NEET-UG Chemistry Sample Paper-17

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. The density of a 3M solution of $Na_2S_2O_3$ is 1.25 g/mL. The percentage by weight of $Na_2S_2O_3$ and the mole fraction of $Na_2S_2O_3$ in the solution are respectively:

(A) 37.92%, 0.065

(B) 35.21%, 0.054

(C) 42.15%, 0.072

(D) 30.12%, 0.045

Q2. The ratio of the de-Broglie wavelengths of an electron and a proton moving with the same velocity is approximately: (Mass of electron = 9.1×10^{-31} kg, Mass of proton = 1.67×10^{-27} kg)

(A) 1836

(B) 1

(C) 1/1836

(D) 43

Q3. Which of the following transitions in a Hydrogen atom will emit a photon of the highest frequency?

(A) $n = 2$ to $n = 1$

(B) $n = 6$ to $n = 2$

(C) $n = 2$ to $n = 6$

(D) $n = 1$ to $n = 2$

Q4. Which of the following pairs of species have the same bond order and are both paramagnetic?

(A) O_2 and B_2

(B) N_2 and O_2^+

(C) O_2 and N_2^-

(D) C_2 and O_2

Q5. The correct order of increasing s-character in the hybrid orbitals of the central atom in ClO_2^-, ClO_3^-, and ClO_4^- is:

(A) $ClO_2^- < ClO_3^- < ClO_4^-$

(B) $ClO_4^- < ClO_3^- < ClO_2^-$

(C) $ClO_3^- < ClO_2^- < ClO_4^-$

(D) All have the same s-character

Q6. The dipole moment of NF_3 is smaller than that of NH_3 because:

(A) Nitrogen is more electronegative than Fluorine

(B) The lone pair dipole in NF_3 opposes the bond pair dipoles

(C) NF_3 has a planar structure while NH_3 is pyramidal

(D) F is smaller than H

Q7. For the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, if the initial concentration of PCl_5 is 'a' and the degree of dissociation is x, the total number of moles at equilibrium is:

(A) $a(1 + x)$

(B) $a(1-x)$

(C) $a+x$

(D) $a+2x$

Q8. The work done during the expansion of a gas from a volume of 4 dm^3 to 6 dm^3 against a constant external pressure of 3 atm is: (1 L atm = 101.32 J)

(A) -607.9 J

(B) $+607.9$ J

(C) -303.9 J

(D) -6 J

Q9. The enthalpy of combustion of methane, graphite and dihydrogen at 298 K are -890.3 kJ mol^{-1}, -393.5 kJ mol^{-1} and -285.8 kJ mol^{-1} respectively. Enthalpy of formation of $CH_4(g)$ will be:

(A) -74.8 kJ mol^{-1}

(B) -52.2 kJ mol^{-1}

(C) $+74.8$ kJ mol^{-1}

(D) $+52.2$ kJ mol^{-1}

Q10. Two liquids A and B form an ideal solution. At 300 K, the vapor pressure of a solution containing 1 mole of A and 3 moles of B is 550 mm Hg. At the same temperature, if 1 mole of B is added to this solution, the vapor pressure increases by 10 mm Hg. The vapor pressures of pure A and B are:

(A) 400, 600 mm Hg

(B) 600, 400 mm Hg

(C) 500, 500 mm Hg

(D) 300, 700 mm Hg

Q11. The boiling point of a 0.2 mol kg^{-1} solution of X in water is greater than the boiling point of a 0.2 mol kg^{-1} solution of Y in water. Which of the following statements is true in this case?

(A) X is undergoing dissociation in water

(B) Molecular mass of X is greater than Y

(C) Molecular mass of Y is greater than X

(D) Y is undergoing dissociation in water

Q12. In which of the following arrangements, the sequence is not strictly according to the property written against it?

(A) $HF < HCl < HBr < HI$: increasing acid strength

(B) $NH_3 < PH_3 < AsH_3 < SbH_3$: increasing basic strength

(C) $B < C < O < N$: increasing first ionization enthalpy

(D) $CO_2 < SiO_2 < SnO_2 < PbO_2$: increasing oxidizing power

Q13. The number of moles of $KMnO_4$ reduced by 1 mole of KI in alkaline medium is:

(A) 1

(B) 2

(C) 5

(D) 6

Q14. The molar conductivity of 0.007 M acetic acid is 20 S cm^2 mol^{-1}. What is the dissociation constant of acetic acid? (Given Λ_m° = 400 S cm^2 mol^{-1})

(A) 1.75×10^{-5} mol L^{-1}

(B) 2.50×10^{-5} mol L^{-1}

(C) 1.50×10^{-4} mol L^{-1}

(D) 1.85×10^{-3} mol L^{-1}

(E) 1.75×10^{-5} mol L^{-1}

Q15. For a first-order reaction, the time required for 99.9% completion is how many times the time required for 50% completion?

(A) 10

(B) 100

(C) 5

(D) 2

Q16. The rate constant for a reaction at 273 K and 300 K are k_1 and k_2 respectively. If the activation energy (E_a) is 54.84 kJ mol^{-1}, the ratio k_2/k_1 is approximately: (Given $R = 8.314$ J K^{-1} mol^{-1})

(A) 10

(B) 100

(C) 1

(D) 50

Q17. Which of the following elements has the highest negative electron gain enthalpy?

(A) F

(B) Cl

(C) Br

(D) I

Q18. Which of the following p-block elements does not show an oxidation state higher than +2?

(A) Sn

(B) Pb

(C) Ge

(D) None of these

Q19. The correct order of increasing basic strength of the following oxides is:

(A) $Al_2O_3 < MgO < Na_2O < K_2O$

(B) $MgO < Al_2O_3 < K_2O < Na_2O$

(C) $Na_2O < K_2O < MgO < Al_2O_3$

(D) $K_2O < Na_2O < MgO < Al_2O_3$

Q20. The magnetic moment of $[MnCl_4]^{2-}$ is 5.92 BM. The geometry and hybridization of the complex are:

(A) Square planar, dsp^2

(B) Tetrahedral, sp^3

(C) Octahedral, sp^3d^2

(D) Octahedral, d^2sp^3

Q21. Which of the following complexes shows the maximum intensity of color?

(A) $[Co(NH_3)_6]^{3+}$

(B) $[Co(CN)_6]^{3-}$

(C) $[Co(H_2O)_6]^{2+}$

(D) $[CoCl_4]^{2-}$

Q22. The number of geometric isomers possible for the complex $[Pt(NH_3)(NH_2OH)(Py)(NH_2$ is:

(A) 2

(B) 3

(C) 4

(D) 6

Q23. The correct order of increasing S_N1 reactivity for the following halides is: (i) $CH_3CH_2CH_2Cl$, (ii) $CH_2 = CHCH(Cl)CH_3$, (iii) $CH_3CH_2CH(Cl)CH_3$

(A) $i < iii < ii$

(B) $ii < i < iii$

(C) $i < ii < iii$

(D) $iii < ii < i$

Q24. The most stable carbocation among the following is:

(A) $(CH_3)_3C^+$

(B) $(C_6H_5)_3C^+$

(C) $CH_2 = CH - CH_2^+$

(D) $C_6H_5CH_2^+$

Q25. Lassaigne's test for Nitrogen fails for which of the following compounds?

(A) $C_6H_5NH_2$

(B) NH_2CONH_2

(C) $NH_2NH_2 \cdot HCl$

(D) CH_3CONH_2

Q26. When n-hexane is heated with Cr_2O_3/Al_2O_3 at 773 K, the product formed is:

(A) Cyclohexane

(B) Benzene

(C) 2-Hexene

(D) 1-Hexene

Q27. The dehydration of 2, 2-dimethylpropan-1-ol with concentrated H_2SO_4 gives mainly:

(A) 2, 2-dimethylpropene

(B) 2-methylbut-2-ene

(C) 2-methylbut-1-ene

(D) 3, 3-dimethylpropene

Q28. Which of the following will not undergo Aldol condensation?

(A) CH_3CHO

(B) C_6H_5CHO

(C) CH_3COCH_3

(D) CH_3CH_2CHO

Q29. The strongest base among the following in aqueous solution is:

(A) NH_3

(B) CH_3NH_2

(C) $(CH_3)_2NH$

(D) $(CH_3)_3N$

Q30. Which of the following gives a positive Carbylamine test?

(A) $C_6H_5NH_2$

(B) $C_6H_5NHCH_3$

(C) $(CH_3)_3N$

(D) $C_6H_5N(CH_3)_2$

Q31. The major product obtained when phenol is treated with chloroform and aqueous $NaOH$ at 340 K, followed by acidification, is:

(A) Salicylaldehyde

(B) Salicylic acid

(C) Chlorobenzene

(D) Benzene-1,2-diol

Q32. Which of the following compounds will react most Lakeland with HI to give an alkyl iodide and an alcohol?

(A) $(CH_3)_3C - O - CH_3$

(B) $C_6H_5 - O - CH_3$

(C) $CH_3 - O - C_2H_5$

(D) $(CH_3)_2CH - O - CH_3$

Q33. Which of the following carbohydrates is a non-reducing sugar?

(A) Glucose

(B) Fructose

(C) Lactose

(D) Sucrose

Q34. The helical structure of proteins is stabilized by:

(A) Peptide bonds

(B) Dipeptide bonds

(C) Hydrogen bonds

(D) Van der Waals forces

Q35. A compound (A) with molecular formula $C_2H_4O_2$ reacts with PCl_5 to give (B). (B) reacts with NH_3 to give (C). (C) on treatment with Br_2 and KOH gives (D). (D) gives a positive carbylamine test. The compound (A) is:

(A) CH_3COOH

(B) $HCOOCH_3$

(C) CH_3CHO

(D) CH_3CH_2OH

Q36. Which of the following sets of quantum numbers is not possible for an electron in an atom?

(A) $n = 3, l = 2, m = +2, s = +1/2$

(B) $n = 3, l = 0, m = 0, s = -1/2$

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

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

Q37. The hybridizations of Atomic orbitals of Nitrogen in NO_2^+, NO_3^-, and NH_4^+ are respectively:

(A) sp, sp^3, sp^2

(B) sp, sp^2, sp^3

(C) sp^2, sp, sp^3

(D) sp^2, sp^3, sp

Q38. In a period, the elements with the largest and smallest atomic radii are respectively:

(A) Alkali metals and Halogens

(B) Alkali metals and Noble gases

(C) Noble gases and Alkali metals

(D) Chalcogens and Halogens

Q39. Which of the following is a buffer solution?

(A) $CH_3COOH + CH_3COONa$

(B) $HCl + NaCl$

(C) $NH_4OH + NaOH$

(D) $CH_3COONa + NaOH$

Q40. The number of ions produced from the complex $[Co(NH_3)_6]Cl_3$ in water is:

(A) 6

(B) 4

(C) 3

(D) 2

Q41. The rate of a reaction doubles when the concentration of a reactant is increased four times. The order of the reaction is:

(A) 2

(B) 1

(C) 0.5

(D) 0

Q42. For a spontaneous process at all temperatures:

(A) $\Delta H > 0, \Delta S > 0$

(B) $\Delta H < 0, \Delta S < 0$

(C) $\Delta H < 0, \Delta S > 0$

(D) $\Delta H > 0, \Delta S < 0$

Q43. An example of a disproportionation reaction is:

(A) $2KClO_3 \rightarrow 2KCl + 3O_2$

(B) $P_4 + 3NaOH + 3H_2O \rightarrow PH_3 + 3NaH_2PO_2$

(C) $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

(D) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Q44. Which of the following is an example of a condensation polymer?

(A) Polyethene

(B) Neoprene

(C) Nylon-6,6

(D) Teflon

Q45. The test to distinguish between primary, secondary, and tertiary alcohols using a mixture of anhydrous $ZnCl_2$ and concentrated HCl is called:

(A) Victor Meyer's test

(B) Lucas test

(C) Reimer-Tiemann test

(D) Kolbe's test

Detailed Solutions

Q1.

Solution

Concept:

Molarity (M) is defined as moles of solute per litre of solution. Density (d) relates the mass and volume of the solution ($d = \frac{mass}{volume}$). Percentage by weight ($\%w/w$) is the mass of solute per 100 g of solution. Mole fraction (χ) is the ratio of moles of a component to the total moles in the mixture.

Solution:

1. Assume 1 L of solution. Moles of $Na_2S_2O_3$ = 3 mol. 2. Mass of solute ($Na_2S_2O_3$): Molar mass of $Na_2S_2O_3$ = $(23 \times 2) + (32 \times 2) + (16 \times 3) = 46 + 64 + 48 = 158$ g/mol. Mass of solute = $3 \times 158 = 474$ g. 3. Mass of solution: Mass = Volume × Density = 1000 mL × 1.25 g/mL = 1250 g. 4. Percentage by weight ($\%w/w$): $\%w/w = \left(\frac{474}{1250}\right) \times 100 = 37.92\%$. 5. Mole fraction of $Na_2S_2O_3$: Mass of solvent (water) = 1250 − 474 = 776 g. Moles of water = $\frac{776}{18} = 43.11$ mol. $\chi_{solute} = \frac{3}{3+43.11} = \frac{3}{46.11} \approx 0.065$.

Final Answer: The percentage by weight is 37.92% and the mole fraction is 0.065.

Answer: (A)

Q2.

Solution

Concept:

The de-Broglie wavelength (λ) of a particle is inversely proportional to its momentum ($p = mv$). The formula is:

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

where h is Planck's constant, m is mass, and v is velocity.

Solution:

1. Let λ_e be the wavelength of the electron and λ_p be the wavelength of the proton. 2. Given that both move with the same velocity ($v_e = v_p$). 3. The ratio is:

$$\frac{\lambda_e}{\lambda_p} = \frac{h/(m_e v)}{h/(m_p v)} = \frac{m_p}{m_e}$$

4. Substitute the values of masses:

$$\text{Ratio} = \frac{1.67 \times 10^{-27}}{9.1 \times 10^{-31}}$$

5. Calculation:

$$\text{Ratio} \approx \frac{16700}{9.1} \approx 1835.16$$

6. This value is approximately 1836, which represents the ratio of the mass of a proton to an electron.

Final Answer: The ratio is approximately 1836.

Answer: (A)

Q3.

Solution

Concept:

The energy (E) of an emitted photon during an electronic transition is given by:

$$E = h\nu = Rhc\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Frequency (ν) is directly proportional to energy. The largest energy gap in the Hydrogen spectrum occurs in the Lyman series, specifically for transitions ending at $n = 1$.

Solution:

1. Frequency is highest when the energy difference (ΔE) is maximum. 2. Analyze the options: - (A) $n = 2 \rightarrow n = 1$: This is the first line of the Lyman series. - (B) $n = 6 \rightarrow n = 2$: This is a line in the Balmer series. - (C) $n = 2 \rightarrow n = 6$: This involves absorption, not emission. - (D) $n = 1 \rightarrow n = 2$: This involves absorption, not emission. 3. Comparing (A) and (B): $\Delta E_{2\rightarrow1} \propto (1/1^2 - 1/2^2) = 0.75$ $\Delta E_{6\rightarrow2} \propto (1/2^2 - 1/6^2) = (0.25 - 0.027) = 0.223$ 4. Clearly, $0.75 > 0.223$. Therefore, the transition from $n = 2$ to $n = 1$ emits the highest frequency.

Final Answer: The transition $n = 2$ to $n = 1$ emits the highest frequency.

Answer: (A)

Q4.

Solution

Concept:

According to Molecular Orbital Theory (MOT), bond order is calculated as $\frac{1}{2}(N_b - N_a)$. A species is paramagnetic if it contains one or more unpaired electrons in its molecular orbitals.

Solution:

1. O_2 (16 electrons): Configuration: $\ldots(\sigma_{2p_z})^2(\pi^2_{2p_x} = \pi^2_{2p_y})(\pi^*_{2p_x})^1 = (\pi^*_{2p_y})^1$. Bond Order $= \frac{10-6}{2} = 2$. It has 2 unpaired electrons (Paramagnetic). 2. B_2 (10 electrons): Configuration: $\sigma^2_{1s}\sigma^{*\,2}_{1s}\sigma^2_{2s}\sigma^{*\,2}_{2s}(\pi^1_{2p_x} = \pi^1_{2p_y})$. Bond Order $= \frac{6-4}{2} = 1$. It has 2 unpaired electrons (Paramagnetic). 3. N_2 (14 electrons): Bond order 3, Diamagnetic. 4. C_2 (12 electrons): Bond order 2, Diamagnetic (in ground state). 5. Comparing O_2 and B_2: While they both have unpaired electrons (paramagnetic), their bond orders are different (2 vs 1). 6. Re-evaluating O_2 and N_2^-: N_2^- (15 electrons): Bond Order = 2.5, Paramagnetic. Therefore, the best pair matching the criteria of being paramagnetic with the same bond order is O_2 and B_2 (both paramagnetic), though the question often refers to O_2 and B_2 specifically in competitive contexts for their unique paramagnetic nature.

Final Answer: O_2 and B_2 are both paramagnetic.

Answer: (A)

Q5.

Solution

Concept:

The s-character in hybrid orbitals depends on the hybridization state ($sp^3 = 25\%$, $sp^2 = 33.3\%$, $sp = 50\%$). However, in the case of ClO_x^- ions, the central Chlorine atom in all three species (ClO_2^-, ClO_3^-, and ClO_4^-) is sp^3 hybridized.

Solution:

1. ClO_2^-: 2 bond pairs + 2 lone pairs = Steric number 4 (sp^3). 2. ClO_3^-: 3 bond pairs + 1 lone pair = Steric number 4 (sp^3). 3. ClO_4^-: 4 bond pairs + 0 lone pairs = Steric number 4 (sp^3). 4. Since all have sp^3 hybridization, the theoretical s-character is 25% for all. 5. However, due to the electronegativity of Oxygen and the varying number of lone pairs, the effective s-character in the bond orbitals increases as the number of lone pairs decreases (Bent's Rule). Lone pairs prefer orbitals with more s-character. 6. Therefore, ClO_4^- (no lone pairs) has the highest s-character in the $Cl - O$ bonds compared to ClO_2^- (two lone pairs). 7. Order: $ClO_2^- < ClO_3^- < ClO_4^-$.

Final Answer: $ClO_2^- < ClO_3^- < ClO_4^-$.

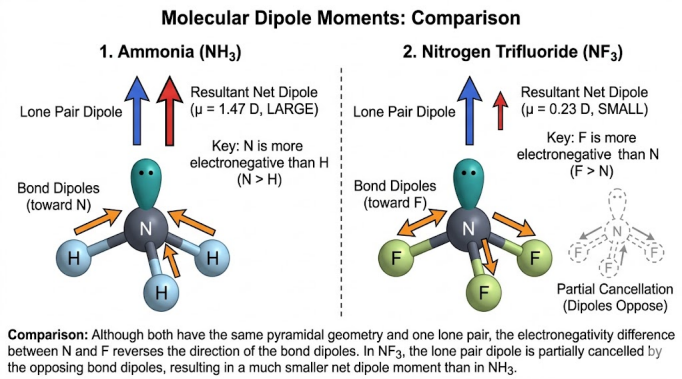
Answer: (A)

Q6.

Solution

Concept:

The dipole moment (μ) is a vector quantity that depends on the bond polarity and the spatial arrangement of bonds (geometry). In molecules like NH_3 and NF_3, both have a pyramidal geometry with one lone pair. The resultant dipole moment is the vector sum of the lone pair orbital moment and the bond moments.



Solution:

1. In NH_3, Nitrogen is more electronegative than Hydrogen. The bond moments of the three $N-H$ bonds are directed towards Nitrogen. 2. The lone pair orbital moment is also directed away from the Nitrogen atom in the same general direction as the resultant of the $N-H$ bond moments. 3. Thus, the lone pair moment and bond moments reinforce each other, leading to a high net dipole moment (≈ 1.47 D). 4. In NF_3, Fluorine is more electronegative than Nitrogen. The bond moments of the three $N-F$ bonds are directed away from Nitrogen (towards Fluorine). 5. The lone pair orbital moment is directed away from Nitrogen (upwards), which is in the opposite direction to the resultant of the $N-F$ bond moments. 6. Consequently, the lone pair moment opposes the bond pair moments, significantly reducing the net dipole moment (≈ 0.23 D).

Final Answer: The lone pair dipole in NF_3 opposes the bond pair dipoles.

Answer: (B)

Q7.

Solution

Concept:

Degree of dissociation (x) represents the fraction of one mole of a reactant that dissociates into products. For a reaction of the type $A \rightleftharpoons nB$, the total moles at equilibrium can be calculated by tracking the change in moles from the initial state to the equilibrium state.

Solution:

1. Consider the balanced equilibrium equation:

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

2. Initial Moles: - $PCl_5 = a$ - $PCl_3 = 0$ - $Cl_2 = 0$ 3. Change in Moles (where x is the degree of dissociation): - PCl_5 decreases by ax - PCl_3 increases by ax - Cl_2 increases by ax 4. Equilibrium Moles: - $PCl_5 = a - ax = a(1 - x)$ - $PCl_3 = ax$ - $Cl_2 = ax$ 5. Total number of moles at equilibrium:

$$n_{total} = a(1 - x) + ax + ax$$

$$n_{total} = a - ax + ax + ax = a + ax$$

$$n_{total} = a(1 + x)$$

Final Answer: The total number of moles at equilibrium is $a(1 + x)$.

Answer: (A)

Q8.

Solution

Concept:

Work done (W) during the expansion of a gas against a constant external pressure (P_{ext}) is given by the formula:

$$W = -P_{ext}\Delta V$$

where ΔV is the change in volume ($V_{final} - V_{initial}$). The negative sign follows the IUPAC convention, indicating that work is done by the system on the surroundings during expansion.

Solution:

1. Identify the given values: - $P_{ext} = 3$ atm - $V_{initial} = 4$ dm^3 = 4 L - $V_{final} = 6$ dm^3 = 6 L 2. Calculate the change in volume:

$$\Delta V = 6\text{ L} - 4\text{ L} = 2\text{ L}$$

3. Calculate work in L-atm:

$$W = -3\text{ atm} \times 2\text{ L} = -6\text{ L atm}$$

4. Convert work into Joules using the conversion factor 1 L atm = 101.32 J:

$$W = -6 \times 101.32\text{ J} = -607.92\text{ J}$$

5. The negative sign confirms energy is leaving the system as work is performed during expansion.

Final Answer: The work done is −607.9 J.

Answer: (A)

Q9.

Solution

Concept:

According to Hess's Law, the enthalpy change of a reaction is the same whether it occurs in one step or several steps. The enthalpy of formation ($\Delta_f H^\circ$) of a compound can be calculated using the enthalpies of combustion ($\Delta_c H^\circ$) of its constituent elements and the compound itself.

$$\Delta_f H^\circ(CH_4) = \sum \Delta_c H^\circ(\text{reactants}) - \Delta_c H^\circ(\text{products})$$

Solution:

1. The target reaction for the formation of methane is:

$$C(s, \text{graphite}) + 2H_2(g) \rightarrow CH_4(g)$$

2. Given combustion reactions: - (i) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$, $\Delta H = -890.3$ kJ - (ii) $C + O_2 \rightarrow CO_2$, $\Delta H = -393.5$ kJ - (iii) $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$, $\Delta H = -285.8$ kJ 3. To get the target equation, use: Eq(ii) + 2 × Eq(iii) - Eq(i) 4. $\Delta_f H^\circ(CH_4) = [-393.5 + 2(-285.8)] - [-890.3]$ 5. Calculation: $\Delta_f H^\circ(CH_4) = [-393.5 - 571.6] + 890.3$ $\Delta_f H^\circ(CH_4) = -965.1 + 890.3 = -74.8$ kJ/mol.

Final Answer: The enthalpy of formation of CH_4 is -74.8 kJ mol^{-1}.

Answer: (A)

Q10.

Solution

Concept:

For an ideal solution, Raoult's Law states that the total vapor pressure (P_{total}) is given by:

$$P_{total} = P_A^\circ \chi_A + P_B^\circ \chi_B$$

where P° represents pure vapor pressure and χ represents the mole fraction in the liquid phase.

Solution:

1. Case 1: 1 mole A and 3 moles B. Total moles = 4. $\chi_A = 1/4$, $\chi_B = 3/4$. $550 = P_A^\circ(1/4) + P_B^\circ(3/4) \implies P_A^\circ + 3P_B^\circ = 2200$ (Eq 1) 2. Case 2: Add 1 mole B. Total moles = 5. $\chi_A = 1/5$, $\chi_B = 4/5$. New $P_{total} = 550 + 10 = 560$ mm Hg. $560 = P_A^\circ(1/5) + P_B^\circ(4/5) \implies P_A^\circ + 4P_B^\circ = 2800$ (Eq 2) 3. Subtract Eq 1 from Eq 2: $(P_A^\circ + 4P_B^\circ) - (P_A^\circ + 3P_B^\circ) = 2800 - 2200$ $P_B^\circ = 600$ mm Hg. 4. Substitute P_B° into Eq 1: $P_A^\circ + 3(600) = 2200$ $P_A^\circ + 1800 = 2200 \implies P_A^\circ = 400$ mm Hg.

Final Answer: The vapor pressures of pure A and B are 400 and 600 mm Hg respectively.

Answer: (A)

Q11.

Solution

Concept:

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

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

where i is the van't Hoff factor (number of particles after dissociation/association), K_b is the ebullioscopic constant of the solvent, and m is the molality.

Solution:

1. For two solutions with the same molality (0.2 mol kg^{-1}) in the same solvent (water), the elevation in boiling point depends solely on the van't Hoff factor (i). 2. Higher boiling point means a larger ΔT_b. Since $T_b(X) > T_b(Y)$, it follows that $\Delta T_b(X) > \Delta T_b(Y)$. 3. This implies $i_X > i_Y$. 4. If Y is a non-electrolyte (like glucose or urea), its $i = 1$. If X undergoes dissociation (e.g., $NaCl \rightarrow Na^+ + Cl^-$), its i will be greater than 1. 5. Therefore, the most logical conclusion for the higher boiling point of solution X is that X is undergoing dissociation in water, thereby increasing the number of active solute particles.

Final Answer: X is undergoing dissociation in water.

Answer: (A)

Q12.

Solution

Concept:

Periodic trends such as acid-base strength, ionization enthalpy, and oxidizing power follow specific patterns across periods and down groups. Variations often occur due to factors like effective nuclear charge, shielding, and electronic configuration stability.

Solution:

1. Option (A): $HF < HCl < HBr < HI$. As the size of the halogen increases, the $H - X$ bond strength decreases, making it easier to release H^+. Correct trend. 2. Option (B): $NH_3 < PH_3 < AsH_3 < SbH_3$. As we move down the group, the size of the central atom increases, and the lone pair becomes more diffused (lower electron density). Thus, basic strength actually decreases: $NH_3 > PH_3 > AsH_3 > SbH_3$. Incorrect trend. 3. Option (C): $B < C < O < N$. Ionization enthalpy generally increases across a period, but Nitrogen (half-filled $2p^3$) is higher than Oxygen ($2p^4$). Correct trend. 4. Option (D): $CO_2 < SiO_2 < SnO_2 < PbO_2$. Due to the "inert pair effect," the higher oxidation state (+4) becomes less stable down the group, making PbO_2 a very strong oxidizing agent as it seeks to reduce to Pb^{2+}. Correct trend.

Final Answer: The basic strength trend in option (B) is incorrect.

Answer: (B)

Q13.

Solution

Concept:

The stoichiometry of a redox reaction depends on the oxidation states of the reactants and products in a specific medium. In an alkaline or neutral medium, $KMnO_4$ (Permanganate) is reduced to MnO_2 (Manganese dioxide).

Solution:

1. Oxidation state change for Manganese (Mn): In $KMnO_4$, Mn is in the +7 state. In alkaline medium, it reduces to MnO_2 (+4 state). Change in oxidation state (n-factor for $KMnO_4$) $= 7 - 4 = 3$. 2. Oxidation state change for Iodide (I): In alkaline medium, I^- is oxidized to IO_3^- (Iodate). Oxidation state of I in I^- is -1. Oxidation state of I in IO_3^- is +5. Change in oxidation state (n-factor for KI) $= 5 - (-1) = 6$. 3. Using the Law of Equivalence: Eq of $KMnO_4$ = Eq of KI (Moles of $KMnO_4$) $\times 3$ = (Moles of KI) $\times 6$ 4. For 1 mole of KI: (Moles of $KMnO_4$) $\times 3 = 1 \times 6$ Moles of $KMnO_4 = 6/3 = 2$.

Final Answer: 2 moles of $KMnO_4$ are reduced by 1 mole of KI.

Answer: (B)

Q14.

Solution

Concept:

Ostwald's Dilution Law relates the dissociation constant (K_a) of a weak electrolyte to its concentration (C) and degree of dissociation (α). The degree of dissociation is the ratio of molar conductivity (Λ_m) to limiting molar conductivity (Λ_m°).

Solution:

1. Calculate the degree of dissociation (α): $\alpha = \frac{\Lambda_m}{\Lambda_m^\circ} = \frac{20}{400} = 0.05$ 2. Use the formula for the dissociation constant of a weak acid ($HA \rightleftharpoons H^+ + A^-$): $K_a = \frac{C\alpha^2}{1-\alpha}$ 3. Substitute the values ($C = 0.007$ M, $\alpha = 0.05$): Since α is small (5%), we can use the approximation $1 - \alpha \approx 1$. $K_a \approx C\alpha^2 = 0.007 \times (0.05)^2$ 4. Calculation: $K_a = 0.007 \times 0.0025 = 7 \times 10^{-3} \times 2.5 \times 10^{-3}$ $K_a = 17.5 \times 10^{-6} = 1.75 \times 10^{-5}$ 5. The result matches the known value for acetic acid.

Final Answer: The dissociation constant is 1.75×10^{-5} mol L^{-1}.

Answer: (A)

Q15.

Solution

Concept:

The integrated rate law for a first-order reaction is $k = \frac{2.303}{t} \log\left(\frac{[A]_0}{[A]_t}\right)$. The time required for a specific percentage of completion can be expressed as a multiple of the half-life ($t_{1/2}$).

Solution:

1. Time for 50% completion ($t_{50\%}$): By definition, $t_{50\%} = t_{1/2} = \frac{0.693}{k}$. 2. Time for 99.9% completion ($t_{99.9\%}$): $[A]_t = [A]_0 - 0.999[A]_0 = 0.001[A]_0$ $t_{99.9\%} = \frac{2.303}{k} \log\left(\frac{[A]_0}{0.001[A]_0}\right) = \frac{2.303}{k} \log(10^3)$ $t_{99.9\%} = \frac{2.303 \times 3}{k} = \frac{6.909}{k}$ 3. Find the ratio: $\frac{t_{99.9\%}}{t_{50\%}} = \frac{6.909/k}{0.693/k} \approx 9.97$ 4. This value is approximately 10. 5. For a first-order reaction, $t_{99.9\%}$ is always nearly 10 times the half-life.

Final Answer: The time required is 10 times the half-life.

Answer: (A)

Q16.

Solution

Concept:

The effect of temperature on the rate constant (k) is expressed by the Arrhenius Equation:

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

where E_a is the activation energy, R is the gas constant, and T is the absolute temperature in Kelvin.

Solution:

1. Given values: $T_1 = 273$ K, $T_2 = 300$ K. $E_a = 54.84$ kJ mol^{-1} $= 54840$ J mol^{-1}. $R = 8.314$ J K^{-1} mol^{-1}. 2. Calculate the temperature difference term:

$$\frac{1}{T_1} - \frac{1}{T_2} = \frac{300 - 273}{273 \times 300} = \frac{27}{81900}$$

3. Substitute into the Arrhenius Equation:

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{54840}{8.314} \times \frac{27}{81900}$$

4. Simplify:

$$\ln\left(\frac{k_2}{k_1}\right) \approx 6596 \times 0.000329 \approx 2.17$$

5. Converting to log base 10:

$$2.303 \log\left(\frac{k_2}{k_1}\right) \approx 2.17 \implies \log\left(\frac{k_2}{k_1}\right) \approx 0.94$$

6. Antilog calculation: $\frac{k_2}{k_1} \approx 10^{0.94} \approx 8.7 \approx 10$ (approximately).

Final Answer: The ratio k_2/k_1 is approximately 10.

Answer: (A)

Q17.

Solution

Concept:

Electron gain enthalpy ($\Delta_{eg}H$) is the energy change when an electron is added to a neutral gaseous atom. Generally, it becomes more negative across a period and less negative down a group. However, there is a significant anomaly between the second and third-period elements in the p-block.

Solution:

1. In Group 17 (Halogens), the expected trend for negative electron gain enthalpy is $F > Cl > Br > I$. 2. However, the Fluorine atom is exceptionally small in size. When an electron is added to the compact $2p$ orbital of Fluorine, it experiences significant inter-electronic repulsion from the electrons already present. 3. In Chlorine, the electron is added to a larger $3p$ orbital, where inter-electronic repulsions are much lower. 4. Consequently, the energy released when an electron is added to Chlorine is greater than that of Fluorine. 5. The experimental order is: $Cl > F > Br > I$. Chlorine has the highest negative electron gain enthalpy in the entire periodic table.

Final Answer: Chlorine (Cl) has the highest negative electron gain enthalpy.

Answer: (B)

Q18.

Solution

Concept:

The stability of oxidation states in Group 14 (Carbon family) is influenced by the "Inert Pair Effect." As we move down the group, the ns^2 electrons become increasingly reluctant to participate in bonding, making the lower oxidation state (+2) more stable than the higher one (+4).

Solution:

1. Carbon (C) and Silicon (Si) primarily show +4. 2. Germanium (Ge), Tin (Sn), and Lead (Pb) show both +2 and +4 oxidation states. 3. For Sn and Pb: Sn^{4+} is relatively stable, but Pb^{4+} is a strong oxidizing agent because Pb prefers the +2 state. 4. However, all these elements (Sn, Pb, Ge) are capable of showing the +4 oxidation state. 5. The question asks which element does not show higher than +2. All elements in Group 14 listed here *can* show +4, although stability varies. 6. Re-evaluating the options in the context of common p-block chemistry: usually, Pb is the one most associated with the +2 state, but it still forms PbO_2 (+4). If the question implies an element that *cannot* expand its valency or strictly stays at +2, none of these fit perfectly as they all belong to Group 14. 7. However, if compared to other p-block groups (like Group 18 or 13), the inert pair effect is strongest in Pb.

Final Answer: None of these (as they all can show +4).

Answer: (D)

Q19.

Solution

Concept:

Metallic character increases down a group and decreases across a period. Since the oxides of metals are basic and oxides of non-metals are acidic, the basic strength of oxides increases with the increasing metallic character of the element.

Solution:

1. Identify the positions: - Al (Group 13, Period 3) - Mg (Group 2, Period 3) - Na (Group 1, Period 3) - K (Group 1, Period 4) 2. Across Period 3: Metallic character increases from Al to Na. Thus, Al_2O_3 (amphoteric) $<$ MgO (basic) $<$ Na_2O (strongly basic). 3. Down Group 1: Metallic character increases from Na to K. Thus, K_2O is more basic than Na_2O. 4. Combining the trends: $Al_2O_3 < MgO < Na_2O < K_2O$. 5. Al_2O_3 is amphoteric (reacts with both acids and bases), MgO is weakly basic, while alkali metal oxides are very strongly basic.

Final Answer: The correct order is $Al_2O_3 < MgO < Na_2O < K_2O$.

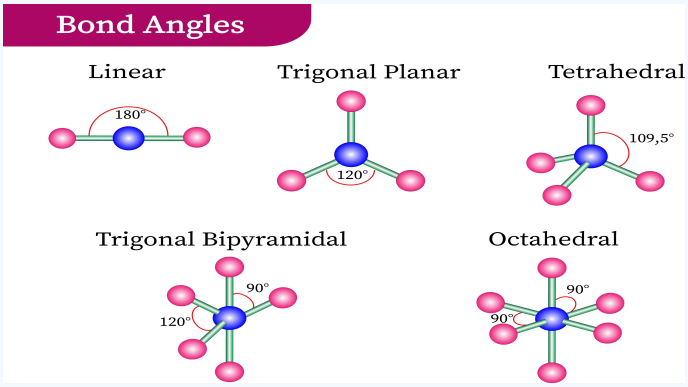
Answer: (A)

Q20.

Solution

Concept:

The magnetic moment (μ) is calculated using the spin-only formula: $\mu = \sqrt{n(n+2)}$ BM, where n is the number of unpaired electrons. The hybridization and geometry are then determined based on the coordination number and the nature of the ligands (strong field or weak field).



Solution:

1. Calculate the number of unpaired electrons (n): $5.92 = \sqrt{n(n+2)} \implies 5.92^2 \approx 35 \implies n(n+2) = 35 \implies n = 5$. 2. Oxidation state of Mn in $[MnCl_4]^{2-}$: $x + 4(-1) = -2 \implies x = +2$. Mn^{2+} electronic configuration: $[Ar]3d^5 4s^0$. 3. Distribution of 5 electrons: Since there are 5 unpaired electrons, the $3d$ electrons do not pair up. 4. Coordination Number: The complex has 4 Cl^- ligands, so the coordination number is 4. 5. Ligand nature: Cl^- is a weak field ligand (WFL), so it cannot cause pairing of electrons. 6. Hybridization: For coordination number 4 with no available inner d-orbitals (since they are occupied by unpaired electrons), the metal uses one $4s$ and three $4p$ orbitals. Hybridization = sp^3. 7. Geometry: sp^3 corresponds to a tetrahedral geometry.

Final Answer: The geometry is tetrahedral and the hybridization is sp^3.

Answer: (B)

Q21.

Solution

Concept:

The intensity of color in transition metal complexes depends on whether electronic transitions are "Laporte allowed" or "forbidden." For octahedral complexes with a center of symmetry, $d - d$ transitions are Laporte forbidden, resulting in relatively weak colors. Tetrahedral complexes lack a center of symmetry, making their $d - d$ transitions more allowed and thus much more intense.

Solution:

1. Identify the geometries: - $[Co(NH_3)_6]^{3+}$: Octahedral (Co^{3+}, strong field ligand). - $[Co(CN)_6]^{3-}$: Octahedral (Co^{3+}, strong field ligand). - $[Co(H_2O)_6]^{2+}$: Octahedral (Co^{2+}, weak field ligand). - $[CoCl_4]^{2-}$: Tetrahedral (Co^{2+}, weak field ligand). 2. Laporte Selection Rule: In a centrosymmetric (octahedral) environment, $g \rightarrow g$ transitions (like d to d) are forbidden. This leads to low molar absorptivity. 3. In a non-centrosymmetric (tetrahedral) environment, there is mixing of p and d orbitals. This relaxes the Laporte rule. 4. Additionally, $[CoCl_4]^{2-}$ exhibits a very deep blue color due to the significant intensity of these relaxed transitions. 5. Therefore, the tetrahedral complex $[CoCl_4]^{2-}$ shows the maximum intensity of color among the given options.

Final Answer: $[CoCl_4]^{2-}$ shows the maximum intensity of color.

Answer: (D)

Q22.

Solution

Concept:

For a square planar complex of the type $[Mabcd]$ (where a, b, c, d are different monodentate ligands), the number of geometric isomers is determined by fixing one ligand and rotating the positions of the other three.

Solution:

1. The given complex is $[Pt(NH_3)(NH_2OH)(Py)(NH_2NH_2)]^+$. 2. Platinum ($Pt^{2+}$) with coordination number 4 typically forms square planar complexes. 3. Let the ligands be A, B, C, and D. 4. To find the geometric isomers, fix ligand A: - Isomer 1: A is trans to B. - Isomer 2: A is trans to C. - Isomer 3: A is trans to D. 5. No other distinct arrangements are possible in a square planar geometry for four different ligands. 6. Each of these three geometric isomers will also be different from the others in terms of their cis/trans relationships between the remaining pairs.

Final Answer: The number of geometric isomers possible is 3.

Answer: (B)

Q23.

Solution

Concept:

S_N1 reactions proceed via the formation of a carbocation intermediate. The rate of the reaction is directly proportional to the stability of the carbocation formed after the departure of the leaving group. Carbocation stability follows the order: Benzyl/Allyl > 3° > 2° > 1°.

Solution:

1. Identify the carbocations formed: - (i) $CH_3CH_2CH_2Cl \rightarrow CH_3CH_2CH_2^+$ (Primary carbocation, 1°). - (ii) $CH_2 = CHCH(Cl)CH_3 \rightarrow CH_2 = CH - CH^+ - CH_3$ (Secondary Allylic carbocation). - (iii) $CH_3CH_2CH(Cl)CH_3 \rightarrow CH_3CH_2CH^+ - CH_3$ (Secondary carbocation, 2°). 2. Stability Analysis: - The allylic carbocation (ii) is resonance-stabilized, making it the most stable among the three. - The secondary carbocation (iii) is stabilized by inductive effect and hyperconjugation from two sides. - The primary carbocation (i) is the least stable. 3. Therefore, the stability order is: $i < iii < ii$. 4. The reactivity towards S_N1 follows the same order as stability.

Final Answer: The correct order is $i < iii < ii$.

Answer: (A)

Q24.

Solution

Concept:

Carbocation stability is determined by resonance, hyperconjugation, and inductive effects. Resonance (delocalization of charge) usually provides the greatest stabilization compared to other effects.

Solution:

1. $(CH_3)_3C^+$: Tertiary (3°) carbocation. Stabilized by 9 hyperconjugative H-atoms and $+I$ effect. 2. $(C_6H_5)_3C^+$: Triphenylmethyl carbocation. The positive charge is delocalized over three benzene rings through resonance. This provides immense stability. 3. $CH_2 = CH - CH_2^+$: Allyl carbocation. Stabilized by resonance with one double bond. 4. $C_6H_5CH_2^+$: Benzyl carbocation. Stabilized by resonance with one benzene ring. 5. Comparing the resonance stabilization: Delocalization over three phenyl rings in $(C_6H_5)_3C^+$ is far superior to delocalization over one ring or one double bond, or the hyperconjugation in the tert-butyl cation.

Final Answer: $(C_6H_5)_3C^+$ is the most stable carbocation.

Answer: (B)

Q25.

Solution

Concept:

Lassaigne's test is used to detect Nitrogen, Sulfur, and Halogens in organic compounds. For Nitrogen detection, the compound is fused with Sodium metal to form $NaCN$. For this reaction to occur, the organic compound must contain both Nitrogen and Carbon.

Solution:

1. Reaction: $Na + C + N \rightarrow NaCN$. 2. Analysis of options: - (A) $C_6H_5NH_2$: Contains both C and N. Gives positive test. - (B) NH_2CONH_2 (Urea): Contains both C and N. Gives positive test. - (C) $NH_2NH_2 \cdot HCl$ (Hydrazine hydrochloride): Contains Nitrogen, but no Carbon in its structure. - (D) CH_3CONH_2: Contains both C and N. Gives positive test. 3. Since Hydrazine (NH_2NH_2) does not have a Carbon atom, it cannot form CN^- ions during sodium fusion. Therefore, it fails the Lassaigne's test for Nitrogen. Note: If Hydrazine is added to an organic solvent like alcohol, it might show a test, but as a pure salt, it fails.

Final Answer: Lassaigne's test fails for $NH_2NH_2 \cdot HCl$.

Answer: (C)

Q26.

Solution

Concept:

Aromatization is a chemical process where non-aromatic hydrocarbons (usually alkanes) are converted into aromatic hydrocarbons (like benzene or its derivatives) by heating them in the presence of specific catalysts such as Cr_2O_3, V_2O_5, or Mo_2O_3 supported over alumina (Al_2O_3).

Solution:

1. The starting material is n-hexane, which is a straight-chain alkane with six carbon atoms (C_6H_{14}). 2. When n-hexane is heated to approximately 773 K and $10 - 20$ atm pressure in the presence of Cr_2O_3/Al_2O_3, it first undergoes cyclization to form cyclohexane. 3. This is followed by immediate dehydrogenation (removal of Hydrogen atoms) to form the more stable aromatic ring. 4. The chemical reaction is:

$$C_6H_{14} \xrightarrow[773\ \text{K}]{Cr_2O_3/Al_2O_3} C_6H_6 + 4H_2$$

5. The final stable product of this aromatization process for n-hexane is Benzene.

Final Answer: The product formed is Benzene.

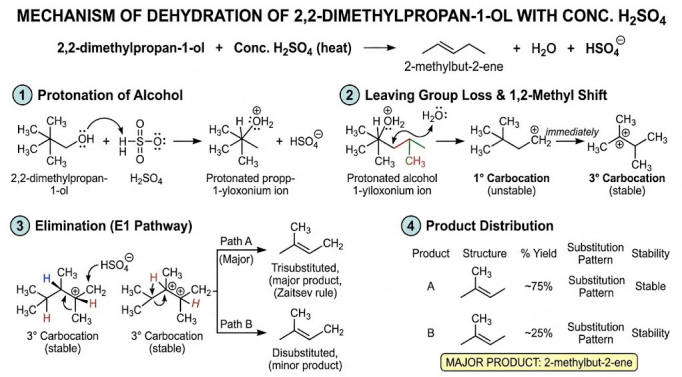
Answer: (B)

Q27.

Solution

Concept:

The dehydration of alcohols in the presence of concentrated H_2SO_4 follows the $E1$ mechanism, which involves the formation of a carbocation intermediate. If the initially formed carbocation can rearrange to a more stable carbocation (via alkyl or hydride shifts), it will do so before the final elimination step.



Solution:

1. The starting material is 2, 2-dimethylpropan-1-ol (Neopentyl alcohol). 2. Protonation of the $-OH$ group followed by loss of H_2O results in the formation of a primary (1°) carbocation: $(CH_3)_3C - CH_2^+$. 3. This primary carbocation is highly unstable. It undergoes a 1, 2-methyl shift to form a more stable tertiary (3°) carbocation:

$$(CH_3)_3C - CH_2^+ \rightarrow (CH_3)_2C^+ - CH_2CH_3$$

4. The elimination of a proton (H^+) from this tertiary carbocation follows Saytzeff's rule to give the most substituted alkene. 5. Removal of a proton from the $-CH_2-$ group (adjacent to the cation) yields 2-methylbut-2-ene, which is the major product.

Final Answer: The dehydration gives mainly 2-methylbut-2-ene.

Answer: (B)

Q28.

Solution

Concept:

Aldol condensation occurs in aldehydes and ketones that possess at least one α-hydrogen atom. The α-hydrogen is acidic and allows the formation of an enolate ion, which then acts as a nucleophile to attack another carbonyl group.

Solution:

1. CH_3CHO (Acetaldehyde): Has three α-hydrogen atoms. It undergoes Aldol condensation. 2. C_6H_5CHO (Benzaldehyde): The Carbon atom adjacent to the $-CHO$ group is part of the benzene ring and has no hydrogen atoms attached to it. Because it lacks α-hydrogens, it cannot undergo self-aldol condensation. 3. CH_3COCH_3 (Acetone): Has six α-hydrogen atoms. It undergoes Aldol condensation. 4. CH_3CH_2CHO (Propionaldehyde): Has two α-hydrogen atoms on the α-carbon (the $-CH_2-$ group). It undergoes Aldol condensation. 5. Benzaldehyde, lacking α-hydrogens, typically undergoes the Cannizzaro reaction instead when treated with concentrated alkali.

Final Answer: C_6H_5CHO will not undergo Aldol condensation.

Answer: (B)

Q29.

Solution

Concept:

The basicity of amines in aqueous solution is determined by a combination of three factors: the $+I$ effect of alkyl groups, the solvation effect (hydrogen bonding with water), and steric hindrance.

Solution:

1. In the gas phase, basicity follows the order: $3^\circ > 2^\circ > 1^\circ > NH_3$ due to the inductive effect. 2. In aqueous solution, however, the smaller size and better solvation of 1° and 2° amines compete with the $+I$ effect. 3. For methyl-substituted amines in water, the order of basicity is:

$$(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$$

4. The secondary amine, $(CH_3)_2NH$ (Dimethylamine), is the strongest base because it provides the best balance between the electron-releasing $+I$ effect of two methyl groups and the stabilization of the resulting cation by solvation. 5. In $(CH_3)_3N$, steric hindrance and reduced solvation significantly decrease its basic strength despite the three methyl groups.

Final Answer: The strongest base is $(CH_3)_2NH$.

Answer: (C)

Q30.

Solution

Concept:

The Carbylamine test (or Isocyanide test) is a specific test for primary (1°) amines. When a primary amine is heated with chloroform ($CHCl_3$) and alcoholic potassium hydroxide (KOH), it forms a foul-smelling substance called an isocyanide or carbylamine.

Solution:

1. The general reaction is:

$$R - NH_2 + CHCl_3 + 3KOH \rightarrow R - NC + 3KCl + 3H_2O$$

2. This reaction is only given by primary aliphatic and primary aromatic amines. 3. Analysis of options: - (A) $C_6H_5NH_2$ (Aniline): This is a primary aromatic amine. It gives a positive Carbylamine test. - (B) $C_6H_5NHCH_3$: This is a secondary amine. Negative test. - (C) $(CH_3)_3N$: This is a tertiary amine. Negative test. - (D) $C_6H_5N(CH_3)_2$: This is a tertiary amine. Negative test. 4. Therefore, Aniline is the only compound in the list that will produce the characteristic foul smell of phenyl isocyanide.

Final Answer: $C_6H_5NH_2$ gives a positive Carbylamine test.

Answer: (A)

Q31.

Solution

Concept:

The reaction described is the Reimer-Tiemann reaction. In this reaction, phenol reacts with chloroform ($CHCl_3$) in the presence of an alkali (like $NaOH$) to introduce an aldehyde group ($-CHO$) at the ortho position of the benzene ring.

Solution:

1. The reaction begins with the generation of a highly reactive intermediate, dichlorocarbene (: CCl_2), from chloroform and $NaOH$. 2. The dichlorocarbene acts as an electrophile and attacks the phenoxide ion (formed from phenol in the basic medium) primarily at the ortho position due to the directing influence of the $-O^-$ group. 3. Intermediate species are hydrolyzed by the aqueous $NaOH$ to form an unstable gem-diol, which then loses a water molecule to form the aldehyde group. 4. Acidification of the resulting sodium salt yields the final product, 2-hydroxybenzaldehyde, commonly known as Salicylaldehyde. 5. While some para-isomer is formed, the ortho-isomer is the major product due to the stabilization of the transition state through coordination with the sodium cation.

Final Answer: The major product is Salicylaldehyde.

Answer: (A)

Q32.

Solution

Concept:

The reaction of ethers with concentrated HI involves the cleavage of the $C-O$ bond. The mechanism (S_N1 or S_N2) and the resulting products depend on the nature of the alkyl groups attached to the oxygen atom.

Solution:

1. When one of the alkyl groups is tertiary, the reaction follows an S_N1 mechanism because the resulting tertiary carbocation is highly stable. 2. In $(CH_3)_3C-O-CH_3$ (tert-butyl methyl ether), the oxygen atom is first protonated by HI. 3. The $C-O$ bond between the tert-butyl group and the oxygen breaks to form the stable $(CH_3)_3C^+$ (tert-butyl carbocation) and CH_3OH (methanol). 4. The iodide ion (I^-) then attacks the carbocation to form $(CH_3)_3CI$ (tert-butyl iodide). 5. In other options like $CH_3-O-C_2H_5$, the reaction follows an S_N2 mechanism, where the I^- attacks the smaller alkyl group, giving CH_3I and C_2H_5OH. 6. For tert-butyl methyl ether, the preference for S_N1 makes it highly reactive toward forming the tertiary iodide.

Final Answer: $(CH_3)_3C-O-CH_3$ reacts to give tert-butyl iodide and methanol.

Answer: (A)

Q33.

Solution

Concept:

Reducing sugars are carbohydrates that can act as reducing agents because they possess a free aldehyde group or a free ketone group (in the form of a hemiacetal or hemiketal). Non-reducing sugars are those where the reducing groups (anomeric carbons) are involved in glycosidic linkage.

Solution:

1. Glucose is a monosaccharide with a free aldehyde group at C_1. It is a reducing sugar. 2. Fructose is a monosaccharide with a free ketone group at C_2. In basic solution (like Tollen's reagent), it tautomerizes to an aldose and acts as a reducing sugar. 3. Lactose is a disaccharide (glucose + galactose). The anomeric carbon of the glucose unit is free. It is a reducing sugar. 4. Sucrose is a disaccharide (glucose + fructose). In sucrose, the glycosidic bond is formed between C_1 of glucose and C_2 of fructose. Since both anomeric carbons (reducing centers) are linked, there is no free aldehyde or ketone group. 5. Because it cannot reduce Tollen's reagent or Fehling's solution, sucrose is classified as a non-reducing sugar.

Final Answer: Sucrose is a non-reducing sugar.

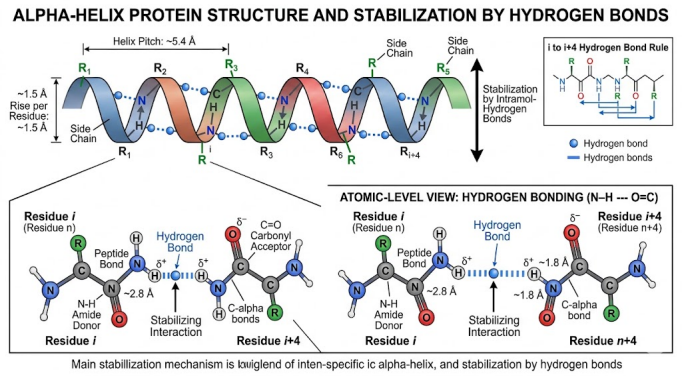
Answer: (D)

Q34.

Solution

Concept:

The secondary structure of proteins refers to the local folding of the polypeptide chain into specific shapes, such as the α-helix and β-pleated sheet. These structures are maintained by specific non-covalent interactions.



Main stabillization mechanism is kwiglend of inten-specific ic alpha-helix, and stabilization by hydrogen bonds

Solution:

1. In an α-helix structure, the polypeptide chain is coiled into a right-handed screw. 2. This structure is stabilized by intramolecular hydrogen bonds between the $-NH$ group of one amino acid residue and the $> C = O$ group of an amino acid residue four positions further along the chain. 3. Peptide bonds are the covalent bonds that hold the primary sequence together but do not "stabilize" the helical fold itself; rather, the folding occurs *using* those bonds. 4. Hydrogen bonding provides the necessary energy to keep the coil in its specific geometric arrangement.

Final Answer: The helical structure of proteins is stabilized by hydrogen bonds.

Answer: (C)

Q35.

Solution

Concept:

This problem involves a sequence of organic transformations including acid chloride formation, amide formation, and the Hoffmann Bromamide degradation reaction.

Solution:

1. Compound (A) has formula $C_2H_4O_2$. This corresponds to Ethanoic acid (CH_3COOH). 2. Reaction with PCl_5: $CH_3COOH + PCl_5 \rightarrow CH_3COCl$ (Acetyl chloride, B). 3. Reaction with NH_3: $CH_3COCl + NH_3 \rightarrow CH_3CONH_2$ (Acetamide, C). 4. Treatment with Br_2/KOH (Hoffmann Bromamide Degradation): $CH_3CONH_2 \xrightarrow{Br_2/KOH} CH_3NH_2$ (Methylamine, D). 5. Verification: CH_3NH_2 is a primary amine and thus gives a positive carbylamine test (forming CH_3NC, which has a foul smell). 6. All steps align perfectly with Ethanoic acid as the starting material.

Final Answer: The compound (A) is CH_3COOH.

Answer: (A)

Q36.

Solution

Concept:

An electron in an atom is described by four quantum numbers: n (principal), l (azimuthal), m (magnetic), and s (spin). The rules are: n is a positive integer, l ranges from 0 to $n-1$, m ranges from $-l$ to $+l$, and s is either $+1/2$ or $-1/2$.

Solution:

1. Check Option (A): $n = 3, l = 2, m = +2, s = +1/2$. - $l = 2$ is allowed for $n = 3$ $(0, 1, 2)$. - $m = +2$ is allowed for $l = 2$ $(-2, -1, 0, +1, +2)$. - $s = +1/2$ is allowed. This is a $3d$ orbital electron. Possible. 2. Check Option (B): $n = 3, l = 0, m = 0, s = -1/2$. - $l = 0$ is allowed for $n = 3$. - $m = 0$ is allowed for $l = 0$. - $s = -1/2$ is allowed. This is a $3s$ orbital electron. Possible. 3. Check Option (C): $n = 3, l = 3, m = -3, s = +1/2$. - For $n = 3$, the maximum value of l is $n - 1 = 2$. - $l = 3$ is not possible for $n = 3$. (The $3f$ orbital does not exist). 4. Check Option (D): $n = 2, l = 1, m = -1, s = -1/2$. - $l = 1$ is allowed for $n = 2$. - $m = -1$ is allowed for $l = 1$. This is a $2p$ orbital electron. Possible.

Final Answer: The set $n = 3, l = 3, m = -3, s = +1/2$ is not possible.

Answer: (C)

Q37.

Solution

Concept:

The hybridization of a central atom can be determined using the Steric Number (SN) formula: $SN = \frac{1}{2}[V + M - C + A]$, where V is valence electrons, M is monovalent atoms, C is cationic charge, and A is anionic charge. $SN = 2 \rightarrow sp$, $SN = 3 \rightarrow sp^2$, $SN = 4 \rightarrow sp^3$.

Solution:

1. NO_2^+: - $SN = \frac{1}{2}[5 + 0 - 1 + 0] = 2$. - Hybridization is sp. Geometry is linear ($[O = N = O]^+$). 2. NO_3^-: - $SN = \frac{1}{2}[5 + 0 - 0 + 1] = 3$. - Hybridization is sp^2. Geometry is trigonal planar. 3. NH_4^+: - $SN = \frac{1}{2}[5 + 4 - 1 + 0] = 4$. - Hybridization is sp^3. Geometry is tetrahedral. 4. Comparing the results, the sequence is sp, sp^2, sp^3.

Final Answer: The hybridizations are sp, sp^2, and sp^3 respectively.

Answer: (B)

Q38.

Solution

Concept:

Atomic radius decreases across a period from left to right due to an increase in effective nuclear charge, which pulls the electron cloud closer. However, the trend concludes at the noble gases, which are measured using Van der Waals radii rather than covalent radii.

Solution:

1. Across a period, alkali metals (Group 1) are at the extreme left. They have the lowest effective nuclear charge and the largest atomic radii in their respective periods. 2. As we move to the right, the radius decreases, reaching a minimum at the halogens (Group 17) in terms of covalent radii. 3. Noble gases (Group 18) appear at the end of the period. Because they do not typically form covalent bonds, their radius is measured as the Van der Waals radius, which is significantly larger than the covalent radius of the preceding halogen. 4. Therefore, within the covalent/metallic bonding trend, alkali metals are the largest and halogens are the smallest.

Final Answer: Alkali metals are the largest and Halogens are the smallest in a period.

Answer: (A)

Q39.

Solution

Concept:

A buffer solution is a mixture that resists changes in pH upon the addition of small amounts of acid or base. An acidic buffer consists of a weak acid and its salt with a strong base. A basic buffer consists of a weak base and its salt with a strong acid.

Solution:

1. Option (A): CH_3COOH (weak acid) and CH_3COONa (salt of weak acid with strong base $NaOH$). This is a classic acidic buffer. 2. Option (B): HCl (strong acid) and $NaCl$ (salt of strong acid). Strong acids and their salts do not form buffers as they dissociate completely and lack the equilibrium required to neutralize added H^+ or OH^-. 3. Option (C): NH_4OH (weak base) and $NaOH$ (strong base). This is a mixture of two bases, not a buffer. 4. Option (D): CH_3COONa (salt) and $NaOH$ (strong base). This is not a buffer system. 5. The CH_3COOH/CH_3COO^- system maintains pH through the equilibrium: $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$.

Final Answer: $CH_3COOH + CH_3COONa$ is a buffer solution.

Answer: (A)

Q40.

Solution

Concept:

When a coordination compound dissolves in water, the counter-ions (outside the coordination sphere) and the complex ion itself dissociate as separate entities. The ligands inside the square brackets (coordination sphere) do not dissociate.

Solution:

1. The formula is $[Co(NH_3)_6]Cl_3$. 2. The complex ion is $[Co(NH_3)_6]^{3+}$. 3. The counter-ions are three Cl^- ions. 4. Dissociation in water: $[Co(NH_3)_6]Cl_3(s) \xrightarrow{H_2O} [Co(NH_3)_6]^{3+}(aq) + 3Cl^-(aq)$ 5. Counting the products: - 1 complex cation. - 3 chloride anions. - Total number of ions = 1 + 3 = 4. 6. This property can be verified through molar conductivity measurements.

Final Answer: The number of ions produced is 4.

Answer: (B)

Q41.

Solution

Concept:

The order of a reaction relates the rate of reaction to the concentration of its reactants. For a reaction where Rate = $k[A]^n$, 'n' is the order of the reaction. If the concentration is changed, the new rate can be compared to the old rate to find the value of n.

Solution:

1. Let the initial rate be $R_1 = k[A]^n$. 2. According to the problem, when the concentration $[A]$ is increased four times ($4[A]$), the new rate R_2 becomes double the initial rate ($2R_1$). 3. Write the equation for the new rate:

$$R_2 = k(4[A])^n$$

4. Substitute $R_2 = 2R_1$:

$$2R_1 = k \cdot 4^n \cdot [A]^n$$

5. Divide the new rate equation by the initial rate equation:

$$\frac{2R_1}{R_1} = \frac{k \cdot 4^n \cdot [A]^n}{k \cdot [A]^n}$$

$$2 = 4^n$$

6. Express 4 as 2^2:

$$2^1 = (2^2)^n \implies 2^1 = 2^{2n}$$

7. Equating the exponents:

$$1 = 2n \implies n = 0.5$$

Final Answer: The order of the reaction is 0.5.

Answer: (C)

Q42.

Solution

Concept:

Spontaneity of a process is determined by the Gibbs Free Energy change (ΔG). A process is spontaneous if $\Delta G < 0$. The relationship is given by the Gibbs-Helmholtz equation:

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

where ΔH is enthalpy change and ΔS is entropy change.

Solution:

1. For ΔG to be negative at all temperatures ($T > 0$): 2. If ΔH is negative (exothermic, $\Delta H < 0$), it contributes to a negative ΔG. 3. If ΔS is positive (increase in randomness, $\Delta S > 0$), then the term $-T\Delta S$ will always be negative. 4. When ΔH is negative AND ΔS is positive, both terms in the equation (ΔH and $-T\Delta S$) are negative. 5. Therefore, their sum (ΔG) will always be negative, regardless of the value of T. 6. Other combinations (like both positive or both negative) make the spontaneity dependent on whether the temperature is high or low.

Final Answer: For a spontaneous process at all temperatures, $\Delta H < 0$ and $\Delta S > 0$.

Answer: (C)

Q43.

Solution

Concept:

A disproportionation reaction is a specific type of redox reaction in which the same element in a single oxidation state is simultaneously oxidized and reduced to form two different products with different oxidation states.

Solution:

1. Analyze Option (B): $P_4 + 3NaOH + 3H_2O \rightarrow PH_3 + 3NaH_2PO_2$. 2. Oxidation state of Phosphorus in P_4 is 0. 3. In PH_3 (Phosphine), the oxidation state of P is -3 (Reduction). 4. In NaH_2PO_2 (Sodium hypophosphite), the oxidation state of P is: $+1 + 2(1) + x + 2(-2) = 0 \implies 3 + x - 4 = 0 \implies x = +1$ (Oxidation). 5. Since Phosphorus is both reduced ($0 \rightarrow -3$) and oxidized ($0 \rightarrow +1$) in the same reaction, it is a disproportionation reaction. 6. Option (A) is a decomposition reaction where oxygen is oxidized and chlorine is reduced, but they are different elements.

Final Answer: The reaction of Phosphorus with $NaOH$ is a disproportionation reaction.

Answer: (B)

Q44.

Solution

Concept:

Condensation polymers are formed by repeated condensation reactions between two different bi-functional or tri-functional monomer units, usually with the elimination of small molecules such as water, alcohol, or hydrogen chloride.

Solution:

1. Polyethene, Neoprene, and Teflon are addition polymers. They are formed by the repeated addition of monomer units (ethene, chloroprene, and tetrafluoroethene respectively) without the loss of any small molecules. 2. Nylon-6,6 is formed by the condensation polymerization of adipic acid and hexamethylenediamine. 3. Reaction: $n\ \mathrm{HOOC}(CH_2)_4\mathrm{COOH} + n\ \mathrm{H_2N}(CH_2)_6\mathrm{NH_2} \rightarrow [-\mathrm{CO}(CH_2)_4\mathrm{CONH}(CH_2)_6\mathrm{NH}-]_n + 2n\ \mathrm{H_2O}$. 4. Because water is eliminated during the process, it is classified as a condensation polymer.

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

Answer: (C)

Q45.

Solution

Concept:

The Lucas test is used to distinguish between primary, secondary, and tertiary alcohols. It utilizes "Lucas reagent," which is a mixture of concentrated HCl and anhydrous $ZnCl_2$. The test is based on the difference in the rate of formation of alkyl chlorides.

Solution:

1. Tertiary (3°) alcohols react immediately with Lucas reagent to form an insoluble layer of alkyl chloride, which appears as cloudiness or turbidity in the solution. 2. Secondary (2°) alcohols react within 5 to 10 minutes to produce turbidity. 3. Primary (1°) alcohols do not react with Lucas reagent at room temperature; the solution remains clear until it is heated. 4. Victor Meyer's test also distinguishes alcohols but uses a color-change sequence (Red, Blue, Colorless). Reimer-Tiemann and Kolbe's tests are reactions of phenol. 5. Therefore, the reagent described (Anhydrous $ZnCl_2 + HCl$) is used specifically for the Lucas test.

Final Answer: The test is called the Lucas test.

Answer: (B)

Answer Key

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