NEET-UG Chemistry Sample Paper - 6

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. Which of the following sets of quantum numbers is not possible for an electron in a 4d orbital?

(A) $n = 4, l = 2, m = +1, s = +1/2$

(B) $n = 4, l = 2, m = 0, s = -1/2$

(C) $n = 4, l = 3, m = -2, s = +1/2$

(D) $n = 4, l = 2, m = -1, s = +1/2$

Q2. Identify the compound that will exhibit the highest dipole moment:

(A) $cis - 1, 2 - dichloroethene$

(B) $trans - 1, 2 - dichloroethene$

(C) $1, 1 - dichloroethene$

(D) $p - dichlorobenzene$

Q3. Look at the following P-V diagram for an ideal gas undergoing a reversible adiabatic expansion. If the curve starts at (P_1, V_1) and ends at (P_2, V_2), the slope of this curve at any point is:

(A) $\frac{P}{V}$

(B) $-\frac{P}{V}$

(C) $-\gamma\frac{P}{V}$

(D) $\gamma\frac{P}{V}$

Q4. For a reaction $X + Y \rightarrow$ Products, doubling the concentration of X doubles the rate, but doubling the concentration of Y quadruples the rate. The overall order of the reaction is:

(A) 2

(B) 3

(C) 4

(D) 1

Q5. Which of the following is a "fac-mer" isomerism exhibition candidate?

(A) $[Co(NH_3)_4Cl_2]^+$

(B) $[Pt(NH_3)_2Cl_2]$

(C) $[Co(NH_3)_3(NO_2)_3]$

(D) $[Fe(OH)_6]^{3-}$

Q6. Analyze the provided Energy Profile Diagram for an exothermic reaction $A+B \rightarrow C + D$. The distance between the energy of the reactants and the peak of the transition state represents:

(A) Enthalpy of reaction (ΔH)

(B) Activation energy of the forward reaction (E_a)

(C) Activation energy of the backward reaction ($E_{a(rev)}$)

(D) Total internal energy

Q7. The solubility of $AgCl_{(s)}$ with solubility product 1.6×10^{-10} in 0.1 M $NaCl$ solution is:

(A) 1.26×10^{-5} M

(B) 1.6×10^{-9} M

(C) 1.6×10^{-11} M

(D) Zero

Q8. In the following reaction sequence, identify Product B: $Ethyne \xrightarrow{Hg^{2+}/H_2SO_4} A \xrightarrow{NH_2OH} B$

(A) Acetaldehyde

(B) Acetaldoxime

(C) Ethanol

(D) Ethylamine

Q9. Given the structure of the carbohydrate α-D-Glucopyranose, the number of chiral carbons present is:

(A) 4

(B) 5

(C) 3

(D) 6

Q10. Which of the following p-block elements does not show an oxidation state of +6?

(A) Sulfur

(B) Selenium

(C) Tellurium

(D) Polonium

Q11. The correct order of acid strength for the following is:

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

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

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

(D) $HClO_2 < HClO < HClO_3 < HClO_4$

Q12. The magnetic moment of $[NiCl_4]^{2-}$ is (Atomic number of Ni = 28):

(A) 1.82 BM

(B) 2.82 BM

(C) 4.82 BM

(D) 0 BM

Q13. Observe the following Unit Cell diagram. If atoms of element 'A' occupy the corners and atoms of element 'B' occupy the face centers, what is the formula of the compound if one 'B' atom is missing from one face?

(A) AB_3

(B) A_2B_5

(C) $AB_{2.5}$

(D) A_2B_3

Q14. Which among the following is the most stable carbocation?

(A) $(CH_3)_3C^+$

(B) $(C_6H_5)_3C^+$

(C) $CH_3CH_2^+$

(D) $(C_6H_5)_2CH^+$

Q15. Study the titration curve provided (Strong Acid vs. Weak Base). The pH at the equivalence point will be:

(A) Exactly 7

(B) Greater than 7

(C) Less than 7

(D) 14

Q16. Which of the following is the correct order of increasing field strength of ligands in a spectrochemical series?

(A) $SCN^- < F^- < CN^- < C_2O_4^{2-}$

(B) $F^- < SCN^- < C_2O_4^{2-} < CN^-$

(C) $SCN^- < F^- < C_2O_4^{2-} < CN^-$

(D) $CN^- < C_2O_4^{2-} < F^- < SCN^-$

Q17. The number of σ and π bonds in pent-2-en-4-yne is:

(A) 10σ and 3π

(B) 8σ and 5π

(C) 11σ and 2π

(D) 13σ and 0π

Q18. Which of the following reactions is used to prepare salicylaldehyde from phenol?

(A) Kolbe's reaction

(B) Reimer-Tiemann reaction

(C) Etard reaction

(D) Stephen's reduction

Q19. The molar conductivity of 0.007 M acetic acid is 20 $\text{S} \cdot \text{cm}^2 \cdot \text{mol}^{-1}$. What is the dissociation constant of acetic acid? (Λ_m° for $H^+ = 350$ and $CH_3COO^- = 50$)

(A) 1.75×10^{-5}

(B) 2.50×10^{-5}

(C) 1.75×10^{-4}

(D) 2.50×10^{-4}

Q20. Which one of the following is a free radical substitution reaction?

(A) Benzene + $Cl_2/AlCl_3$

(B) Acetylene + HBr

(C) Methane + Cl_2/UV light

(D) Propene + HCl

Q21. Identify the major product 'X' in the following reaction: Aniline + $NaNO_2/HCl$ at $0-5$°C $\rightarrow A \xrightarrow{CuCN/KCN} X$.

(A) Chlorobenzene

(B) Benzene

(C) Benzonitrile

(D) Benzylamine

Q22. The freezing point depression constant (K_f) of benzene is 5.12 K kg/mol. The freezing point depression for a solution of molality 0.078 m containing a non-electrolyte solute in benzene is:

(A) 0.40 K

(B) 0.80 K

(C) 0.20 K

(D) 0.60 K

Q23. Match the following: (a) $CO + H_2$ (ii) Synthesis gas; (b) Temporary hardness (i) Mg$(HCO_3)_2$; (c) B_2H_6 (iii) Electron deficient hydride.

(A) (a)-(ii), (b)-(i), (c)-(iii)

(B) (a)-(iii), (b)-(ii), (c)-(i)

(C) (a)-(i), (b)-(iii), (c)-(ii)

(D) (a)-(ii), (b)-(iii), (c)-(i)

Q24. The pK_a of a weak acid (HA) is 4.8. The pK_b of a weak base (BOH) is 4.78. The pH of an aqueous solution of the corresponding salt (BA) will be:

(A) 9.58

(B) 4.79

(C) 7.01

(D) 9.22

Q25. Among the following, the one that is not a greenhouse gas is:

(A) Nitrous oxide

(B) Methane

(C) Ozone

(D) Sulfur dioxide

Q26. Given the Haworth structure of Sucrose. It is composed of:

(A) α-D-glucose and α-D-fructose

(B) α-D-glucose and β-D-fructose

(C) β-D-glucose and α-D-fructose

(D) β-D-glucose and β-D-fructose

Q27. In the structure of ClF_3, the number of lone pairs of electrons on central atom 'Cl' is:

(A) 1

(B) 2

(C) 3

(D) 4

Q28. Which of the following is an amphoteric oxide?

(A) V_2O_5

(B) CrO_3

(C) Cr_2O_3

(D) Mn_2O_7

Q29. The compound that does not give iodoform test is:

(A) Ethanol

(B) Ethanal

(C) Pentan-2-one

(D) Pentan-3-one

Q30. Analyze the graph of Radial Probability Distribution for a 2s orbital. The number of nodes present is:

(A) 0

(B) 1

(C) 2

(D) 3

Q31. For the reaction $2Cl(g) \rightarrow Cl_2(g)$, the signs of ΔH and ΔS are:

(A) $\Delta H = +ve, \Delta S = +ve$

(B) $\Delta H = +ve, \Delta S = -ve$

(C) $\Delta H = -ve, \Delta S = +ve$

(D) $\Delta H = -ve, \Delta S = -ve$

Q32. The IUPAC name of the element with atomic number 119 is:

(A) Unnilennium

(B) Ununennium

(C) Ununoctium

(D) Unnilseptium

Q33. Which of the following is used as a stabilizer in the storage of H_2O_2?

(A) Urea

(B) Alkali

(C) Dust

(D) Phosphoric acid

Q34. The major product formed in dehydrohalogenation of 2-Bromopentane is Pent-2-ene. This product formation is based on:

(A) Saytzeff's Rule

(B) Hund's Rule

(C) Hofmann's Rule

(D) Huckel's Rule

Q35. Zirconium $(Zr, Z = 40)$ and Hafnium $(Hf, Z = 72)$ have similar atomic and ionic radii because of:

(A) Belonging to the same group

(B) Diagonal relationship

(C) Lanthanoid contraction

(D) Having similar chemical properties

Q36. Which of the following molecules is non-polar in nature?

(A) $POCl_3$

(B) CH_2O

(C) $SbCl_5$

(D) NO_2

Q37. In the given electrochemical cell $Zn|Zn^{2+}||Cu^{2+}|Cu$, if the concentration of Cu^{2+} is increased, the cell potential (E_{cell}):

(A) Increases

(B) Decreases

(C) Remains same

(D) Becomes zero

Q38. Deficiency of Vitamin K causes:

(A) Beri-beri

(B) Cheilosis

(C) Increase in blood clotting time

(D) Night blindness

Q39. The process of separation of a racemic mixture into d and l enantiomers is called:

(A) Resolution

(B) Racemization

(C) Inversion

(D) Retention

Q40. Which of the following is a condensation polymer?

(A) Nylon-6,6

(B) Neoprene

(C) Teflon

(D) Buna-S

Q41. The half-life for a zero-order reaction is:

(A) Independent of initial concentration

(B) Directly proportional to initial concentration

(C) Inversely proportional to initial concentration

(D) Directly proportional to square of initial concentration

Q42. Gadolinium has a low value of third ionization enthalpy because of:

(A) Small size

(B) High exchange energy

(C) High electronegativity

(D) Effective shielding

Q43. The most suitable reagent for the conversion of $R - CH_2 - OH \rightarrow R - CHO$ is:

(A) $KMnO_4$

(B) $K_2Cr_2O_7$

(C) PCC

(D) CrO_3

Q44. Which of the following is not an aromatic compound?

(A) Cyclooctatetraene

(B) Benzene

(C) Pyridine

(D) Anthracene

Q45. The correct bond order in the following species is:

(A) $O_2^{2-} < O_2^{-} < O_2$
(B) $O_2 < O_2^{-} < O_2^{2-}$
(C) $O_2^{-} < O_2 < O_2^{2-}$
(D) $O_2^{2-} < O_2 < O_2^{-}$

Detailed Solutions

Q1.

Solution

Concept:
The state of an electron in an atom is defined by four quantum numbers:

(a) Principal quantum number (n): Represents the shell. For a 4d orbital, $n = 4$.

(b) Azimuthal quantum number (l): Represents the subshell. For d-orbitals, $l = 2$.

(c) Magnetic quantum number (m): Represents the orientation of the orbital, ranging from $-l$ to $+l$.

(d) Spin quantum number (s): Represents the electron spin, either $+1/2$ or $-1/2$.

The fundamental constraint is that l must be less than n ($l < n$), and $|m| \leq l$.

Solution:

(a) For a 4d orbital, the value of the principal quantum number n is 4.

(b) For any 'd' subshell, the azimuthal quantum number l is always 2.

(c) Evaluating the given options:

- Option A: $n = 4,\ l = 2,\ m = +1,\ s = +1/2$. This is valid since $l = 2$ and m is within -2 to $+2$.
- Option B: $n = 4,\ l = 2,\ m = 0,\ s = -1/2$. This is valid.
- Option C: $n = 4,\ l = 3,\ m = -2,\ s = +1/2$. Here, $l = 3$ corresponds to an 'f' orbital, not a 'd' orbital. Therefore, $n = 4,\ l = 3$ represents a 4f orbital.
- Option D: $n = 4,\ l = 2,\ m = -1,\ s = +1/2$. This is valid.

(d) Since the question specifically asks for a 4d orbital, l must be 2. Option C violates this condition.

Final Answer: The set in Option C is not possible for a 4d orbital.

Answer: (C)

Q2.

Solution

Concept:

The dipole moment (μ) is a vector quantity that depends on the charge separation and the geometry of the molecule.

(a) In *trans* isomers or symmetrical molecules like *p*-dichlorobenzene, individual bond dipoles often cancel each other out, leading to $\mu = 0$.

(b) In *cis* isomers, the bond dipoles are oriented in a way that they add up vectorially.

(c) 1, 1-dichloroethene also has a resultant dipole, but the symmetry and vector addition in *cis*-1, 2-dichloroethene typically result in a higher net value due to the specific bond angles.

Solution:

(a) *p*-dichlorobenzene: The two $C - Cl$ bond dipoles are at $180°$ to each other. They cancel perfectly, so $\mu = 0$.

(b) *trans*-1, 2-dichloroethene: The two $C - Cl$ dipoles point in opposite directions across the double bond, resulting in $\mu = 0$.

(c) 1, 1-dichloroethene: Both chlorine atoms are on the same carbon. There is a net dipole, but the vector sum is lower than the *cis* form.

(d) *cis*-1, 2-dichloroethene: Both $C - Cl$ dipoles are on the same side of the double bond. Their horizontal components cancel, but their vertical components add up significantly.

(e) Therefore, the *cis* isomer has the most significant non-zero resultant dipole moment among the choices.

Final Answer: The highest dipole moment is exhibited by *cis*-1, 2-dichloroethene.

Answer: (A)

Q3.

Solution

Concept:

In thermodynamics, the slope of a curve on a P-V diagram represents the rate of change of pressure with respect to volume $\left(\frac{dP}{dV}\right)$.

For an ideal gas:

(a) For an isothermal process: PV = constant. Differentiating gives

$$P\,dV + V\,dP = 0 \quad \Rightarrow \quad \frac{dP}{dV} = -\frac{P}{V}.$$

(b) For an adiabatic process: PV^{γ} = constant, where $\gamma = \frac{C_p}{C_v}$.

Solution:

$$PV^{\gamma} = K$$

$$\frac{d}{dV}(PV^{\gamma}) = 0$$

$$P\frac{d}{dV}(V^{\gamma}) + V^{\gamma}\frac{dP}{dV} = 0$$

$$P\left(\gamma V^{\gamma-1}\right) + V^{\gamma}\frac{dP}{dV} = 0$$

$$V^{\gamma}\frac{dP}{dV} = -\gamma PV^{\gamma-1}$$

$$\frac{dP}{dV} = \frac{-\gamma PV^{\gamma-1}}{V^{\gamma}}$$

$$\frac{dP}{dV} = -\gamma\frac{P}{V}$$

Final Answer: The slope of the adiabatic curve is $-\gamma\frac{P}{V}$.

Answer: (C)

Q4.

Solution

Concept:
The rate law for a reaction expresses the rate in terms of the concentration of reactants raised to a power (the order). For the reaction

$$X + Y \longrightarrow \text{Products},$$

the rate law is:

$$\text{Rate} = k[X]^a[Y]^b$$

where a is the order with respect to X and b is the order with respect to Y. The overall order is $n = a + b$.

Solution:

(a) Given that doubling the concentration of X ($[X] \rightarrow 2[X]$) doubles the rate:

$$2 \times \text{Rate} = k(2[X])^a[Y]^b$$

Dividing by the original rate:

$$2 = 2^a \Rightarrow a = 1$$

(b) Given that doubling the concentration of Y ($[Y] \rightarrow 2[Y]$) quadruples the rate:

$$4 \times \text{Rate} = k[X]^a(2[Y])^b$$

Dividing by the original rate:

$$4 = 2^b \Rightarrow b = 2$$

(c) Overall order:

$$n = a + b = 1 + 2 = 3$$

(d) The reaction is first-order with respect to X and second-order with respect to Y.

Final Answer: The overall order of the reaction is 3.

Answer: (B)

Q5.

Solution

Concept:

Facial (fac) and Meridional (mer) isomerism is a type of geometrical isomerism observed in octahedral complexes with the general formula $[MA_3B_3]$.

(a) fac-isomer: Three identical ligands occupy the corners of one triangular face of the octahedron (positions 1, 2, 3).

(b) mer-isomer: Three identical ligands occupy a plane passing through the metal center (positions 1, 2, 6).

Solution:

(a) Analyze the coordination formulas of the given options:

- Option A: $[Co(NH_3)_4Cl_2]^+$. This is an $[MA_4B_2]$ type, which shows cis-$trans$ isomerism but not fac-mer.
- Option B: $[Pt(NH_3)_2Cl_2]$. This is a square planar $[MA_2B_2]$ complex, showing cis-$trans$ isomerism.
- Option C: $[Co(NH_3)_3(NO_2)_3]$. This is an $[MA_3B_3]$ type complex. It can have the three NH_3 groups on one face (fac) or on a meridian (mer).
- Option D: $[Fe(OH)_6]^{3-}$. This is an $[MA_6]$ type; no geometrical isomerism is possible.

(b) Only the $[MA_3B_3]$ configuration satisfies the structural requirement for fac-mer isomerism.

Final Answer: The complex $[Co(NH_3)_3(NO_2)_3]$ exhibits fac-mer isomerism.

Answer: (C)

Q6.

Solution

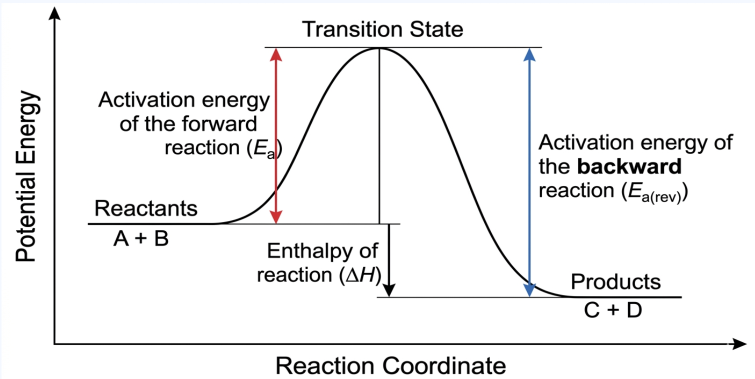
Concept:

In a chemical reaction, the Energy Profile Diagram plots the potential energy against the reaction coordinate.

(a) Reactants must overcome an energy barrier to reach the Transition State (Activated Complex) before forming products.

(b) The Activation Energy (E_a) is the minimum energy required for the reactants to transform into products.

(c) For an exothermic reaction, the energy of the products is lower than the energy of the reactants.



Solution:

(a) Locate the energy level of the reactants ($H_{\text{reactants}}$) on the y-axis.

(b) Locate the peak of the curve, which represents the Transition State.

(c) The vertical distance from the reactant level to the peak is specifically defined as the Activation Energy of the forward reaction (E_a).

(d) The difference between the reactant level and product level is the enthalpy change (ΔH).

(e) The distance from the product level to the peak would represent the activation energy for the reverse reaction $(E_{a(\text{rev})})$.

Final Answer: The distance from the reactant level to the peak represents the Activation Energy (E_a).

Answer: (B)

Q7.

Solution

Concept:
The solubility of a sparingly soluble salt is significantly reduced in the presence of a common ion. This is known as the Common Ion Effect.
For the equilibrium:

$$AgCl_{(s)} \rightleftharpoons Ag^+_{(aq)} + Cl^-_{(aq)}$$

The solubility product is:

$$K_{sp} = [Ag^+][Cl^-]$$

In a solution containing $NaCl$, the concentration of Cl^- is primarily contributed by the strong electrolyte ($NaCl$).
Solution:

(a) Let the solubility of $AgCl$ in 0.1 M $NaCl$ be s.

(b) The concentration of ions at equilibrium will be:

$$[Ag^+] = s, \qquad [Cl^-] = s + 0.1 \approx 0.1$$

(c) Substitute into K_{sp}:

$$1.6 \times 10^{-10} = s \times 0.1$$

(d) Solve for s:

$$s = \frac{1.6 \times 10^{-10}}{0.1} = 1.6 \times 10^{-9}\,\text{M}$$

(e) Comparing with solubility in pure water:

$$\sqrt{K_{sp}} \approx 1.26 \times 10^{-5}$$

the solubility decreases significantly.

Final Answer: The solubility is 1.6×10^{-9} M.

Answer: (B)

Q8.

Solution

Concept:

This is a two-step reaction involving hydration of an alkyne followed by a reaction with hydroxylamine.

(a) Hydration of Ethyne: In the presence of $HgSO_4$ and H_2SO_4 (Kucherov's reaction), ethyne forms an enol which tautomerizes to an aldehyde.

(b) Formation of Oxime: Carbonyl compounds react with hydroxylamine (NH_2OH) to form oximes ($> C = N - OH$).

Solution:

(a) Step 1:

$$HC \equiv CH + H_2O \xrightarrow{Hg^{2+}/H^+} CH_2 = CH - OH$$

(Vinyl alcohol)

(b) Tautomerization:

$$CH_2 = CH - OH \rightarrow CH_3CHO$$

(Product A is acetaldehyde)

(c) Step 2:

$$CH_3CHO + NH_2OH \rightarrow CH_3CH = NOH + H_2O$$

(d) Product $CH_3CH = NOH$ is acetaldoxime.

Final Answer: Product B is acetaldoxime.

Answer: (B)

Q9.

Solution

Concept:

A chiral carbon is attached to four different groups.

In cyclic pyranose glucose:

(a) Carbons are numbered 1 to 6.

(b) Carbon-6 lies outside the ring.

Solution:

(a) C-1: Chiral

(b) C-2: Chiral

(c) C-3: Chiral

(d) C-4: Chiral

(e) C-5: Chiral

(f) C-6: Achiral (CH_2OH)

(g) Total chiral centers = 5

Final Answer: 5

Answer: (B)

Q10.

Solution

Concept:
Group 16 elements show oxidation states +2, +4, +6.
Down the group:

- Stability of +6 decreases
- Due to Inert Pair Effect

Solution:

(a) Sulfur: Shows +6

(b) Selenium, Tellurium: Show +6

(c) Polonium: Strong inert pair effect

(d) +6 state unstable for Polonium

Final Answer: Polonium

Answer: (D)

Q11.

Solution

Concept:
Acidity increases with oxidation state and resonance stabilization.
Solution:

(a) Oxidation states:

$$HClO(+1),\ HClO_2(+3),\ HClO_3(+5),\ HClO_4(+7)$$

(b) Increasing electron-withdrawing effect

(c) Conjugate base stability:

$$ClO^- < ClO_2^- < ClO_3^- < ClO_4^-$$

(d) Hence acidity increases in same order

Final Answer:

$$HClO < HClO_2 < HClO_3 < HClO_4$$

Answer: (A)

Q12.

Solution

Concept:

The magnetic moment (μ) of a coordination complex is calculated using the spin-only formula:

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

where n is the number of unpaired electrons.

(a) Determine the oxidation state of the central metal.

(b) Determine the electronic configuration of the metal ion.

(c) Check ligand strength (strong/weak field) to determine pairing.

Solution:

(a) In $[NiCl_4]^{2-}$, let oxidation state of Ni be x:

$$x + 4(-1) = -2 \implies x = +2$$

(b) Atomic number of Ni = 28 Configuration:

$$Ni = [Ar]\,3d^8 4s^2$$

(c) For Ni^{2+}:

$$Ni^{2+} = [Ar]\,3d^8$$

(d) Electron distribution:

$$\uparrow\downarrow\ \uparrow\downarrow\ \uparrow\downarrow\ \uparrow\ \uparrow$$

(e) Cl^- is a weak field ligand $\Rightarrow$ no pairing Thus, $n = 2$

(f) Magnetic moment:

$$\begin{aligned}\mu &= \sqrt{2(2+2)} \\ &= \sqrt{8} \\ &\approx 2.82\ \text{BM}\end{aligned}$$

Final Answer: The magnetic moment is 2.82 BM.

Answer: (B)

Q13.

Solution

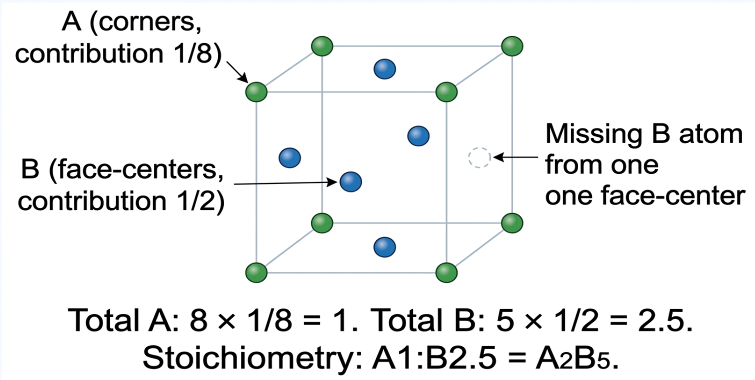
Concept:

The formula of a crystalline compound depends on atom contribution:

(a) Corner atoms → $\frac{1}{8}$ contribution

(b) Face-center atoms → $\frac{1}{2}$ contribution

(c) Total atoms = number × contribution



Solution:

(a) Number of A atoms at corners = 8

$$\text{Total A} = 8 \times \frac{1}{8} = 1$$

(b) Number of B atoms at faces:

$$6 - 1 = 5$$

$$\text{Total B} = 5 \times \frac{1}{2} = 2.5$$

(c) Ratio:

$$A : B = 1 : 2.5$$

(d) Simplest ratio:

$$\times 2 \;\Rightarrow\; A_2B_5$$

Final Answer: A_2B_5

Answer: (B)

Q14.

Solution

Concept:
Carbocation stability depends on:

(a) Resonance (most important)

(b) Hyperconjugation

(c) Inductive effect

Triphenylmethyl carbocation shows strong resonance stabilization.
Solution:

(a) $(CH_3)_3C^+$: Stabilized by 9 α-hydrogens (hyperconjugation)

(b) $CH_3CH_2^+$: Stabilized by 3 α-hydrogens

(c) $(C_6H_5)_2CH^+$: Resonance with 2 phenyl rings

(d) $(C_6H_5)_3C^+$: Resonance with 3 phenyl rings (extensive delocalization)

(e) Resonance > Hyperconjugation $\Rightarrow$ highest stability

Final Answer: $(C_6H_5)_3C^+$

Answer: (B)

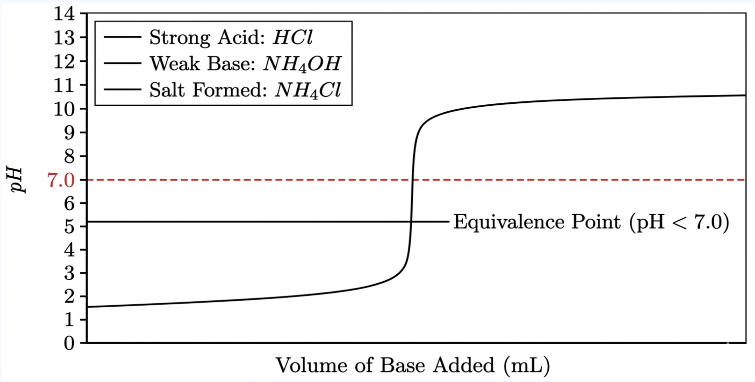
Q15.

Solution

Concept:

At equivalence point:

- Strong acid + Strong base → pH = 7
- Strong acid + Weak base → pH < 7
- Weak acid + Strong base → pH > 7



Solution:

(a) Strong acid (HCl) + Weak base (NH_4OH)

(b) Salt formed: NH_4Cl

(c) Hydrolysis:

$$NH_4^+ + H_2O \rightleftharpoons NH_4OH + H^+$$

(d) H^+ produced $\Rightarrow$ acidic solution

(e) Therefore, pH < 7

Final Answer: pH < 7

Answer: (C)

Q16.

Solution

Concept:

The spectrochemical series is an experimentally determined list of ligands arranged in order of their ability to split the d-orbitals (Crystal Field Splitting Energy, Δ_o). 1. Weak field ligands (like halides) produce low splitting. 2. Strong field ligands (like CN^- or CO) produce high splitting. 3. Common order: $I^- < Br^- < SCN^- < Cl^- < S^2- < F^- < OH^- < C_2O_4^{2-} < H_2O < NCS^- < edta^{4-} < NH_3 < en < NO_2^- < CN^- < CO$.

Solution:

1. Comparing the given ligands: SCN^-, F^-, $C_2O_4^{2-}$, and CN^-. 2. Halide ions like F^- are generally weak field ligands. 3. SCN^- (when bonded through Sulfur) is lower in the series than F^-. 4. Oxalate ($C_2O_4^{2-}$) is a chelating ligand and is stronger than halides. 5. Cyanide (CN^-) is one of the strongest field ligands due to its π-acidic character. 6. Following the official spectrochemical series: $SCN^- < F^- < C_2O_4^{2-} < CN^-$.

Final Answer: The correct order is $SCN^- < F^- < C_2O_4^{2-} < CN^-$.

Answer: (C)

Q17.

Solution

Concept:

1. A σ (sigma) bond is formed by the head-on overlap of orbitals. Every single bond is a σ bond; double bonds contain one σ and one π; triple bonds contain one σ and two π. 2. The structure of Pent-2-en-4-yne must be drawn correctly to count the bonds: - "Pent" means 5 carbons. - "2-en" means a double bond at the 2nd carbon. - "4-yne" means a triple bond at the 4th carbon.

Solution:

1. Structure: $CH_3 - CH = CH - C \equiv CH$ 2. Break down the bonds: - C_1 to H (3 single bonds) = 3 σ - $C_1 - C_2$ (1 single bond) = 1 σ - C_2 to H (1 single bond) = 1 σ - $C_2 = C_3$ (1 double bond) = 1 σ + 1 π - C_3 to H (1 single bond) = 1 σ - $C_3 - C_4$ (1 single bond) = 1 σ - $C_4 \equiv C_5$ (1 triple bond) = 1 σ + 2 π - C_5 to H (1 single bond) = 1 σ 3. Total σ bonds: 3 + 1 + 1 + 1 + 1 + 1 + 1 + 1 = 10. 4. Total π bonds: 1 (from double) + 2 (from triple) = 3.

Final Answer: There are 10 σ and 3 π bonds.

Answer: (A)

Q18.

Solution

Concept:
The synthesis of salicylaldehyde (o-hydroxybenzaldehyde) from phenol is a classic organic name reaction involving electrophilic aromatic substitution. 1. Reimer-Tiemann Reaction: Phenol reacts with Chloroform ($CHCl_3$) in the presence of Sodium Hydroxide ($NaOH$). 2. Kolbe's Reaction: Phenol reacts with CO_2 to form Salicylic acid. 3. Etard Reaction: Oxidation of Toluene to Benzaldehyde. 4. Stephen's Reduction: Nitrile to Aldehyde.

Solution:
1. In the Reimer-Tiemann reaction, the active electrophile is Dichlorocarbene ($: CCl_2$). 2. The carbene attacks the phenoxide ion at the ortho position. 3. Intermediate hydrolysis leads to the formation of an aldehyde group ($-CHO$) on the ring. 4. Phenol + $CHCl_3$ + $NaOH$ $\rightarrow$ Salicylaldehyde. 5. This is the specific method used for salicylaldehyde.

Final Answer: The Reimer-Tiemann reaction is used.

Answer: (B)

Q19.

Solution

Concept:
The dissociation constant (K_a) of a weak electrolyte is related to its degree of dissociation (α) and concentration (C) by Ostwald's Dilution Law:

$$K_a = \frac{C\alpha^2}{1-\alpha} \approx C\alpha^2 \text{ (if } \alpha \text{ is small)}$$

The degree of dissociation is given by:

$$\alpha = \frac{\Lambda_m}{\Lambda_m^\circ}$$

Solution:
1. Calculate Λ_m° for acetic acid using Kohlrausch's Law: $\Lambda_m^\circ(CH_3COOH) = \lambda^\circ(H^+) + \lambda^\circ(CH_3COO^-)$ $\Lambda_m^\circ = 350 + 50 = 400 \text{ S} \cdot \text{cm}^2 \cdot \text{mol}^{-1}$ 2. Calculate the degree of dissociation α: $\alpha = \frac{\Lambda_m}{\Lambda_m^\circ} = \frac{20}{400} = 0.05$ 3. Calculate K_a using $C = 0.007$ M: $K_a = C\alpha^2 = 0.007 \times (0.05)^2$ $K_a = 0.007 \times 0.0025 = 1.75 \times 10^{-5}$ 4. Since α is small ($0.05 < 0.1$), the approximation $1 - \alpha \approx 1$ is valid.

Final Answer: The dissociation constant is 1.75×10^{-5}.

Answer: (A)

Q20.

Solution

Concept:

Chemical reactions are classified based on the mechanism and the type of reagent involved. 1. Electrophilic Substitution: Common in aromatic rings (e.g., Nitration, Halogenation of Benzene). 2. Electrophilic Addition: Common in alkenes and alkynes. 3. Free Radical Substitution: Occurs in alkanes under high temperature or UV light, involving initiation, propagation, and termination steps.

Solution:

1. Benzene + $Cl_2/AlCl_3$: This is Electrophilic Aromatic Substitution (chlorination). 2. Acetylene + HBr: This is Electrophilic Addition across a triple bond. 3. Methane + Cl_2/UV light: This involves the formation of $Cl\cdot$ radicals which abstract a hydrogen from methane. This is a classic Free Radical Substitution. 4. Propene + HCl: This is Electrophilic Addition (Markovnikov's addition).

Final Answer: Methane + Cl_2/UV light is a free radical substitution.

Answer: (C)

Q21.

Solution

Concept:

This sequence involves the formation of a diazonium salt followed by a Sandmeyer-type or Gattermann-type substitution. 1. Diazotization: Aniline reacts with nitrous acid (generated in situ from $NaNO_2$ and HCl) at low temperatures to form Benzene Diazonium Chloride. 2. Substitution: The diazonium group ($-N_2^+Cl^-$) is a very good leaving group and can be replaced by a nucleophile like the cyanide ion ($-CN$) using Copper(I) cyanide.

Solution:

1. Reaction 1: $C_6H_5NH_2 + NaNO_2 + 2HCl \xrightarrow{0-5°C} C_6H_5N_2^+Cl^- + NaCl + 2H_2O$. - Product 'A' is Benzene Diazonium Chloride. 2. Reaction 2: $C_6H_5N_2^+Cl^- + CuCN/KCN \rightarrow C_6H_5CN + N_2 + CuCl$. - The $-N_2^+$ group is replaced by the $-CN$ group. 3. The final product 'X' is Benzonitrile (also known as Phenyl cyanide).

Final Answer: The major product 'X' is Benzonitrile.

Answer: (C)

Q22.

Solution

Concept:

Colligative properties depend on the number of solute particles. Depression in freezing point (ΔT_f) is given by:

$$\Delta T_f = i \cdot K_f \cdot m$$

where: - i is the Van't Hoff factor (for non-electrolytes, $i = 1$). - K_f is the molal depression constant. - m is the molality of the solution.

Solution:

1. Identify the given values: - $K_f = 5.12$ K kg/mol - $m = 0.078$ m - $i = 1$ (as the solute is a non-electrolyte). 2. Apply the formula: $\Delta T_f = 1 \times 5.12 \times 0.078$ 3. Perform the calculation: $5.12 \times 0.078 = 0.39936$ 4. Rounding to significant figures or matching the closest option: $\Delta T_f \approx 0.40$ K.

Final Answer: The freezing point depression is 0.40 K.

Answer: (A)

Q23.

Solution

Concept:

This question tests knowledge across Hydrogen and s-block chemistry. 1. Synthesis Gas (Syngas): A mixture of Carbon monoxide and Hydrogen ($CO + H_2$). 2. Hardness of Water: Temporary hardness is caused by the presence of bicarbonates of Calcium and Magnesium. 3. Diborane (B_2H_6): An electron-deficient hydride where Boron does not have an octet, leading to bridge bonding (banana bonds).

Solution:

1. Match (a): $CO + H_2$ is called synthesis gas or water gas. So, (a) matches with (ii). 2. Match (b): Temporary hardness is due to $Mg(HCO_3)_2$ or $Ca(HCO_3)_2$. So, (b) matches with (i). 3. Match (c): B_2H_6 is the classic example of an electron-deficient hydride. So, (c) matches with (iii). 4. Combining these: (a)-(ii), (b)-(i), (c)-(iii).

Final Answer: The correct matching is (a)-(ii), (b)-(i), (c)-(iii).

Answer: (A)

Q24.

Solution

Concept:

The salt BA is formed from a weak acid (HA) and a weak base (BOH). The pH of a solution of a salt of a weak acid and a weak base is independent of concentration and is given by:

$$pH = 7 + \frac{1}{2}(pK_a - pK_b)$$

Solution:

1. Given values: - $pK_a = 4.8$ - $pK_b = 4.78$ 2. Substitute the values into the formula: $pH = 7 + \frac{1}{2}(4.8 - 4.78)$ 3. Calculate the difference: $4.8 - 4.78 = 0.02$ 4. Multiply by 1/2: $0.5 \times 0.02 = 0.01$ 5. Final calculation: $pH = 7 + 0.01 = 7.01$. 6. Since $pK_a > pK_b$, the acid is slightly weaker than the base, resulting in a slightly basic solution (pH just above 7).

Final Answer: The pH of the solution will be 7.01.

Answer: (C)

Q25.

Solution

Concept:

Greenhouse gases are atmospheric gases that absorb and emit radiation within the thermal infrared range, causing the greenhouse effect. 1. Primary greenhouse gases: H_2O (vapor), CO_2, CH_4, N_2O, and O_3. 2. Chlorofluorocarbons (CFCs) also act as potent greenhouse gases. 3. SO_2, while a major pollutant and contributor to acid rain, is generally considered to have a cooling effect on the climate by reflecting sunlight (aerosol effect) rather than acting as a greenhouse gas.

Solution:

1. Nitrous oxide (N_2O): Confirmed greenhouse gas. 2. Methane (CH_4): Potent greenhouse gas. 3. Ozone (O_3): Greenhouse gas in the troposphere. 4. Sulfur dioxide (SO_2): Not a greenhouse gas. It is a primary air pollutant leading to atmospheric haze and acid rain, but it does not trap infrared radiation in the same way.

Final Answer: Sulfur dioxide is not a greenhouse gas.

Answer: (D)

Q26.

Solution

Concept:
Sucrose is a non-reducing disaccharide, commonly known as table sugar. It is formed by a glycosidic linkage between two monosaccharide units. 1. It consists of glucose and fructose. 2. The linkage is a $1,2$-glycosidic bond involving the anomeric carbons of both sugars: the $C-1$ of α-D-glucose and the $C-2$ of β-D-fructose. 3. Because both anomeric carbons are involved in the bond, sucrose does not show mutarotation and does not reduce Fehling's or Tollen's reagent.
Solution:
1. Hydrolysis of sucrose yields an equimolar mixture of α-D-glucose and β-D-fructose. 2. In the Haworth structure: - The glucose unit is in the pyranose form (six-membered ring). - The fructose unit is in the furanose form (five-membered ring). 3. The specific isomers involved are the α form for glucose and the β form for fructose. 4. Therefore, sucrose is specifically α-D-glucopyranosyl-β-D-fructofuranoside.
Final Answer: Sucrose is composed of α-D-glucose and β-D-fructose.

Answer: (B)

Q27.

Solution

Concept:
The number of lone pairs and the geometry of a molecule can be determined using the Valence Shell Electron Pair Repulsion (VSEPR) theory. 1. Identify the central atom and its valence electrons. 2. Count the number of bonded atoms. 3. Calculate the number of lone pairs using the formula:

$$\text{Lone Pairs} = \frac{\text{Valence electrons} - \text{Shared electrons}}{2}$$

Solution:
1. Chlorine (Cl) is the central atom in ClF_3. It belongs to Group 17 and has 7 valence electrons. 2. There are 3 Fluorine atoms attached to Chlorine, meaning Chlorine uses 3 of its electrons to form 3 single σ bonds. 3. Remaining electrons on Chlorine = $7 - 3 = 4$ electrons. 4. These 4 electrons form pairs: $\frac{4}{2} = 2$ lone pairs. 5. With 3 bond pairs and 2 lone pairs, the steric number is 5 (sp^3d hybridization). The geometry is T-shaped to minimize lone pair-lone pair repulsions.
Final Answer: The number of lone pairs on the central atom 'Cl' is 2.

Answer: (B)

Q28.

Solution

Concept:
The nature of oxides (acidic, basic, or amphoteric) of d-block elements depends on the oxidation state of the metal. 1. Oxides in low oxidation states are generally basic (e.g., CrO, MnO). 2. Oxides in intermediate oxidation states are often amphoteric (react with both acids and bases). 3. Oxides in high oxidation states are generally acidic (e.g., CrO_3, Mn_2O_7).

Solution:
1. Mn_2O_7: Manganese is in the +7 oxidation state (very high). It is strongly acidic. 2. CrO_3: Chromium is in the +6 oxidation state. It is acidic (forms chromic acid in water). 3. V_2O_5: Vanadium is in the +5 oxidation state. It is primarily amphoteric, though it leans towards acidic character. 4. Cr_{2O3}: Chromium is in the +3 oxidation state (intermediate). It reacts with both concentrated acids and strong alkalis to form salts. Thus, it is a classic amphoteric oxide.

Final Answer: Cr_2O_3 is an amphoteric oxide.

Answer: (C)

Q29.

Solution

Concept:
The Iodoform test is used to identify the presence of a methyl ketone group ($CH_3 - CO-$) or a methyl carbinol group ($CH_3 - CH(OH)-$). 1. Reagents: Iodine (I_2) and Sodium hydroxide ($NaOH$). 2. A positive test is indicated by the formation of a yellow precipitate of Iodoform (CHI_3). 3. Alcohols that can be oxidized to methyl ketones (like ethanol or secondary alcohols with a methyl group at the alpha position) also give a positive test.

Solution:
1. Ethanol (CH_3CH_2OH): Can be oxidized to CH_3CHO. It contains the $CH_3CH(OH)-$ group. Positive test. 2. Ethanal (CH_3CHO): Contains the $CH_3 - CO-$ group. Positive test. 3. Pentan-2-one ($CH_3 - CO - CH_2CH_2CH_3$): Contains the $CH_3 - CO-$ group. Positive test. 4. Pentan-3-one ($CH_3CH_2 - CO - CH_2CH_3$): This is a symmetrical ketone. It does not have a methyl group directly attached to the carbonyl carbon. It contains ethyl groups on both sides. Negative test.

Final Answer: Pentan-3-one does not give the iodoform test.

Answer: (D)

Q30.

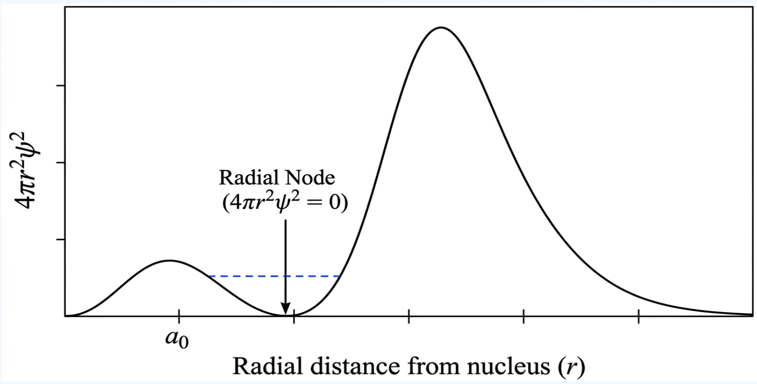
Solution

Concept:

Radial nodes are regions in space where the probability of finding an electron is zero ($R(r)^2 = 0$).
1. The number of radial nodes for any orbital is given by the formula:

$$\text{Radial Nodes} = n - l - 1$$

where n is the principal quantum number and l is the azimuthal quantum number. 2. For an 's' orbital, $l = 0$.



Solution:

1. For a 2s orbital: - n = 2 - l = 0 2. Applying the formula:

$$\text{Radial Nodes} = 2 - 0 - 1 = 1$$

3. A 2s orbital has one radial node, which appears as a spherical surface where the probability density drops to zero before increasing again as we move away from the nucleus. 4. In a graph of $4\pi r^2 R^2$ vs r, this node is represented by the point where the curve touches the x-axis (excluding the origin).

Final Answer: The number of nodes in a 2s orbital is 1.

Answer: (B)

Q31.

Solution

Concept:
The sign of enthalpy (ΔH) and entropy (ΔS) determines the nature of a chemical process. 1. Bond formation is an exothermic process because energy is released when atoms come together to form a stable bond. 2. Entropy (S) is a measure of randomness or disorder. When two separate gaseous atoms combine to form a single molecule, the number of particles decreases, leading to a decrease in randomness.

Solution:
1. Consider the reaction: $2Cl(g) \to Cl_2(g)$. 2. Enthalpy (ΔH): A chemical bond is being formed between two Chlorine atoms. Since bond formation releases energy, the process is exothermic. Therefore, $\Delta H < 0$ (Negative). 3. Entropy (ΔS): On the reactant side, there are 2 moles of gaseous particles. On the product side, there is only 1 mole of gaseous particles. 4. The system is moving from a state of more particles (higher disorder) to a state of fewer particles (lower disorder). Thus, entropy decreases. Therefore, $\Delta S < 0$ (Negative).

Final Answer: Both ΔH and ΔS are negative.

Answer: (D)

Q32.

Solution

Concept:
The IUPAC nomenclature for elements with atomic numbers $Z > 100$ is derived directly from the numerical roots of the atomic number: 0 = nil, 1 = un, 2 = bi, 3 = tri, 4 = quad, 5 = pent, 6 = hex, 7 = sept, 8 = oct, 9 = enn. The suffix "ium" is added at the end.

Solution:
1. Break down the atomic number 119: - 1 = un - 1 = un - 9 = enn 2. Combine the roots: un + un + enn. 3. Add the suffix "ium": un + un + enn + ium = Ununennium. 4. The symbol for this element would be Uue. 5. Note: "Unnilennium" would be 109, and "Ununoctium" is 118.

Final Answer: The IUPAC name is Ununennium.

Answer: (B)

Q33.

Solution

Concept:
Hydrogen peroxide (H_2O_2) is a highly unstable liquid that decomposes over time into water and oxygen. This decomposition is catalyzed by light, dust particles, and traces of alkali from glass containers.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

To prevent this, stabilizers (inhibitors) are added to slow down the rate of decomposition.
Solution:
1. H_2O_2 is stored in wax-lined glass or plastic vessels in the dark. 2. Stabilizers act by neutralizing catalytic impurities or by acting as negative catalysts. 3. Common stabilizers include urea, acetanilide, and certain acids. 4. Phosphoric acid (H_3PO_4) is widely used as a stabilizer because it maintains an acidic environment which inhibits the decomposition reaction catalyzed by alkaline traces.
Final Answer: Phosphoric acid is used as a stabilizer.

Answer: (D)

Q34.

Solution

Concept:
Dehydrohalogenation of alkyl halides is an elimination reaction (β-elimination). When multiple alkenes can be formed, the major product is determined by Saytzeff's (Zaitsev's) Rule. 1. Saytzeff's Rule states that in an elimination reaction, the most substituted alkene (the one with the greater number of alkyl groups attached to the doubly bonded carbon atoms) is the preferred product. 2. Highly substituted alkenes are more stable due to greater hyperconjugation.
Solution:
1. 2-Bromopentane structure: $CH_3 - CH(Br) - CH_2 - CH_2 - CH_3$. 2. Elimination of HBr can happen in two ways: - From C_1 and C_2 $\rightarrow$ Pent-1-ene (Less substituted). - From C_2 and C_3 $\rightarrow$ Pent-2-ene (More substituted). 3. Pent-2-ene has two alkyl groups (methyl and ethyl) on the double bond, whereas Pent-1-ene has only one (propyl). 4. Therefore, Pent-2-ene is the major product according to Saytzeff's Rule.
Final Answer: The product formation is based on Saytzeff's Rule.

Answer: (A)

Q35.

Solution

Concept:
Normally, atomic and ionic radii increase down a group due to the addition of new shells. However, in the 5d transition series, this increase is offset by a phenomenon known as Lanthanoid Contraction. 1. Lanthanoid Contraction is the steady decrease in the size of atoms and ions with increasing atomic number from Lanthanum to Lutetium. 2. It occurs because of the poor shielding effect of $4f$ electrons, which causes the effective nuclear charge to increase significantly, pulling the outer electrons closer.

Solution:
1. Zirconium (Zr) belongs to the 4d series (Period 5). 2. Hafnium (Hf) belongs to the 5d series (Period 6). 3. Between Zr and Hf, the 14 Lanthanoid elements ($Z = 58$ to 71) involve filling the $4f$ subshell. 4. The poor shielding of these $4f$ electrons leads to a contraction in the size of Hf. 5. As a result, the expected increase in size from Zr to Hf is cancelled out, making their radii nearly identical ($Zr \approx 160$ pm, $Hf \approx 159$ pm).

Final Answer: The similarity is due to Lanthanoid contraction.

Answer: (C)

Q36.

Solution

Concept:
The polarity of a molecule is determined by its molecular geometry and the vector sum of its individual bond dipoles. 1. A molecule is polar if it has a non-zero net dipole moment ($\mu \neq 0$). 2. A molecule is non-polar if the bond dipoles are equal in magnitude and oriented in such a way that they cancel each other out ($\mu = 0$). 3. Symmetric geometries like Linear (AX_2), Trigonal Planar (AX_3), Tetrahedral (AX_4), and Trigonal Bipyramidal (AX_5) often result in non-polar molecules if all surrounding atoms are identical.

Solution:
1. CH_2O (Formaldehyde): Trigonal planar geometry, but the $C - O$ bond dipole is different from the $C - H$ bond dipoles. It is polar. 2. NO_2: V-shaped (bent) geometry with an odd electron. It is polar. 3. $POCl_3$: Tetrahedral geometry, but the atoms attached to Phosphorus are not identical (one Oxygen, three Chlorines). It is polar. 4. $SbCl_5$: Antimony (Group 15) forms five bonds with Chlorine. The geometry is Trigonal Bipyramidal. - The three equatorial $Sb - Cl$ bonds cancel each other at 120°. - The two axial $Sb - Cl$ bonds cancel each other at 180°. 5. Because of this perfect symmetry, the net dipole moment is zero.

Final Answer: $SbCl_5$ is non-polar in nature.

Answer: (C)

Q37.

Solution

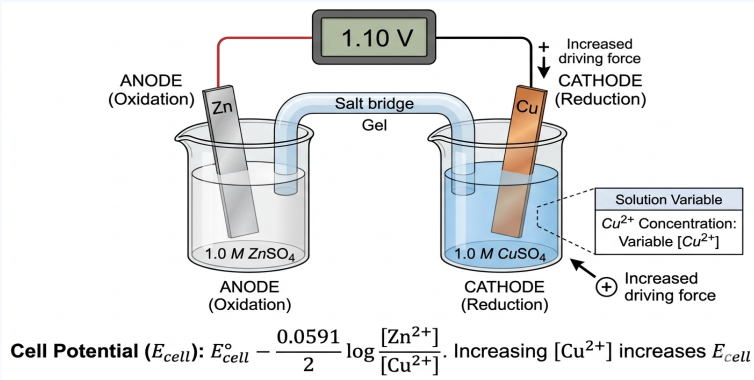
Concept:

The potential of an electrochemical cell under non-standard conditions is given by the Nernst Equation:

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{n} \log \frac{[\text{Anode Ion}]}{[\text{Cathode Ion}]}$$

For the Daniell cell ($Zn|Zn^{2+}||Cu^{2+}|Cu$):

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{2} \log \frac{[Zn^{2+}]}{[Cu^{2+}]}$$



Solution:

1. In the cell notation, Zn is the anode (oxidation) and Cu is the cathode (reduction). 2. The reaction is: $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$. 3. From the Nernst equation, E_{cell} is directly related to the term $-\log([Zn^{2+}]/[Cu^{2+}])$, which is equivalent to $+\log([Cu^{2+}]/[Zn^{2+}])$. 4. Therefore:

$$E_{cell} = E^{\circ}_{cell} + \frac{0.0591}{2} \log[Cu^{2+}] - \frac{0.0591}{2} \log[Zn^{2+}]$$

5. If the concentration of Cu^{2+} (the reactant/cathode ion) is increased, the value of the log term increases. 6. Consequently, the overall cell potential E_{cell} increases.

Final Answer: The cell potential increases.

Answer: (A)

Q38.

Solution

Concept:

Vitamins are essential micronutrients required for various biological functions. They are categorized based on their solubility (fat-soluble vs. water-soluble). 1. Vitamin K is a fat-soluble vitamin. 2. It plays a critical role in the synthesis of proteins required for blood coagulation (clotting). 3. Specifically, it is a cofactor for the enzyme that carboxylates glutamate residues in clotting factors II (prothrombin), VII, IX, and X.

Solution:

1. Beri-beri: Caused by deficiency of Vitamin B_1 (Thiamine). 2. Cheilosis: Caused by deficiency of Vitamin B_2 (Riboflavin). 3. Night blindness: Caused by deficiency of Vitamin A (Retinol). 4. Increase in blood clotting time: This is the direct result of Vitamin K deficiency. Without sufficient Vitamin K, the liver cannot produce functional clotting factors, leading to excessive bleeding even from minor injuries.

Final Answer: Deficiency of Vitamin K causes an increase in blood clotting time.

Answer: (C)

Q39.

Solution

Concept:

Stereoisomerism involving non-superimposable mirror images (enantiomers) leads to optical activity. 1. A mixture containing equal amounts of *d* (dextrorotatory) and *l* (levorotatory) forms is called a racemic mixture (or racemate) and is optically inactive due to external compensation. 2. The process of converting a racemic mixture back into its individual pure enantiomers is a fundamental technique in organic chemistry.

Solution:

1. Inversion: Specifically refers to the Walden inversion where the configuration of a chiral center is reversed (common in S_N2 reactions). 2. Retention: When the configuration around a chiral center remains the same during a reaction. 3. Racemization: The process of converting an optically active compound into a racemic mixture. 4. Resolution: The separation of a racemic mixture into its constituent *d* and *l* isomers. Since enantiomers have identical physical properties (like boiling point), they cannot be separated by simple distillation; specialized methods like chemical, biochemical, or chromatographic resolution are used.

Final Answer: The process is called Resolution.

Answer: (A)

Q40.

Solution

Concept:

Polymers are classified by their mode of polymerization: 1. Addition Polymers: Formed by the repeated addition of monomer molecules possessing double or triple bonds. No small molecules are eliminated (e.g., Polyethene, PVC, Teflon, Buna-S). 2. Condensation Polymers: Formed by the reaction between two different bi-functional or tri-functional monomer units. In this process, small molecules like H_2O, NH_3, or HCl are eliminated.

Solution:

1. Neoprene: Addition polymer of chloroprene. 2. Teflon: Addition polymer of tetrafluoroethene. 3. Buna-S: Addition polymer (copolymer) of 1,3-butadiene and styrene. 4. Nylon-6,6: Prepared by the condensation of adipic acid ($HOOC(CH_2)_4COOH$) and hexamethylenediamine ($H_2N(CH_2)_6NH_2$). 5. During the formation of the amide linkage, a molecule of water is eliminated for each bond formed. Thus, it is a condensation polymer.

Final Answer: Nylon-6,6 is a condensation polymer.

Answer: (A)

Q41.

Solution

Concept:
The half-life ($t_{1/2}$) of a chemical reaction is the time required for the concentration of a reactant to decrease to half of its initial value. For a zero-order reaction, the rate is independent of the concentration of reactants:

$$\text{Rate} = k[A]^0 = k$$

The integrated rate equation for a zero-order reaction is:

$$[A] = [A]_0 - kt$$

Solution:
1. At $t = t_{1/2}$, the concentration of the reactant $[A]$ becomes $[A]_0/2$. 2. Substitute these values into the integrated rate equation:

$$\frac{[A]_0}{2} = [A]_0 - k \cdot t_{1/2}$$

3. Rearrange the equation to solve for $t_{1/2}$:

$$k \cdot t_{1/2} = [A]_0 - \frac{[A]_0}{2}$$

$$k \cdot t_{1/2} = \frac{[A]_0}{2}$$

$$t_{1/2} = \frac{[A]_0}{2k}$$

4. Since k is a constant, the equation shows that $t_{1/2}$ is directly proportional to the initial concentration $[A]_0$.
Final Answer: The half-life is directly proportional to the initial concentration.

Answer: (B)

Q42.

Solution

Concept:
Ionization enthalpy is the energy required to remove an electron from a gaseous atom or ion. For f-block elements (Lanthanoids), the electronic configuration significantly influences these values. 1. Gadolinium (Gd) has an atomic number of 64. 2. Its electronic configuration is $[Xe]4f^75d^16s^2$.

Solution:
1. First and Second ionization enthalpies involve removing electrons from the 6s orbital. 2. The Third ionization enthalpy (IE_3) involves removing an electron from the $5d^1$ orbital: $Gd^{2+}([Xe]4f^75d^1) \rightarrow Gd^{3+}([Xe]4f^7) + e^-$. 3. After the loss of the 5d electron, the resulting Gd^{3+} ion attains a stable half-filled f-subshell ($4f^7$). 4. The high stability associated with the half-filled configuration (due to high exchange energy and symmetrical distribution) makes the removal of the third electron relatively easier compared to its neighbors. 5. While exchange energy is the primary driver for stability, the question asks why the value is low; it is because the transition leads to a highly stable state.

Final Answer: The low value is due to high exchange energy and the resulting half-filled stability.

Answer: (B)

Q43.

Solution

Concept:
The oxidation of alcohols to carbonyl compounds depends on the strength of the oxidizing agent. 1. Strong oxidizing agents (like $KMnO_4$ or $K_2Cr_2O_7$ in acidic media) oxidize primary alcohols directly to carboxylic acids. 2. Controlled or mild oxidizing agents are required to stop the oxidation at the aldehyde stage.

Solution:
1. $KMnO_4$ and $K_2Cr_2O_7$: These are strong reagents that will convert $R-CH_2-OH$ to $R-COOH$. 2. CrO_3: In aqueous acidic media, it also tends to over-oxidize to the acid. 3. PCC (Pyridinium Chlorochromate): This is a specialized reagent (a complex of chromium trioxide with pyridine and HCl) used in anhydrous solvents like CH_2Cl_2. 4. PCC is highly selective; it oxidizes primary alcohols to aldehydes and secondary alcohols to ketones without further oxidation to carboxylic acids.

Final Answer: The most suitable reagent is PCC.

Answer: (C)

Q44.

Solution

Concept:

According to Huckel's Rule, for a compound to be aromatic, it must be: 1. Cyclic. 2. Planar. 3. Conjugated (complete delocalization of π electrons). 4. Contain $(4n + 2)\pi$ electrons (where $n = 0, 1, 2...$).

Solution:

1. Benzene: Cyclic, planar, 6π electrons ($n = 1$). Aromatic. 2. Pyridine: Cyclic, planar, 6π electrons (the nitrogen lone pair is in an sp^2 orbital and not part of the π system). Aromatic. 3. Anthracene: Three fused benzene rings, 14π electrons ($n = 3$). Aromatic. 4. Cyclooctatetraene (C_8H_8): It has 8π electrons. According to $4n + 2$, it should have 6 or 10 to be aromatic. More importantly, to avoid "anti-aromaticity," the molecule adopts a non-planar "tub-shaped" conformation. 5. Since it is non-planar and does not follow Huckel's rule, it is non-aromatic.

Final Answer: Cyclooctatetraene is not an aromatic compound.

Answer: (A)

Q45.

Solution

Concept:

Bond order represents the number of chemical bonds between a pair of atoms. In Molecular Orbital (MO) theory, it is calculated as:

$$\text{Bond Order (B.O.)} = \frac{N_b - N_a}{2}$$

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

Solution:

(a) Oxygen (O_2): Total 16 electrons.

Configuration:

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

$$\text{B.O.} = \frac{10-6}{2} = 2$$

(b) Superoxide ion (O_2^-): Total 17 electrons.

The extra electron enters an antibonding π^* orbital:

$$\text{B.O.} = \frac{10-7}{2} = 1.5$$

(c) Peroxide ion (O_2^{2-}): Total 18 electrons.

Two extra electrons occupy antibonding π^* orbitals:

$$\text{B.O.} = \frac{10-8}{2} = 1$$

(d) The bond order decreases as the number of antibonding electrons increases.

(e) Order:

$$O_2^{2-}(1) < O_2^-(1.5) < O_2(2)$$

Final Answer: The correct order of bond order is $O_2^{2-} < O_2^- < O_2$.

Answer: (A)

Answer Key

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