept: Ionic bonds are formed by complete transfer of electrons, while covalent bonds are formed by sharing of electrons. Bond strength depends on:

- Electronegativity difference
- Bond length
- Orbital overlap
- Charge density

Generally, covalent bonds are stronger due to directional overlap of orbitals.
Solution: Ionic bond:

- Formed by electrostatic attraction
- Non-directional

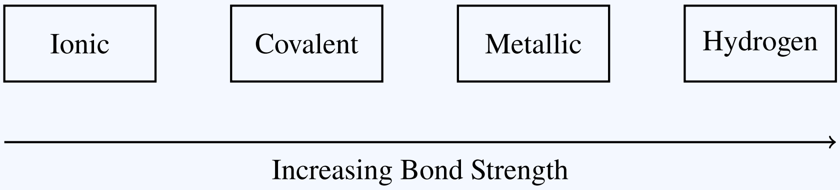
Covalent bond:

- Formed by sharing of electrons
- Strong directional overlap

Bond strength comparison:

$$\text{Covalent bond} > \text{Ionic bond} > \text{Metallic bond} > \text{Hydrogen bond}$$

Explanation: Covalent bonds are strongest due to effective orbital overlap and high bond dissociation energy.



Final Answer: $\boxed{\text{Covalent bond}}$

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

Q8.

Solution

Concept: At constant pressure, the heat absorbed or released by a system is equal to the change in enthalpy (ΔH). Enthalpy is a thermodynamic state function defined as:

$$H = U + PV$$

where U is internal energy. If heat is absorbed, ΔH is positive, and if heat is released, ΔH is negative. This relation is valid for processes occurring at constant pressure.

Solution: Given that heat absorbed at constant pressure is 200 J:

$$q_p = \Delta H$$

$$\Delta H = +200\,J$$

Since heat is taken in by the system, enthalpy increases.

Final Answer: $\boxed{+200\,J}$

Answer: (A)

Q9.

Solution

Concept: Spontaneity of a reaction is determined by Gibbs free energy:

$$\Delta G = \Delta H - T\Delta S$$

A reaction is spontaneous when $\Delta G < 0$. If both enthalpy change (ΔH) and entropy change (ΔS) are positive, spontaneity depends on temperature. At high temperature, the term $T\Delta S$ becomes large enough to overcome positive ΔH, making ΔG negative.

Solution: Given:

$$\Delta H > 0, \quad \Delta S > 0$$

At high temperature:

$$T\Delta S > \Delta H \Rightarrow \Delta G < 0$$

Hence, the reaction becomes spontaneous at high temperature because entropy contribution dominates.

Final Answer: $\boxed{\text{Spontaneous at high temperature}}$

Answer: (A)

Q10.

Solution

Concept: Molarity (M) is defined as number of moles of solute per litre of solution:

$$M = \frac{\text{moles of solute}}{\text{volume of solution in L}}$$

Molality (m) is defined as number of moles of solute per kilogram of solvent:

$$m = \frac{\text{moles of solute}}{\text{mass of solvent in kg}}$$

Difference:

- Molarity depends on volume (changes with temperature).
- Molality depends on mass (independent of temperature).

Solution: Step 1: Calculate moles of NaCl Molar mass = 58.5 g/mol

$$\text{Moles} = \frac{5.85}{58.5} = 0.1 \text{ mol}$$

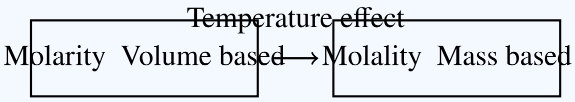
Step 2: Convert volume to litre

$$500\, mL = 0.5\, L$$

Step 3: Calculate molarity

$$M = \frac{0.1}{0.5} = 0.2\, M$$

Explanation: Molarity uses volume of solution, so it changes with temperature. Molality uses mass of solvent, so it remains constant even when temperature changes.



Final Answer: $\boxed{0.2\, M}$

Answer: (B)

Q11.

Solution

Concept: Colligative properties depend only on the number of solute particles present in a solution and not on their nature. Boiling point elevation is one such property and is given by:

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

where K_b is the ebullioscopic constant and m is molality. When a non-volatile solute is added, vapor pressure decreases, leading to an increase in boiling point.

Solution: Given:

$$m = 1, \quad K_b = 0.52$$

$$\Delta T_b = K_b \cdot m = 0.52 \times 1 = 0.52^\circ C$$

Final Answer: $\boxed{0.52^\circ C}$

Answer: (A)

Q12.

Solution

Concept: Dynamic equilibrium is a state in a reversible reaction where the rate of forward reaction becomes equal to the rate of backward reaction. At this stage, concentrations of reactants and products remain constant but reactions continue to occur. According to Le Chatelier's principle, equilibrium position shifts when factors like concentration, pressure, or temperature are changed.

Solution: For the reaction:

$$H_2 + I_2 \rightleftharpoons 2HI$$

At equilibrium:

$$\text{Rate of forward reaction} = \text{Rate of backward reaction}$$

Thus, although reactions continue at the molecular level, there is no net change in concentration of species.

Final Answer: $\boxed{\text{Rate forward = rate backward}}$

Answer: (A)

Q13.

Solution

Concept: pH is a measure of hydrogen ion concentration in a solution and is defined as:

$$\text{pH} = -\log[H^+]$$

The pH scale generally ranges from 0 to 14, where acidic solutions have pH <7, neutral is 7, and basic solutions have pH >7.

Solution: Given:

$$[H^+] = 1 \times 10^{-3}$$

$$\text{pH} = -\log(10^{-3}) = 3$$

Final Answer: $\boxed{3}$

Answer: (A)

Q14.

Solution

Concept: In the ion-electron method, redox reactions are balanced by separating oxidation and reduction half-reactions. An oxidising agent gains electrons (is reduced), while a reducing agent loses electrons (is oxidised). This method ensures conservation of both mass and charge.

Solution: For the reaction in acidic medium:

$$\text{MnO}_4^- + \text{Fe}^{2+} \longrightarrow \text{Mn}^{2+} + \text{Fe}^{3+}$$

Balanced half-reactions:Reduction:

$$\text{MnO}_4^- + 8H^+ + 5e^- \longrightarrow \text{Mn}^{2+} + 4H_2O$$

Oxidation:

$$\text{Fe}^{2+} \longrightarrow \text{Fe}^{3+} + e^-$$

Multiplying oxidation by 5 and adding:

$$5\text{Fe}^{2+} + \text{MnO}_4^- + 8H^+ \longrightarrow 5\text{Fe}^{3+} + \text{Mn}^{2+} + 4H_2O$$

Final Answer: $\boxed{5Fe^{2+} + MnO_4^- + 8H^+ \longrightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O}$

Answer: (A)

Q15.

Solution

Concept: The standard emf of an electrochemical cell is given by:

$$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$$

A reaction is spontaneous if $E^\circ_{\text{cell}} > 0$, meaning the cell can generate electrical energy from a redox reaction.

Solution: Given:

$$E^\circ_{Ag^+/Ag} = +0.80V, \quad E^\circ_{Cu^{2+}/Cu} = +0.34V$$

Ag has higher reduction potential, so it acts as cathode.

$$E^\circ_{\text{cell}} = 0.80 - 0.34 = 0.46V$$

Since emf is positive, the reaction is spontaneous.

Final Answer: $\boxed{0.46V}$

Answer: (A)

Q16.

Solution

Concept: For a first-order reaction, the half-life is independent of initial concentration and is given by:

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

First-order reactions show exponential decay behavior and constant half-life, making them easy to analyze in kinetics studies.

Solution: Given:

$$t_{1/2} = 693\,s$$

Using formula:

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{693}$$

$$k = 1.0 \times 10^{-3}\,s^{-1}$$

Final Answer: $\boxed{1.0 \times 10^{-3}\,s^{-1}}$

Answer: (A)

Q17.

Solution

Concept: The Arrhenius equation relates the rate constant of a reaction to temperature and activation energy:

$$k = Ae^{-E_a/RT}$$

Taking logarithm:

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

It explains that rate increases with temperature because more molecules acquire energy equal to or greater than activation energy.

Solution: Given:

$$\frac{k_2}{k_1} = 2, \quad T_1 = 300K, \quad T_2 = 310K, \quad R = 8.314$$

$$\ln 2 = \frac{E_a}{8.314}\left(\frac{1}{300} - \frac{1}{310}\right)$$

$$0.693 = \frac{E_a}{8.314} \times \frac{10}{93000}$$

$$0.693 = \frac{E_a}{8.314} \times 1.075 \times 10^{-4}$$

$$E_a = \frac{0.693 \times 8.314}{1.075 \times 10^{-4}}$$

$$E_a \approx 53,600\, J/mol = 52\, kJ/mol$$

Final Answer: $\boxed{52\, kJ/mol}$

Answer: (A)

Q18.

Solution

Concept: Ionization energy is the energy required to remove the outermost electron from an isolated gaseous atom. Across a period, ionization energy increases due to increasing nuclear charge and decreasing atomic size. Down a group, it decreases due to increased shielding and atomic radius. However, small exceptions occur due to electron configuration stability.

Solution: Across period 2 elements:- N: $1s^2\ 2s^2\ 2p^3$ (half-filled stable)- O: $1s^2\ 2s^2\ 2p^4$ (electron pairing causes repulsion)- F: highest effective nuclear charge- Ne: noble gas, completely filled shell, very stableAlthough Ne has a closed shell, ionization energy is generally not compared for noble gases in the same trend series of bonding elements. Among N, O, and F, fluorine has the highest effective nuclear charge and smallest size, so it requires maximum energy to remove an electron.Thus, ionization energy order:

$$F > O > N$$

Final Answer: $\boxed{F}$

Answer: (C)

Q19.

Solution

Concept: The inert pair effect refers to the reluctance of the outermost ns^2 electrons of heavier p-block elements to participate in bonding. As we move down the group, the ns^2 electrons become more tightly held by the nucleus due to poor shielding by intervening d and f electrons and increased effective nuclear charge.
Consequences:

- Lower oxidation states become more stable.
- Higher oxidation states become less stable for heavier elements.

Solution: Thallium (Tl) belongs to group 13 with configuration:

$$[Tl] : [Xe]\,4f^{14}5d^{10}6s^2 6p^1$$

For Tl:

- +3 oxidation state requires loss of $6s^2$ and $6p^1$ electrons.
- +1 oxidation state involves loss of only $6p^1$, while $6s^2$ remains inert.

Why Tl$^+$ is more stable: The $6s^2$ electrons are strongly stabilized due to poor shielding by inner electrons and relativistic effects, making them less available for bonding. Hence, removing all three electrons is difficult, and +1 state is favored.
Explanation: This is a direct consequence of the inert pair effect, which increases down the group and is most prominent in heavier p-block elements like Tl.

$$\boxed{\text{Tl}^{+}\ \ \text{Stable}} \xrightarrow{\text{Inert pair effect}} \boxed{\text{Tl}^{3+}\ \ \text{Less stable}}$$

Final Answer: $\boxed{\text{Due to inert pair effect}}$

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

Q20.

Solution

Concept: VSEPR theory explains molecular shape based on repulsion between electron pairs around the central atom. XeF_4 is a noble gas compound where xenon has 8 valence electrons. It forms 4 sigma bonds with fluorine atoms and retains 2 lone pairs. Thus, there are 6 electron domains, giving octahedral electron pair geometry. Lone pairs occupy opposite positions to minimize repulsion, leading to a square planar shape.
Solution: Xenon in XeF_4 has:

$$4 \text{ bond pairs} + 2 \text{ lone pairs} = 6 \text{ electron pairs}$$

Hence, hybridisation is:

$$sp^3d^2$$

Electron pair geometry is octahedral, but due to two lone pairs occupying axial positions, the molecular shape becomes square planar.
Final Answer: $\boxed{\text{Square planar}}$

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

Q21.

Solution

Concept: The acidity of oxoacids depends on the number of oxygen atoms and the stability of the conjugate base. In chlorine oxoacids, higher oxidation state of chlorine and greater number of oxygen atoms increase acidity due to strong electron-withdrawing effect and resonance stabilization of the conjugate base.
Solution: For chlorine oxoacids:- HClO: Cl (+1 oxidation state)- $HClO_2$: Cl (+3)- $HClO_3$: Cl (+5)- $HClO_4$: Cl (+7)As oxidation state increases, electron-withdrawing effect increases, weakening the O–H bond and stabilizing the conjugate base via resonance. Therefore acidity increases in the order:

$$HClO_4 > HClO_3 > HClO_2 > HClO$$

Final Answer: $\boxed{HClO_4 > HClO_3 > HClO_2 > HClO}$

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

Q22.

Solution

Concept: Transition elements show variable oxidation states because both (n-1)d and ns electrons are available for bonding. The energy difference between these orbitals is small, allowing different numbers of electrons to participate in bond formation. The stability of a particular oxidation state depends on electronic configuration and exchange energy.

Solution: Manganese has electronic configuration:

$$[Ar]\,3d^5\,4s^2$$

It can use both 4s and all 5 unpaired 3d electrons for bonding. Since Mn has maximum number of valence electrons (7 total), it can exhibit oxidation states up to +7, which is the highest in the 3d series.Thus, involvement of both 3d and 4s electrons leads to variable oxidation states.

Final Answer: $\boxed{\text{Due to involvement of 3d and 4s electrons}}$

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

Q23.

Solution

Concept: Magnetic moment of transition metal ions depends on the number of unpaired electrons. It is calculated using:

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

where n is the number of unpaired electrons. Fe^{2+} commonly exists in high-spin state in weak field ligands, leading to maximum unpaired electrons.

Solution: Electronic configuration of Fe:

$$Fe = [Ar]\,3d^6\,4s^2$$

Fe^{2+}:

$$[Ar]\,3d^6$$

In weak field case (high spin), distribution is:

$$t_{2g}^4 e_g^2 \Rightarrow 4 \text{ unpaired electrons}$$

Magnetic moment:

$$\mu = \sqrt{4(4+2)} = \sqrt{24} \approx 4.9\,BM$$

Final Answer: $\boxed{4.9\,BM}$

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

Q24.

Solution

Concept: According to Crystal Field Theory, ligands split the d-orbitals of the central metal ion into two energy levels in an octahedral field: t_{2g} (lower energy) and e_g (higher energy). The distribution of electrons depends on the ligand field strength. In high-spin complexes, weak field ligands cause maximum unpaired electrons, leading to paramagnetism.
Solution: For Fe^{3+}:

$$Fe^{3+} = [Ar]\,3d^5$$

In an octahedral high-spin complex, electrons occupy orbitals as:

$$t_{2g}^3 e_g^2$$

Thus, all 5 electrons are unpaired.Hence:- Number of unpaired electrons = 5 - Magnetic nature = paramagnetic
Final Answer: $\boxed{\text{5 unpaired electrons paramagnetic}}$

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

Q25.

Solution

Concept: Isomerism in coordination compounds occurs when compounds have the same molecular formula but different arrangements of ligands or ions. Ionisation isomerism occurs when ligands inside the coordination sphere exchange places with counter ions, leading to different ions in solution.
Solution: In the given pair:

$$[Co(NH_3)_5Br]SO_4 \quad \text{and} \quad [Co(NH_3)_5SO_4]Br$$

In the first compound, Br^- is inside the coordination sphere and SO_4^{2-} is outside. In the second compound, SO_4^{2-} is inside and Br^- is outside. This exchange of coordinated ion and counter ion leads to ionisation isomerism.
Final Answer: $\boxed{\text{Ionisation isomerism}}$

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

Q26.

Solution

Concept: In coordination compounds, oxidation state is calculated by balancing total charge of the complex ion. Coordination number is the total number of ligand donor atoms attached to the central metal ion. Octahedral complexes show crystal field splitting into lower energy t_{2g} and higher energy e_g orbitals due to interaction with ligands along the axes.

Solution: For $[Cr(H_2O)_4Cl_2]^+$:Let oxidation state of Cr = x

$$x + 4(0) + 2(-1) = +1$$

$$x - 2 = +1 \Rightarrow x = +3$$

Coordination number:

$$4(H_2O) + 2(Cl^-) = 6$$

Thus geometry is octahedral.In octahedral field, d-orbitals split into:

$$t_{2g}\ \text{(lower energy)}, \quad e_g\ \text{(higher energy)}$$

Electrons fill according to ligand field strength.

Final Answer: $\boxed{+3,\ 6,\ \text{octahedral}}$

Answer: (A)

Q27.

Solution

Concept: The chelation effect refers to the enhanced stability of a coordination complex formed when a multidentate ligand binds to a central metal ion through two or more donor atoms simultaneously. Such ligands form ring structures called chelate rings. This effect significantly increases complex stability compared to complexes formed with monodentate ligands due to both enthalpy and entropy factors.

Solution: EDTA (ethylenediaminetetraacetic acid) is a hexadentate ligand, meaning it can coordinate to a metal ion through six donor sites: two nitrogen atoms and four oxygen atoms from carboxylate groups. When EDTA binds to a metal ion, it wraps around the metal ion and forms several stable five-membered chelate rings.The high stability of EDTA complexes is explained by the chelation effect. When EDTA replaces several monodentate ligands, the number of particles in solution increases, which leads to an increase in entropy. This entropy gain makes the formation of the complex thermodynamically more favorable. Additionally, the formation of ring structures strengthens the metal–ligand bonding and reduces the likelihood of dissociation.Because EDTA has multiple binding sites, it can effectively “lock” the metal ion in a stable structure, making it extremely difficult for the complex to break apart. This is why EDTA is widely used in analytical chemistry (complexometric titrations), medicine (treatment of heavy metal poisoning), and water treatment (removal of Ca^{2+} and Mg^{2+} ions).Thus, EDTA is a strong chelating agent due to its ability to form multiple coordinate bonds simultaneously with a single metal ion, resulting in highly stable chelate complexes.

Final Answer: $\boxed{\text{Due to multiple bonding sites}}$

Answer: (A)

Q28.

Solution

Concept: Chromatography is a separation and purification technique based on the differential distribution of components between a stationary phase and a mobile phase. In adsorption chromatography, separation occurs due to different degrees of adsorption of components on a solid stationary phase. In partition chromatography, separation is based on different solubilities of components between two liquid phases. The key principle governing separation is the difference in interaction strength of components with the stationary phase.

Solution: In adsorption chromatography, components are adsorbed on a solid surface (like silica gel) with different strengths. In partition chromatography, components distribute themselves between two immiscible liquid phases based on their solubility. In both cases, separation occurs because different compounds travel at different rates depending on their affinity toward stationary and mobile phases. Hence, the controlling factor is differential adsorption or partitioning behavior.

Final Answer: $\boxed{\text{Differential adsorption/partition}}$

Answer: (A)

Q29.

Solution

Concept: The inductive effect is a permanent electronic effect arising due to the polarization of σ bonds caused by electronegativity differences between atoms or groups. Electron-donating groups exhibit +I effect, while electron-withdrawing groups show -I effect. This effect is transmitted through σ bonds and decreases with distance. In carbocations, stability depends on the ability to disperse the positive charge. Alkyl groups show +I effect and also stabilize carbocations through hyperconjugation.

Solution: A carbocation is a positively charged carbon species with an empty p-orbital. Its stability depends on how effectively the positive charge is stabilized. Alkyl groups attached to the positively charged carbon donate electron density through the +I effect, reducing the electron deficiency. Additionally, hyperconjugation from adjacent C–H bonds further stabilizes the carbocation by delocalizing charge.In a tertiary carbocation, the positively charged carbon is attached to three alkyl groups, which provide maximum +I effect and maximum hyperconjugation. In a secondary carbocation, only two alkyl groups are attached, so stabilization is moderate. In a primary carbocation, only one alkyl group is present, so stabilization is weak. A methyl carbocation has no alkyl groups and is least stable.Thus, the stability order based on inductive effect and hyperconjugation is:

$$\text{tertiary} > \text{secondary} > \text{primary} > \text{methyl}$$

Greater electron donation from surrounding groups increases stability by reducing positive charge density on the carbon atom. Therefore, tertiary carbocations are the most stable among the given options.

Final Answer: $\boxed{\text{Tertiary carbocation}}$

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

Q30.

Solution

Concept: Resonance effect is the delocalization of electrons or positive charge over two or more atoms through overlapping of p-orbitals. This delocalization stabilizes the species by spreading charge over a larger area. Greater the resonance stabilization, higher is the stability of the carbocation.

Solution: - Benzyl carbocation is stabilized by resonance with the aromatic benzene ring, allowing charge delocalization over multiple positions of the ring. - Allyl carbocation is also resonance stabilized, but only over three carbon atoms. - Ethyl carbocation has no resonance stabilization and depends only on inductive effect and hyperconjugation, which are weaker.Thus, stability order is:

$$\text{benzyl} > \text{allyl} > \text{ethyl}$$

Benzyl carbocation is the most stable due to extensive resonance delocalization into the aromatic ring.

Final Answer: $\boxed{\text{Benzyl carbocation}}$

Answer: (A)

Q31.

Solution

Concept: Hyperconjugation is the delocalization of σ-electrons (usually from C–H or C–C bonds) adjacent to a π bond or empty p-orbital. It is also called "no bond resonance". Greater the number of alkyl groups attached to the double bond, greater is the hyperconjugation, and hence greater is the stability of the alkene.

Stability order due to hyperconjugation: More substituted alkenes are more stable:

$$\text{Tetrasubstituted} > \text{Trisubstituted} > \text{Disubstituted} > \text{Monosubstituted} > \text{Ethene}$$

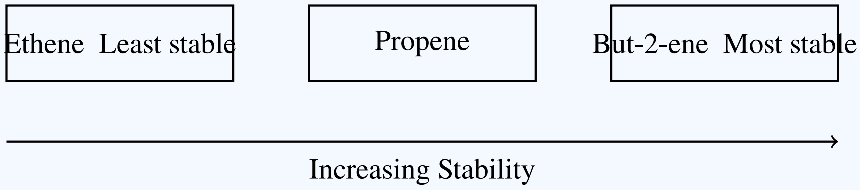
Solution: Given alkenes:

- Ethene: no alkyl substitution $\Rightarrow$ no hyperconjugation
- Propene: one alkyl group $\Rightarrow$ some hyperconjugation
- But-2-ene: two alkyl groups $\Rightarrow$ maximum hyperconjugation

Order of stability:

$$\text{But-2-ene} > \text{Propene} > \text{Ethene}$$

Explanation: But-2-ene is most stable because it has maximum alkyl substitution, leading to maximum hyperconjugative structures which stabilize the double bond. Ethene has no alkyl groups, so it lacks hyperconjugation.



Final Answer: $\boxed{\text{But-2-ene > Propene > Ethene}}$

Answer: (A)

Q32.

Solution

Concept: Alkenes undergo electrophilic addition reactions due to the presence of a reactive π bond. The π electrons are electron-rich and attack electrophiles, leading to formation of a carbocation intermediate. In normal addition of HX to alkenes, Markovnikov's rule is followed. However, in the presence of peroxides, addition of HBr follows a free radical mechanism known as the peroxide or Kharasch effect, leading to anti-Markovnikov addition.

Solution: Propene (CH_3–CH=CH_2) reacts with HBr in presence of peroxide (ROOR). The mechanism proceeds via free radicals:1. Initiation: Peroxide decomposes to form free radicals which generate Br· radicals from HBr. 2. Propagation: Br· attacks the double bond forming a more stable radical intermediate. 3. The radical then abstracts H from HBr to form final product and regenerate Br·.In propene, the radical intermediate forms at the more substituted carbon to stabilize the radical, but bromine attaches to the less substituted carbon due to anti-Markovnikov addition.Thus, Br attaches to the terminal carbon and H to the middle carbon, forming 1-bromopropane (CH_3–CH_2–CH_2Br).This is opposite to normal electrophilic addition where 2-bromopropane is formed.

Final Answer: $\boxed{\text{1-bromopropane}}$

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

Q33.

Solution

Concept: Aromaticity is a special stability shown by cyclic, planar, fully conjugated systems having delocalized -electrons. According to Hückel's rule, a compound is aromatic if it has $(4n + 2)$ -electrons (where $n = 0, 1, 2, \ldots$), is cyclic, planar, and fully conjugated. If a system has $4n$ -electrons, it becomes antiaromatic and is highly unstable. If it is not planar or not fully conjugated, it is non-aromatic.

Solution: Benzene has 6 -electrons, satisfying Hückel's rule $(4n + 2)$ with $n = 1$. It is planar, cyclic, and fully conjugated, hence it is aromatic and highly stable.Cyclobutadiene has 4 -electrons ($4n$ system), making it antiaromatic and very unstable.Cyclooctatetraene has 8 -electrons, but it is non-planar (tub-shaped structure), so it avoids antiaromaticity and is non-aromatic.Thus, among the given options, only benzene satisfies all conditions of aromaticity.

Final Answer: $\boxed{\text{Benzene}}$

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

Q34.

Solution

Concept: Friedel–Crafts alkylation is an electrophilic aromatic substitution reaction in which an alkyl group is introduced into benzene using an alkyl halide in presence of a Lewis acid catalyst ($AlCl_3$). The alkyl group is electron donating (+I effect), which activates the benzene ring toward further electrophilic substitution, leading to polyalkylation.

Solution: In Friedel–Crafts alkylation, the first alkyl group introduced increases electron density on the benzene ring due to its +I effect. This makes the ring more reactive than benzene itself, so it undergoes further substitution reactions easily. As a result, multiple alkyl groups can get attached, leading to polyalkylation.Thus, polyalkylation occurs because the alkyl group is activating in nature.

Final Answer: $\boxed{\text{Due to activating alkyl group}}$

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

Q35.

Solution

Concept: SN1 reaction proceeds via formation of a carbocation intermediate. The rate depends only on carbocation stability: more stable carbocation forms faster. Tertiary carbocations are most stable due to +I effect and hyperconjugation, while primary and methyl carbocations are least stable. SN2 reactions involve backside attack and are favored for less hindered substrates.

Solution: Carbocation stability order:

$$(CH_3)_3C^+ > C_2H_5^+ > CH_3^+$$

Thus, among the given haloalkanes:- $(CH_3)_3CCl$ forms a tertiary carbocation → most stable → fastest SN1 reaction - C_2H_5Cl forms primary carbocation → slower - CH_3Cl forms methyl carbocation → least stable → slowestTherefore, tert-butyl chloride reacts fastest via SN1 mechanism.

Final Answer: $\boxed{(CH_3)_3CCl}$

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

Q36.

Solution

Concept: Wurtz reaction is a coupling reaction of alkyl halides with sodium metal in dry ether to form higher alkanes. It proceeds via formation of alkyl radicals or organosodium intermediates, which then couple to give a new carbon–carbon bond. The reaction is mainly used to prepare symmetrical alkanes. However, it has a major limitation when two different alkyl halides are used, leading to a mixture of products.

Solution: In Wurtz reaction, alkyl halides react with sodium in dry ether as:

$$2R{-}X + 2Na \rightarrow R{-}R + 2NaX$$

When CH_3Br and C_2H_5Br are used together, multiple coupling reactions occur:1. CH_3Br + CH_3Br → ethane (C_2H_6) 2. C_2H_5Br + C_2H_5Br → butane (C_4H_{10}) 3. CH_3Br + C_2H_5Br → propane (C_3H_8)Since all possible combinations of radicals are formed in the reaction mixture, a mixture of ethane, propane, and butane is obtained.The main limitation of Wurtz reaction is lack of selectivity. When two different alkyl halides are used, it does not give a single product but instead produces a mixture of alkanes. This reduces its synthetic usefulness for preparing unsymmetrical alkanes.Additionally, side reactions such as elimination may also occur, further reducing yield.

Final Answer: $\boxed{\text{Mixture of ethane propane and}}$

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

Q37.

Solution

Concept: Acidity depends on stability of the conjugate base. Phenol forms phenoxide ion which is stabilized by resonance over the aromatic ring. Ethanol forms ethoxide ion, which has no resonance stabilization and is destabilized by electron-donating +I effect of alkyl group. Therefore phenols are more acidic than alcohols.

Solution: Phenol loses H^+ to form phenoxide ion, where negative charge is delocalized over the benzene ring through resonance structures, increasing stability. Ethanol forms ethoxide ion, where negative charge is localized on oxygen and destabilized by electron-donating alkyl group. Hence phenol is significantly more acidic than ethanol.

Final Answer: $\boxed{\text{Phenol}}$

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

Q38.

Solution

Concept: Aldehydes undergo nucleophilic addition reactions because the carbonyl carbon is electrophilic due to polarity of C=O bond. Nucleophiles attack the carbonyl carbon, forming a tetrahedral intermediate which is then protonated to give addition products. With HCN, cyanohydrin formation occurs.

Solution: Formaldehyde (HCHO) has a highly electrophilic carbonyl carbon. CN^- ion attacks the carbonyl carbon forming an intermediate, which after protonation gives cyanohydrin:

$$HCHO + HCN \rightarrow HO{-}CH_2{-}CN$$

Thus, the product is hydroxyl acetonitrile (cyanohydrin of formaldehyde).

Final Answer: $\boxed{HO{-}CH_2{-}CN}$

Answer: (A)

Q39.

Solution

Concept: Cannizzaro reaction is a disproportionation reaction shown by aldehydes without α-hydrogen in presence of strong base. One molecule is oxidized to carboxylate ion while another is reduced to alcohol.

Solution: Benzaldehyde (C_6H_5CHO) has no α-hydrogen, so it undergoes Cannizzaro reaction with concentrated base:

$$2C_6H_5CHO + OH^- \rightarrow C_6H_5CH_2OH + C_6H_5COO^-$$

Thus, one molecule forms benzyl alcohol and the other forms benzoate ion.

Final Answer: $\boxed{\text{Benzyl alcohol and benzoate ion}}$

Answer: (A)

Q40.

Solution

Concept: Esterification is a condensation reaction between a carboxylic acid and an alcohol in the presence of a strong acid catalyst (usually concentrated H_2SO_4). It produces an ester and water. The reaction is reversible and proceeds via protonation of the carbonyl group followed by nucleophilic attack of alcohol.

Solution: Acetic acid (CH_3COOH) reacts with ethanol (C_2H_5OH) in presence of acid catalyst to form ethyl acetate ($CH_3COOC_2H_5$) and water:

$$CH_3COOH + C_2H_5OH \xrightarrow{H^+} CH_3COOC_2H_5 + H_2O$$

Thus, the ester formed is ethyl acetate.

Final Answer: $\boxed{\text{Ethyl acetate}}$

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

Q41.

Solution

Concept: Diazotization is a reaction in which a primary aromatic amine such as aniline reacts with nitrous acid (HNO_2), generated in situ from sodium nitrite ($NaNO_2$) and hydrochloric acid (HCl) at low temperature (0–5°C), to form diazonium salts. These diazonium salts are highly useful intermediates in organic synthesis for preparing a variety of substituted aromatic compounds.

Solution: In diazotization of aniline, the amino group ($-NH_2$) of aniline is converted into a diazonium group ($-N_2^+$). The reaction proceeds via formation of nitrous acid, which generates nitrosonium ion (NO^+), the active electrophile. This electrophile attacks the aniline, leading to formation of diazonium chloride ($C_6H_5N_2^+Cl^-$) at 0–5°C.Diazonium salts are extremely important because they act as versatile intermediates. They can undergo substitution reactions where the diazonium group is replaced by -Cl, -Br, -OH, -CN, etc., allowing synthesis of a wide range of aromatic derivatives.However, diazonium salts are stable only at low temperatures because the N_2^+ group is weakly bonded and highly reactive. At higher temperatures, they decompose easily, liberating nitrogen gas (N_2), which is a very stable molecule. This decomposition leads to formation of phenol or other substitution products, making the diazonium salt unstable.The instability arises due to weak N–N bond in the diazonium ion and the strong thermodynamic tendency to form stable nitrogen gas. Therefore, low temperature conditions are essential to prevent decomposition and preserve the diazonium salt for further reactions.

Final Answer: $\boxed{\text{Due to instability at high temperature}}$

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

Q42.

Solution

Concept: Basicity of amines depends on the availability of lone pair on nitrogen to accept a proton. Alkyl groups show +I effect which increases electron density on nitrogen and increases basicity. However, in aqueous solution, solvation and steric hindrance also play important roles. Small amines are better solvated and thus show higher basicity.

Solution: In aqueous medium:- CH_3NH_2 has +I effect of one methyl group and is well solvated, so it is strongly basic. - $(CH_3)_3N$ has strong +I effect but bulky structure reduces solvation of protonated form, decreasing its effective basicity in water. - NH_3 has no electron-donating group, so it is least basic among the substituted amines.Thus, the order of basicity in aqueous solution is:

$$CH_3NH_2 > (CH_3)_3N > NH_3$$

Final Answer: $\boxed{CH_3NH_2}$

Answer: (A)

Q43.

Solution

Concept: Carbohydrates are classified as:

- **Monosaccharides:** simplest sugars (glucose, fructose)
- **Disaccharides:** two monosaccharide units (sucrose, maltose, lactose)
- **Polysaccharides:** large polymeric carbohydrates (starch, cellulose)

Reducing sugars are those which can reduce mild oxidizing agents (like Tollens' or Fehling's solution) due to the presence of a free aldehyde group or a free hemiacetal/hemiketal group that can open to form carbonyl group.

Solution: Glucose: Has free aldehyde group in open-chain form ⇒ reducing sugar.

Fructose: Although a ketose, it can tautomerize to aldose under basic conditions ⇒ reducing sugar.

Sucrose: Both anomeric carbons are involved in glycosidic bond ⇒ no free carbonyl group ⇒ non-reducing sugar.

Explanation: Reducing nature depends on the availability of free aldehyde or ketone group. Glucose and fructose show reducing behavior, while sucrose does not due to lack of free anomeric carbon.

Glucose	Reducing
Fructose	Reducing
Sucrose	Non-reducing

Final Answer: Glucose and fructose

Answer: (A)

Q44.

Solution

Concept: DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) are nucleic acids responsible for storage and transfer of genetic information. They are polymers of nucleotides. Each nucleotide consists of a pentose sugar, a nitrogenous base, and a phosphate group. DNA is typically double-stranded and forms a double helix, while RNA is usually single-stranded. In DNA, the two strands are held together by hydrogen bonds between complementary bases, whereas nucleotides within a strand are linked by strong covalent bonds.

Solution: In DNA structure, nucleotides are arranged in a long polynucleotide chain. The sugar (deoxyribose) of one nucleotide is linked to the phosphate group of the next nucleotide through a covalent linkage known as a phosphodiester bond. This bond is formed between the 3'-OH group of one sugar and the 5'-phosphate group of the next nucleotide, creating a stable sugar-phosphate backbone.The two strands of DNA are held together by hydrogen bonds between complementary base pairs: adenine pairs with thymine (A=T) via two hydrogen bonds, and guanine pairs with cytosine (GC) via three hydrogen bonds. This complementary base pairing ensures accurate replication and transmission of genetic information.RNA, on the other hand, contains ribose sugar instead of deoxyribose and uracil instead of thymine. It is generally single-stranded and plays roles in protein synthesis and gene expression.Thus, the structural integrity of DNA is primarily due to phosphodiester bonds within each strand, while hydrogen bonds stabilize the double helix structure between strands.

Final Answer: $\boxed{\text{Phosphodiester bond}}$

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

Q45.

Solution

Concept: Chromatography is a powerful separation and purification technique used to separate components of a mixture based on their different affinities toward a stationary phase and a mobile phase. It is widely used in organic chemistry, biochemistry, and analytical chemistry for purification, identification, and quantitative analysis of compounds. In Thin Layer Chromatography (TLC), a solid stationary phase is coated as a thin layer on a glass or plastic plate, and a solvent acts as the mobile phase.

Solution: In TLC, the stationary phase is usually silica gel or alumina, which is polar in nature. The mixture to be separated is spotted near the base of the plate, and the plate is placed in a solvent system. As the solvent rises due to capillary action, components of the mixture travel at different rates depending on their interaction with the stationary phase and solubility in the mobile phase.Compounds that have stronger attraction (adsorption) toward the stationary phase move slowly, while those with weaker interaction move faster with the solvent. This difference in movement leads to separation of components into distinct spots on the TLC plate. The distance travelled by each component relative to the solvent front is expressed as R_f value, which is useful for identification.The main principle governing separation in TLC is differential adsorption. This means that different compounds in a mixture are adsorbed to different extents on the stationary phase. Although solubility in the mobile phase also plays a role, adsorption is the dominant factor controlling separation.TLC is advantageous because it is simple, quick, and requires very small amounts of sample. It is commonly used to check purity, monitor reaction progress, and identify compounds by comparing R_f values with known standards.

Final Answer: $\boxed{\text{Differential adsorption}}$

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

Answer Key

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