

KIITEE Chemistry Sample Paper – 2

Duration: 50 Minutes

Maximum Marks: 160

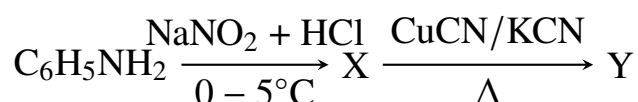
Instructions

- This paper contains **40** Multiple Choice Questions (Single Correct Answer), modelled on the Chemistry portion of **KIITEE** entrance.
- Each correct answer carries **+4 marks**. There is **-1 mark per wrong answer**; unattempted questions score **0**
- Only **one** option is correct. Choose carefully.
- Syllabus level: **Class 11 12 (10+2) Chemistry — Organic Chemistry, Physical Chemistry, Inorganic Chemistry, Environmental Chemistry, Polymers Biomolecules**
- The test is computer based. Personal calculators, log tables, mobile phones, and other electronic gadgets are strictly prohibited.

Q1. An organic compound with molecular formula $C_5H_{10}O$ does not reduce Tollens' reagent but forms a crystalline yellow precipitate with 2,4-dinitrophenylhydrazine. Upon controlled reduction with $NaBH_4$, it yields a secondary alcohol that can be dehydrated to form an alkene. Which of the following is the most likely structural formula of the original compound?

- (A) Pentanal
 (B) Pentan-3-one
 (C) 2-Methylbutanal
 (D) 2,2-Dimethylpropanal

Q2. Consider the following organic transformation sequence:



Identify the final organic product Y formed in this reaction sequence.



- (A) Chlorobenzene
- (B) Benzoic acid
- (C) Benzonitrile
- (D) Benzylamine

Q3. For a certain first-order reaction, the value of the rate constant k is found to be $6.93 \times 10^{-3} \text{ s}^{-1}$. What is the time required for the initial concentration of the reactant to be reduced to exactly one-eighth of its original value?

- (A) 100 s
- (B) 200 s
- (C) 300 s
- (D) 400 s

Q4. Which of the following complex ions is expected to exhibit the maximum value of spin-only magnetic moment based on crystal field theory?

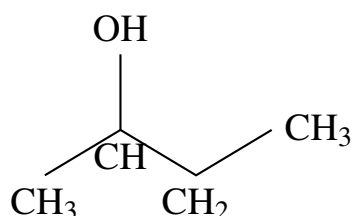
- (A) $[\text{Fe}(\text{CN})_6]^{3-}$
- (B) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
- (C) $[\text{Co}(\text{NH}_3)_6]^{3+}$
- (D) $[\text{Ni}(\text{CN})_4]^{2-}$

Q5. The concentration of a pollutant in a water sample is determined to be 15 parts per million (ppm) by mass. Express this concentration as a percentage by mass of the pollutant in the given sample.

- (A) 0.015%
- (B) 0.0015%
- (C) 0.00015%
- (D) 1.5%

Q6. An organic molecule contains a specific arrangement of atoms shown in the structural diagram below:





When this secondary alcohol is treated with anhydrous CrO₃ in pyridine, which major functional group is produced?

- (A) Carboxylic acid
- (B) Aldehyde
- (C) Ketone
- (D) Ester

Q7. At a given temperature, the vapor pressure of pure liquid solvent A is 100 mmHg and that of pure liquid solvent B is 150 mmHg. An ideal solution is prepared by mixing 2 moles of A and 3 moles of B. Determine the total vapor pressure of this solution.

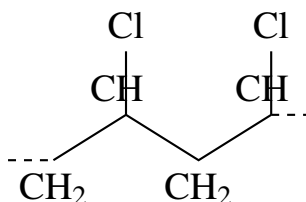
- (A) 120 mmHg
- (B) 125 mmHg
- (C) 130 mmHg
- (D) 140 mmHg

Q8. Among the following pairs of coordination compounds, which pair represents examples of ionization isomerism?

- (A) [Co(NH₃)₅SO₄]Br and [Co(NH₃)₅Br]SO₄
- (B) [Co(NH₃)₆][Cr(CN)₆] and [Cr(NH₃)₆][Co(CN)₆]
- (C) [Co(NH₃)₅(NO₂)]Cl₂ and [Co(NH₃)₅(ONO)]Cl₂
- (D) [Pt(NH₃)₂Cl₂] and [Pt(NH₃)₄][PtCl₄]

Q9. The repeating structural unit of a widely used synthetic polymer is represented below:





What is the standard chemical name of the monomer used to synthesize this addition polymer?

- (A) Tetrafluoroethylene
- (B) Vinyl chloride
- (C) Styrene
- (D) Caprolactam

Q10. The standard reduction potentials of three metallic elements X, Y, and Z are +0.52 V, -2.87 V, and -0.44 V respectively. Arrange these three metals in the correct order of their increasing reducing power.

- (A) $X < Z < Y$
- (B) $Y < Z < X$
- (C) $Z < X < Y$
- (D) $X < Y < Z$

Q11. Which of the following arrangements accurately reflects the correct increasing order of the atomic/ionic radii for the specified chemical species?

- (A) $Mg^{2+} < Na^+ < F^- < O^{2-}$
- (B) $O^{2-} < F^- < Na^+ < Mg^{2+}$
- (C) $Na^+ < Mg^{2+} < O^{2-} < F^-$
- (D) $F^- < O^{2-} < Mg^{2+} < Na^+$

Q12. An organic compound with molecular formula C_7H_8 undergoes free radical chlorination in the presence of sunlight to give compound A. Compound A on subsequent hydrolysis with aqueous NaOH at high temperature yields compound B. When B is oxidized with alkaline $KMnO_4$, it produces benzoic acid. Identify compound A.

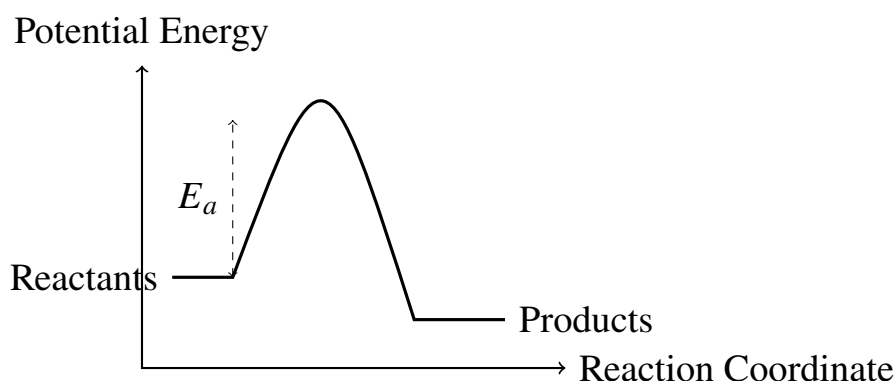


- (A) Benzyl chloride
- (B) Chlorobenzene
- (C) o-Chlorotoluene
- (D) m-Chlorotoluene

Q13. The physical adsorption of a gas on a solid surface (physisorption) is a spontaneous process. Which of the following thermodynamic conditions is universally true for this process?

- (A) $\Delta H > 0$ and $\Delta S > 0$
- (B) $\Delta H < 0$ and $\Delta S > 0$
- (C) $\Delta H < 0$ and $\Delta S < 0$
- (D) $\Delta H > 0$ and $\Delta S < 0$

Q14. Consider the potential energy profile for a chemical reaction shown in the diagram below:



If a positive catalyst is added to this reaction system, how will the potential energy profile change?

- (A) It increases the energy level of the reactants.
 - (B) It lowers the energy level of the products.
 - (C) It decreases the activation energy (E_a) by providing an alternative pathway.
 - (D) It increases the activation energy (E_a) to make the intermediate more stable.
- Q15.** Which of the following oxoacids of phosphorus contains a direct, single covalent phosphorus-phosphorus (P – P) bond in its molecular structure?



- (A) Hophosphorous acid (H_3PO_2)
- (B) Pyrophosphoric acid ($\text{H}_4\text{P}_2\text{O}_7$)
- (C) Hypophosphoric acid ($\text{H}_4\text{P}_2\text{O}_6$)
- (D) Orthophosphoric acid (H_3PO_4)

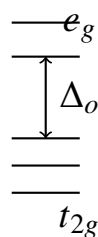
Q16. The primary structure of a protein is fundamentally determined and maintained by which of the following chemical linkages?

- (A) Hydrogen bonds
- (B) Peptide bonds
- (C) Disulfide linkages
- (D) Ionic interactions

Q17. During the quantitative estimation of an organic compound, 0.30 g of the substance yielded 0.44 g of carbon dioxide (CO_2) upon complete combustion. Determine the percentage of carbon present in the compound.

- (A) 40.0%
- (B) 27.3%
- (C) 33.3%
- (D) 12.0%

Q18. The crystal field splitting energy (Δ_o) for an octahedral complex can be affected by the nature of the ligand. Consider the following simple schematic splitting diagram:



Which of the following sequences represents the correct order of increasing field strength (Δ_o values) for the given ligands?

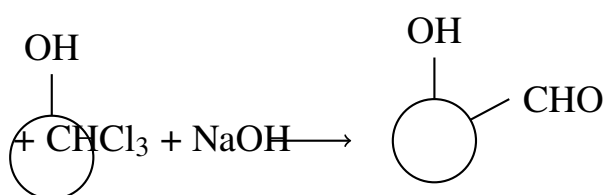


- (A) $I^- < Cl^- < F^- < CN^-$
 (B) $CN^- < F^- < Cl^- < I^-$
 (C) $F^- < Cl^- < I^- < CN^-$
 (D) $I^- < CN^- < Cl^- < F^-$

Q19. Which of the following chemical species contains at least one atom that exhibits an oxidation state of +6?

- (A) MnO_4^-
 (B) $Cr_2O_7^{2-}$
 (C) $Ni(CO)_4$
 (D) $Fe(CN)_6^{3-}$

Q20. An organic compound undergoes a classical name reaction as outlined in the mechanistic representation below:



What is the standard name assigned to this specific organic chemical transformation?

- (A) Reimer-Tiemann reaction
 (B) Kolbe's reaction
 (C) Friedel-Crafts acylation
 (D) Cannizzaro reaction

Q21. The rate constant for a specific chemical reaction is found to double when the temperature is raised from 300 K to 310 K. Calculate the approximate activation energy (E_a) for this reaction in kJ mol^{-1} . (Use $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ and $\ln 2 \approx 0.693$)

- (A) 53.6 kJ mol^{-1}

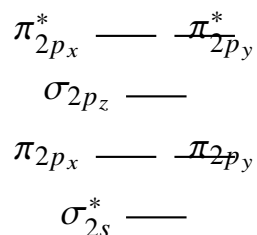


- (B) 26.8 kJ mol^{-1}
 (C) $107.2 \text{ kJ mol}^{-1}$
 (D) 8.31 kJ mol^{-1}

Q22. Which of the following organic structures represents an allylic halide molecule?

- (A) 3-Chloroprop-1-ene
 (B) 1-Chloroprop-1-ene
 (C) 2-Chloroprop-1-ene
 (D) Chlorobenzene

Q23. The molecular orbital configuration of a homonuclear diatomic molecule dictates its properties. Consider the following standard molecular orbital energy ranking layout:



Based on molecular orbital theory, which of the following species has a bond order of exactly 2.5 and exhibits paramagnetic behavior?

- (A) O_2
 (B) N_2^+
 (C) O_2^{2-}
 (D) C_2

Q24. Which of the following industrial polymers is synthesized via an addition polymerization mechanism involving a conjugated diene monomer?

- (A) Buna-S
 (B) Terylene
 (C) Nylon-6



(D) Bakelite

Q25. In a face-centered cubic (fcc) crystalline lattice of identical spherical atoms, what is the exact percentage of total volume that is occupied by the spheres?

(A) 52.4%

(B) 68.0%

(C) 74.0%

(D) 26.0%

Q26. The principal chemical species responsible for the phenomenon of global warming and the greenhouse effect in the Earth's troposphere are:

(A) Nitrogen and Oxygen

(B) Carbon dioxide and Methane

(C) Ozone and Sulfur dioxide

(D) Argon and Nitrous oxide

Q27. When phenol is treated with excess bromine water ($\text{Br}_2/\text{H}_2\text{O}$), it immediately forms a characteristic white precipitate. What is the chemical identity of this product?

(A) 2-Bromophenol

(B) 4-Bromophenol

(C) 2,4,6-Tribromophenol

(D) 2,4-Dibromophenol

Q28. For the specific equilibrium process $\text{PCl}_5(g) \rightleftharpoons \text{PCl}_3(g) + \text{Cl}_2(g)$, which of the following actions will cause the equilibrium position to shift toward the reactant side (left) without changing the value of the equilibrium constant?

(A) Increasing the total volume of the reaction container

(B) Adding an inert gas at constant volume

(C) Increasing the total pressure by reducing container volume



(D) Removing chlorine gas continuously from the mixture

Q29. Which of the following electronic transitions in a atomic hydrogen system will result in the emission of a photon belonging to the visible light region (Balmer series)?

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

(B) From $n = 3$ to $n = 2$

(C) From $n = 4$ to $n = 1$

(D) From $n = 5$ to $n = 3$

Q30. What is the correct chemical name of the primary linkage that connects individual nucleotide units together to form the backbone of a nucleic acid like DNA or RNA?

(A) Glycosidic linkage

(B) Peptide linkage

(C) 3',5'-Phosphodiester linkage

(D) Hydrogen bonding

Q31. An organic compound reacts with benzenesulfonyl chloride (Hinsberg reagent) to form a solid precipitate that remains completely insoluble in an aqueous solution of KOH. What is the classification of the original amine compound?

(A) Primary amine

(B) Secondary amine

(C) Tertiary amine

(D) Quaternary ammonium salt

Q32. An electrochemical cell setup is operating under standard state conditions. Calculate the standard Gibbs free energy change (ΔG°) in kJ mol^{-1} for a cell reaction where $n = 2$ moles of electrons are transferred, given that the standard cell potential (E°_{cell}) is +1.10 V. (Use Faraday's constant $F = 96500 \text{ C mol}^{-1}$)



- (A) $-212.3 \text{ kJ mol}^{-1}$
- (B) $+212.3 \text{ kJ mol}^{-1}$
- (C) $-106.1 \text{ kJ mol}^{-1}$
- (D) $-424.6 \text{ kJ mol}^{-1}$

Q33. Among the following transition metal oxides, which one exhibits highly pronounced metallic conduction and ferromagnetic properties similar to metallic iron?

- (A) TiO_2
- (B) CrO_2
- (C) V_2O_3
- (D) Fe_2O_3

Q34. Which of the following organic compounds will completely fail to undergo the classical aldol condensation reaction when treated with a dilute aqueous base?

- (A) Acetaldehyde
- (B) Propanal
- (C) Benzaldehyde
- (D) Acetone

Q35. The ionic conductance of alkali metal cations in an aqueous solution follows a distinct trend due to varying degrees of hydration. Which of the following pathways correctly orders these ions by increasing molar ionic conductivity?

- (A) $\text{Li}^+ < \text{Na}^+ < \text{K}^+ < \text{Rb}^+$
- (B) $\text{Rb}^+ < \text{K}^+ < \text{Na}^+ < \text{Li}^+$
- (C) $\text{Na}^+ < \text{Li}^+ < \text{K}^+ < \text{Rb}^+$
- (D) $\text{Li}^+ < \text{K}^+ < \text{Na}^+ < \text{Rb}^+$

Q36. The fundamental hybridisation and spatial geometry of the central atom in the xenon fluorouranium compound XeF_4 are correctly designated as:



- (A) sp^3 , Tetrahedral
- (B) sp^3d , Trigonal bipyramidal
- (C) sp^3d^2 , Square planar
- (D) sp^3d^2 , Octahedral

Q37. What is the correct value of the van 't Hoff factor (i) for a dilute aqueous solution of potassium sulfate [K_2SO_4] assuming that the salt undergoes complete 100% ionic dissociation?

- (A) 1
- (B) 2
- (C) 3
- (D) 4

Q38. The atmospheric condition known as classical smog, which typically develops in cool, humid climates during winter seasons, is chemically characterized as being:

- (A) Highly oxidizing in nature due to high peroxide concentrations
- (B) Reducing in nature due to the presence of sulfur dioxide and carbon soot
- (C) Completely neutral and harmless to biological entities
- (D) Composed predominantly of chlorofluorocarbons and nitric acid vapors

Q39. When an ideal gas undergoes a completely reversible and isothermal expansion process into a vacuum, the total work done (w) by the system on the surroundings is mathematically equal to:

- (A) $w = -nRT \ln(V_2/V_1)$
- (B) $w = 0$
- (C) $w = \Delta U$
- (D) $w = q_p$

Q40. Which of the following organic structures contains a chiral carbon atom and can exhibit optical activity?



- (A) 2-Chlorobutane
- (B) 1-Chlorobutane
- (C) 2-Chloropropane
- (D) Chlorocyclohexane



Detailed Solutions

Q1.

Solution

Concept:

To determine the structure of an unknown carbonyl compound, specific organic qualitative tests must be applied. Compounds containing a carbonyl group ($C = O$) react with 2,4-dinitrophenylhydrazine (2,4-DNP) to form highly crystalline yellow or orange precipitates known as 2,4-dinitrophenylhydrazones. Tollens' reagent specifically oxidizes aldehydes to carboxylic acids while reducing silver ions to metallic silver, serving as a classic test to differentiate aldehydes from ketones.

Solution:

- The given compound has the molecular formula $C_5H_{10}O$, which fits the general formula for aliphatic aldehydes or ketones ($C_nH_{2n}O$).
- Since the compound forms a yellow crystalline precipitate with 2,4-DNP, it must contain a carbonyl functional group.
- The compound does not reduce Tollens' reagent, which explicitly eliminates all aldehyde options. Therefore, the compound is a ketone rather than an aldehyde. This rules out pentanal, 2-methylbutanal, and 2,2-dimethylpropanal.
- Reducing a ketone using sodium borohydride ($NaBH_4$) yields a secondary alcohol. Pentan-3-one undergoes reduction to yield pentan-3-ol, which is a secondary alcohol.
- Acid-catalyzed dehydration of pentan-3-ol removes a water molecule to form the alkene pent-2-ene. This fits all parameters of the problem statement.

Final Answer: Pentan-3-one

Answer: (B)

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Q2.

Solution**Concept:**

Aromatic primary amines can be converted into synthetic intermediates through a process called diazotization. Treating aniline with nitrous acid at freezing temperatures produces a highly reactive diazonium salt. This stable intermediate can undergo several substitution pathways. Replacing the diazonium group with a cyano group using copper(I) cyanide is a classical Sandmeyer reaction path that creates a new carbon-carbon bond on an aromatic ring.

Solution:

- The starting material in the given sequence is aniline ($C_6H_5NH_2$), which is a primary aromatic amine.
- In the first step, aniline reacts with a mixture of sodium nitrite ($NaNO_2$) and hydrochloric acid (HCl) at an ice-cold temperature range of $0 - 5^\circ C$. This generates nitrous acid in situ, which converts aniline into benzenediazonium chloride ($C_6H_5N_2^+Cl^-$). Thus, intermediate X is benzenediazonium chloride.
- In the second step, the diazonium salt is treated with copper(I) cyanide ($CuCN$) in the presence of potassium cyanide (KCN) under gentle heating.
- This represents the classic Sandmeyer reaction where the highly nucleophilic cyano group (CN^-) attacks the aromatic ring, displacing the excellent leaving group nitrogen gas (N_2).
- The substitution of the diazonium group by the cyano group produces benzonitrile (C_6H_5CN) as the final organic product Y.

Final Answer: Benzonitrile

Answer: (C)

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Q3.

Solution**Concept:**

Chemical kinetics defines the rate of a first-order reaction based solely on the concentration of a single reactant. The time required for a specific fraction of a reactant to decompose can be calculated using the integrated first-order rate law. An important parameter is the half-life ($t_{1/2}$), which represents the constant duration required for the initial concentration to drop by exactly half.

Solution:

- (a) The first-order integrated rate law expression is given by the equation $t = \frac{2.303}{k} \log \left(\frac{[A]_0}{[A]} \right)$, where $[A]_0$ is the initial concentration and $[A]$ is the concentration at time t .
- (b) Alternatively, we can use the concept of half-life. For a first-order reaction, the half-life is independent of the initial concentration and is calculated as $t_{1/2} = \frac{\ln 2}{k} \approx \frac{0.693}{k}$.
- (c) Given that the rate constant $k = 6.93 \times 10^{-3} \text{ s}^{-1}$, the half-life is $t_{1/2} = \frac{0.693}{6.93 \times 10^{-3} \text{ s}^{-1}} = 100 \text{ s}$.
- (d) The problem asks for the time required to reduce the concentration to one-eighth ($1/8$) of its original value. The fraction can be written in terms of half-lives: $\frac{[A]}{[A]_0} = \left(\frac{1}{2} \right)^n$, where n is the number of half-lives.
- (e) Since $\frac{1}{8} = \left(\frac{1}{2} \right)^3$, exactly 3 half-lives must pass. Total time $t = 3 \times t_{1/2} = 3 \times 100 \text{ s} = 300 \text{ s}$.

Final Answer: 300 s**Answer:** (C)[Go Back to Question 3](#)

Q4.

Solution**Concept:**

The magnetic behavior of coordination complexes depends on the electronic configuration of the central transition metal ion and the field strength of the surrounding ligands. According to crystal field theory, strong-field ligands cause a large d-orbital splitting that forces electrons to pair up, creating low-spin complexes. Conversely, weak-field ligands result in smaller splitting, allowing electrons to remain unpaired in high-spin configurations.

Solution:

- (a) The spin-only magnetic moment is calculated using the formula $\mu = \sqrt{n(n+2)}$ Bohr Magnetons (BM), where n is the total number of unpaired d-electrons. Maximize n to maximize the magnetic moment.
- (b) In $[\text{Fe}(\text{CN})_6]^{3-}$, iron is in the +3 oxidation state (d^5). Because cyanide (CN^-) is a strong-field ligand, it forces electron pairing in the t_{2g} orbitals, leaving only 1 unpaired electron ($n = 1$).
- (c) In $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$, iron is also in the +3 oxidation state (d^5). However, water (H_2O) is a weak-field ligand. The electrons do not pair up, yielding a high-spin complex with 5 unpaired electrons ($n = 5$).
- (d) In $[\text{Co}(\text{NH}_3)_6]^{3+}$, cobalt is in the +3 oxidation state (d^6). Amine (NH_3) acts as a strong-field ligand here, forcing all electrons to pair up completely ($n = 0$).
- (e) In $[\text{Ni}(\text{CN})_4]^{2-}$, nickel is in the +2 state (d^8) and forms a square-planar low-spin complex with zero unpaired electrons ($n = 0$). Therefore, $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ has the maximum value.

Final Answer: $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$

Answer: (B)

[Go Back to Question 4](#)



Q5.

Solution**Concept:**

Concentration terms express the relative amount of solute present in a specific quantity of solution or solvent. Parts per million (ppm) is an expression of concentration used for trace quantities of a substance. It signifies the mass of solute present per 10^6 parts of total solution mass. Mass percentage expresses the mass of solute present per 100 parts of total solution mass.

Solution:

- (a) By mathematical definition, a concentration value given in parts per million (ppm) can be written as: $\text{ppm} = \frac{\text{mass of solute}}{\text{total mass of solution}} \times 10^6$.
- (b) Similarly, the formula for calculating mass percentage is expressed as: $\text{mass } \% = \frac{\text{mass of solute}}{\text{total mass of solution}} \times 10^2$.
- (c) To relate these two concentration terms, we can see that mass percentage is smaller than ppm by a factor of 10^4 . The mathematical conversion expression is: $\text{mass } \% = \frac{\text{ppm}}{10^4} = \text{ppm} \times 10^{-4}$.
- (d) Given that the pollutant concentration in the water sample is equal to 15 ppm, we substitute this value directly into our conversion formula.
- (e) Doing the calculation gives: $\text{mass } \% = \frac{15}{10^4} = 0.0015\%$. Thus, a trace value of 15 ppm is equivalent to 0.0015% by mass.

Final Answer: 0.0015**Answer: (B)**[Go Back to Question 5](#)

Q6.

Solution**Concept:**

Oxidation of alcohols can yield aldehydes, ketones, or carboxylic acids depending on the structure of the alcohol and the oxidizing power of the reagent. Primary alcohols oxidize to aldehydes and can further oxidize to carboxylic acids. Secondary alcohols oxidize to form ketones. Jones reagent or chromium trioxide (CrO_3) in pyridine forms a mild oxidizing system that selectively oxidizes secondary alcohols without breaking carbon bonds.

Solution:

- Analyzing the provided TikZ structural diagram reveals a skeletal carbon chain consisting of four carbon atoms. The molecule is butan-2-ol, as indicated by the hydroxyl ($-\text{OH}$) group attached to the second carbon atom.
- Butan-2-ol possesses a hydroxyl group attached to a carbon atom that is directly bonded to two other carbon atoms. Therefore, it is structurally categorized as a secondary alcohol.
- The chosen chemical reagent is anhydrous chromium trioxide (CrO_3) dissolved in pyridine. This combination forms a selective non-aqueous oxidizing agent.
- When a secondary alcohol undergoes oxidation, the reaction involves the abstraction of the alpha-hydrogen and the hydrogen atom of the hydroxyl group. This converts the single $\text{C}-\text{O}$ bond into a $\text{C}=\text{O}$ double bond.
- Because the carbonyl group is located within the interior of the carbon chain rather than at a terminal position, the resulting functional group is a ketone (specifically, butan-2-one).

Final Answer: Ketone**Answer:** (C)[Go Back to Question 6](#)

Q7.

Solution**Concept:**

Raoult's Law describes the behavior of vapor pressures in ideal liquid solutions. It states that the partial vapor pressure of each volatile component in a liquid mixture is directly proportional to its mole fraction in the solution. The total vapor pressure exerted by an ideal binary liquid mixture is the sum of the individual partial vapor pressures of the components.

Solution:

- (a) According to Raoult's Law, the total vapor pressure (P_{total}) of a binary ideal solution containing components A and B is given by: $P_{\text{total}} = P_A + P_B = (P_A^\circ \times X_A) + (P_B^\circ \times X_B)$.
- (b) The variables P_A° and P_B° are the vapor pressures of the pure solvents, while X_A and X_B represent their respective mole fractions in the liquid phase.
- (c) Given quantities: $n_A = 2$ moles and $n_B = 3$ moles. Total number of moles in the solution is $n_{\text{total}} = 2 + 3 = 5$ moles.
- (d) Calculate mole fractions: $X_A = \frac{n_A}{n_{\text{total}}} = \frac{2}{5} = 0.4$, and $X_B = \frac{n_B}{n_{\text{total}}} = \frac{3}{5} = 0.6$.
- (e) Calculate total pressure by substituting the values: $P_{\text{total}} = (100 \text{ mmHg} \times 0.4) + (150 \text{ mmHg} \times 0.6) = 40 \text{ mmHg} + 90 \text{ mmHg} = 130 \text{ mmHg}$.

Final Answer: 130 mmHg**Answer:** (C)[Go Back to Question 7](#)

Q8.

Solution**Concept:**

Structural isomerism in coordination chemistry occurs when compounds share the same chemical formula but differ in their internal atom connectivity. Ionization isomerism is a specific class where the isomers produce completely different ions when dissolved in an aqueous solution. This happens because a ligand directly coordinated to the central metal ion exchanges places with a counter-ion located outside the coordination sphere.

Solution:

- To identify ionization isomers, look for pairs of complexes that have the exact same total chemical formula but differ in which ion resides inside the brackets (coordination sphere) versus outside (ionization sphere).
- Consider Option A: $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$ and $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$. Both share the same total formula.
- When $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$ dissolves in water, it dissociates to yield the complex cation $[\text{Co}(\text{NH}_3)_5\text{SO}_4]^+$ and a free bromide anion (Br^-). This gives a precipitate with silver nitrate.
- When $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ dissolves in water, it dissociates into the complex cation $[\text{Co}(\text{NH}_3)_5\text{Br}]^{2+}$ and a free sulfate anion (SO_4^{2-}), giving a precipitate with barium chloride.
- Since these two compounds yield entirely different ions upon dissolution despite sharing an identical molecular formula, they represent a classic pair of ionization isomers.

Final Answer: $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$ and $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$

Answer: (A)

[Go Back to Question 8](#)



Q9.

Solution**Concept:**

Polymers are macromolecular structures built by linking repeating structural units derived from small reactive molecules called monomers. In addition polymerization, monomer units containing unsaturated double or triple bonds join together via a chain-growth mechanism without generating any small molecule byproducts. The chemical composition of the polymer's repeating backbone directly mirrors the structure of its monomer precursor.

Solution:

- The provided TikZ diagram shows a linear polymer chain containing a repeating hydrocarbon backbone with a chlorine atom substituted on every second carbon atom: $-\text{CH}_2 - \text{CHCl} - \text{CH}_2 - \text{CHCl}-$.
- This structural pattern corresponds to polyvinyl chloride, commonly abbreviated as PVC. It is a widely used synthetic thermoplastic polymer.
- To deduce the identity of the monomer used to synthesize an addition polymer, convert the single bond within the basic repeating unit back into a carbon-carbon double bond.
- Isolating the two-carbon repeating block yields a molecule with a double bond between the carbons, where one hydrogen is replaced by a chlorine atom: $\text{CH}_2 = \text{CHCl}$.
- The IUPAC name for this molecule is chloroethene, which is universally known by its common chemical name, vinyl chloride. Therefore, vinyl chloride is the specific monomer required.

Final Answer: Vinyl chloride

Answer: (B)

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Q10.

Solution**Concept:**

The electrochemical series arranges chemical elements according to their standard reduction potentials (E°). The standard reduction potential measures a species' thermodynamic tendency to gain electrons. A larger, more positive reduction potential indicates that a substance reduces easily, making it a powerful oxidizing agent. Conversely, a lower or more negative value indicates that a substance loses electrons easily, making it a stronger reducing agent.

Solution:

- Reducing power refers to the ability of an element to act as a reducing agent by losing its own valence electrons to another substance during a redox reaction.
- Mathematically, the reducing power of an element is inversely proportional to its standard reduction potential value (E°). Elements with highly negative reduction potentials show the greatest tendency to undergo oxidation.
- Let us look at the given standard reduction potentials for the three metallic elements: $E_X^\circ = +0.52 \text{ V}$, $E_Y^\circ = -2.87 \text{ V}$, and $E_Z^\circ = -0.44 \text{ V}$.
- Comparing these values shows that metal X has the highest positive potential, metal Z has a intermediate negative potential, and metal Y possesses the lowest (most negative) potential value.
- Arranging them in order of increasing reducing power corresponds to moving from the highest reduction potential to the lowest: $X < Z < Y$.

Final Answer: $X < Z < Y$

Answer: (A)

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Q11.

Solution**Concept:**

Periodic properties of elements reveal predictable trends based on atomic structure. For an isoelectronic series, which consists of atoms and ions containing the exact same total number of electrons, the size or radius is governed strictly by the nuclear charge. As the number of protons in the nucleus increases, the positive charge exerts a stronger electrostatic pull on the shared electron cloud, drawing the shells closer and reducing the overall ionic radius.

Solution:

- Consider the chemical species given in the question: magnesium ions (Mg^{2+}), sodium ions (Na^+), fluoride ions (F^-), and oxide ions (O^{2-}).
- Let us determine the total number of electrons for each species. Magnesium has an atomic number of 12, so the divalent cation has $12 - 2 = 10$ electrons. Sodium has an atomic number of 11, so the monovalent cation has $11 - 1 = 10$ electrons. Fluorine has an atomic number of 9, so the monovalent anion has $9 + 1 = 10$ electrons. Oxygen has an atomic number of 8, so the divalent anion has $8 + 2 = 10$ electrons.
- Since every single one of these species contains exactly 10 electrons, they constitute an isoelectronic series sharing the same electronic configuration.
- Now we evaluate their nuclear charges based on the number of protons in the nucleus: oxide has 8 protons, fluoride has 9 protons, sodium has 11 protons, and magnesium has 12 protons.
- A higher nuclear charge binds the 10 electrons more tightly. Therefore, the species with the highest number of protons (Mg^{2+}) will be the smallest, and the species with the lowest number of protons (O^{2-}) will be the largest. This gives the precise increasing order: $\text{Mg}^{2+} < \text{Na}^+ < \text{F}^- < \text{O}^{2-}$.

Final Answer: $\text{Mg}^{2+} < \text{Na}^+ < \text{F}^- < \text{O}^{2-}$

Answer: (A)

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Q12.

Solution**Concept:**

Aromatic hydrocarbons undergo side-chain substitution under specific free radical conditions. Toluene reacts with chlorine gas in the presence of ultraviolet sunlight via a radical mechanism that selectively targets the aliphatic methyl group rather than the aromatic ring. Subsequent nucleophilic substitution using an aqueous base replaces the halogen atoms with hydroxyl groups, creating intermediate alcohols or carbonyl species that can be oxidized up to a benzoic acid structure.

Solution:

- (a) The starting material has the molecular formula C_7H_8 , which corresponds uniquely to toluene ($C_6H_5CH_3$), a benzene ring attached to a single methyl group.
- (b) When toluene is subjected to free radical chlorination in the presence of sunlight, chlorine atoms substitute the hydrogen atoms located on the side-chain methyl carbon. Depending on the extent of chlorination, this can yield benzyl chloride, benzal chloride, or benzotrichloride.
- (c) The problem states that compound A undergoes subsequent hydrolysis with aqueous sodium hydroxide (NaOH) at high temperature to give compound B, which can be oxidized to form benzoic acid.
- (d) Let us evaluate the options. If compound A is benzyl chloride ($C_6H_5CH_2Cl$), hydrolysis yields benzyl alcohol ($C_6H_5CH_2OH$). Benzyl alcohol contains a primary alcohol unit that easily undergoes oxidation with alkaline potassium permanganate ($KMnO_4$) to produce benzoic acid (C_6H_5COOH).
- (e) This matches the complete sequence perfectly. Radical chlorination of toluene produces benzyl chloride as compound A. Hydrolysis replaces the chlorine atom with a hydroxyl group to form benzyl alcohol as compound B, which is then oxidized to benzoic acid.

Final Answer: Benzyl chloride**Answer:** (A)[Go Back to Question 12](#)

Q13.

Solution**Concept:**

Surface chemistry describes the accumulation of molecular species at a surface rather than in the bulk of a solid or liquid. Physical adsorption, or physisorption, involves weak van der Waals forces acting between the gas molecules and the solid adsorbent surface. The thermodynamic spontaneity of any physical or chemical process is governed by the Gibbs free energy equation, which balances changes in enthalpy and system entropy.

Solution:

- (a) For any process occurring spontaneously at constant temperature and pressure, the change in Gibbs free energy (ΔG) must be mathematically negative ($\Delta G < 0$).
- (b) Physical adsorption involves gas molecules leaving the free-moving gaseous phase to become anchored onto a solid surface. Because the gas molecules lose their translational freedom of movement, the randomness of the system decreases. Therefore, the change in entropy (ΔS) is always negative ($\Delta S < 0$).
- (c) We can analyze the thermodynamic behavior using the fundamental Gibbs-Helmholtz equation: $\Delta G = \Delta H - T\Delta S$.
- (d) Since the entropy term ΔS is negative, the expression $-T\Delta S$ becomes a positive value. For the overall change in Gibbs free energy (ΔG) to remain negative and ensure a spontaneous process, the enthalpy change (ΔH) must be highly negative.
- (e) A negative enthalpy change means that the physical accumulation process releases heat energy, making physisorption an inherently exothermic phenomenon. Consequently, the thermodynamic parameters that are universally true for this spontaneous process are $\Delta H < 0$ and $\Delta S < 0$.

Final Answer: $\Delta H < 0$ and $\Delta S < 0$

Answer: (C)

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Q14.

Solution**Concept:**

Chemical kinetics explores the molecular pathways and energy barriers that govern reaction velocities. The activation energy (E_a) represents the minimum kinetic energy that colliding reactant molecules must possess to form the high-energy activated complex or transition state. A catalyst is a chemical substance that increases the rate of a reaction without being consumed, acting modifying the potential energy profile.

Solution:

- The potential energy profile plotted in the provided diagram displays the energy of the system as reactants transition over an activation barrier to form products. The height of this peak relative to the reactants is the activation energy (E_a).
- When a positive catalyst is introduced into the reaction system, it participates chemically by interacting with the reactants to establish a completely new, alternative reaction mechanism.
- This alternative molecular pathway features a significantly lower transition state energy compared to the original uncatalyzed pathway.
- By lowering the peak of the potential energy barrier, the activation energy (E_a) for both the forward and reverse reactions is decreased. As a result, a much larger fraction of colliding reactant molecules possess the required energy to clear the barrier, accelerating the reaction rate.
- It is crucial to note that the addition of a catalyst does not alter the stable potential energy levels of the initial reactants or the final products. Therefore, it leaves the overall enthalpy change (ΔH) of the reaction completely unaffected while lowering the activation energy barrier.

Final Answer: It decreases the activation energy (E_a) by providing an alternative pathway.

Answer: (C)

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Q15.

Solution**Concept:**

The structural chemistry of p-block elements highlights the diverse molecular geometries of phosphorus oxoacids. Phosphorus forms various oxoacids characterized by tetrahedral coordination where the central atom is bonded to hydroxyl groups, terminal oxo oxygen atoms, hydrogen atoms, or other phosphorus atoms. The presence of direct phosphorus-phosphorus or phosphorus-oxygen-phosphorus linkages determines whether an acid belongs to the hypophosphoric or pyrophosphoric category.

Solution:

- Let us analyze the molecular structures of the given oxoacids of phosphorus to identify their internal bonding patterns.
- Hypophosphorous acid (H_3PO_2) is a monobasic acid containing one central phosphorus atom bonded to one $-\text{OH}$ group, one terminal $=\text{O}$ atom, and two direct $\text{P}-\text{H}$ bonds. It has no direct metal-metal bond.
- Pyrophosphoric acid ($\text{H}_4\text{P}_2\text{O}_7$) is a tetrabasic acid formed by condensing two phosphoric acid molecules. It features a bridging oxygen atom that creates a characteristic symmetric $\text{P}-\text{O}-\text{P}$ linkage.
- Hypophosphoric acid ($\text{H}_4\text{P}_2\text{O}_6$) contains two phosphorus atoms where each phosphorus is in the +4 oxidation state. Structurally, each phosphorus atom is bonded to two $-\text{OH}$ groups and one terminal $=\text{O}$ atom. The two central phosphorus atoms are directly linked to each other via a single, covalent phosphorus-phosphorus ($\text{P}-\text{P}$) bond.
- Orthophosphoric acid (H_3PO_4) is a simple tribasic monomeric acid containing a single phosphorus atom and no catenated bonds. Thus, hypophosphoric acid is the unique species containing a direct $\text{P}-\text{P}$ bond.

Final Answer: Hypophosphoric acid ($\text{H}_4\text{P}_2\text{O}_6$)

Answer: (C)

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Q16.

Solution**Concept:**

Proteins are complex macromolecular polypeptides constructed from individual alpha-amino acid monomers. The structural organization of proteins is categorized into primary, secondary, tertiary, and quaternary levels. The primary structure refers to the linear sequence of amino acids linked along a continuous molecular chain. This specific sequence is encoded genetically and dictates the downstream folding and spatial conformation of the protein.

Solution:

- (a) The primary structure is defined exclusively as the exact, linear arrangement of amino acid residues connected back-to-back in a polypeptide chain.
- (b) This covalent backbone is constructed during protein synthesis when the alpha-amino group of one amino acid reacts with the carboxylic acid group of an adjacent amino acid.
- (c) This condensation reaction eliminates a water molecule to establish a strong, covalent amide linkage, chemically designated as a peptide bond ($-\text{CONH}-$).
- (d) Other higher-order structures rely on different interactions. The secondary structure (alpha-helices and beta-pleated sheets) is maintained primarily by hydrogen bonds formed along the peptide backbone.
- (e) The tertiary and quaternary structures, which describe the three-dimensional folding and assembly of multiple subunits, are stabilized by a combination of disulfide linkages, hydrophobic interactions, ionic bonds, and van der Waals forces. However, the primary structural sequence itself is maintained by covalent peptide bonds.

Final Answer: Peptide bonds

Answer: (B)

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Q17.

Solution**Concept:**

Quantitative organic analysis determines the elemental composition of unknown compounds using stoichiometric mass relations. In Liebig's combustion method, a known mass of an organic compound is burned completely in the presence of excess oxygen. All the carbon atoms present in the sample are converted quantitatively into carbon dioxide gas (CO₂). By measuring the mass of CO₂ produced, the original mass fraction of carbon can be isolated.

Solution:

- (a) Let us state the given parameters from the problem: the mass of the organic compound analyzed is 0.30 g, and the mass of carbon dioxide (CO₂) generated upon complete combustion is 0.44 g.
- (b) We apply molar mass relationships to find the carbon content. The molar mass of carbon dioxide (CO₂) is 44 g mol⁻¹, which contains exactly 12 g mol⁻¹ of pure carbon.
- (c) This means that in 0.44 g of carbon dioxide, the mass of carbon present is calculated as:
mass of C = 0.44 g × $\frac{12}{44}$ = 0.12 g.
- (d) To find the percentage of carbon in the original organic substance, we divide the calculated mass of carbon by the total mass of the initial sample and multiply by 100.
- (e) Performing the calculation: percentage of C = $\frac{\text{mass of C}}{\text{mass of compound}} \times 100 = \frac{0.12 \text{ g}}{0.30 \text{ g}} \times 100 = 40.0\%$.
Therefore, the compound contains exactly 40.0% carbon by mass.

Final Answer: 40.0**Answer:** (A)[Go Back to Question 17](#)

Q18.

Solution**Concept:**

Crystal field theory explains the electronic structures and properties of transition metal complexes. When ligands approach a central metal ion in an octahedral arrangement, the electrostatic fields repel the metal d-orbitals unevenly, splitting them into lower-energy t_{2g} and higher-energy e_g sub-levels. The magnitude of this crystal field splitting energy (Δ_o) depends on the electrostatic field strength of the ligand, as classified in the spectrochemical series.

Solution:

- The spectrochemical series is an empirically derived list that orders ligands based on their ability to split the d-orbitals of a central metal ion.
- Ligands that cause a small splitting of the d-orbitals are classified as weak-field ligands, whereas ligands that produce a large splitting energy separation are designated as strong-field ligands.
- Let us analyze the specific ligands provided in the options: iodide (I^-), chloride (Cl^-), fluoride (F^-), and cyanide (CN^-).
- Halide ligands are classic weak-field ligands. Within the halogen group, field strength increases as the ionic radius decreases and charge density increases. Therefore, iodide produces the smallest splitting, followed by chloride, and then fluoride ($I^- < Cl^- < F^-$).
- Cyanide (CN^-) contains a carbon donor atom capable of strong pi-backbonding with transition metals. This makes it an exceptionally strong-field ligand that produces a maximum Δ_o value. Combining these trends gives the correct increasing sequence: $I^- < Cl^- < F^- < CN^-$.

Final Answer: $I^- < Cl^- < F^- < CN^-$

Answer: (A)

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Q19.

Solution**Concept:**

Oxidation states represent the formal degree of oxidation or reduction of an atom within a chemical species based on electronegativity assignments. In polyatomic ions and neutral coordination complexes, the sum of the individual oxidation numbers of all constituent atoms must equal the net electrical charge carried by the overall species. Oxygen is assigned an oxidation state of -2 in standard oxoanions, while neutral ligands like carbon monoxide contribute zero net charge.

Solution:

- (a) Let us calculate the oxidation state of the central transition metal atom for each provided chemical option to identify where an oxidation state of $+6$ occurs.
- (b) For the permanganate ion (MnO_4^-): Let x be the oxidation state of manganese. The equation is $x + 4(-2) = -1$, which simplifies to $x - 8 = -1$, giving $x = +7$.
- (c) For the dichromate ion ($\text{Cr}_2\text{O}_7^{2-}$): Let y be the oxidation state of chromium. The equation is $2y + 7(-2) = -2$, which simplifies to $2y - 14 = -2$. Solving this gives $2y = 12$, which yields $y = +6$.
- (d) For the neutral nickel tetracarbonyl complex ($\text{Ni}(\text{CO})_4$): Carbon monoxide (CO) is a neutral ligand. Therefore, the oxidation state of the central nickel atom is exactly 0 .
- (e) For the ferricyanide ion ($[\text{Fe}(\text{CN})_6]^{3-}$): Cyanide (CN^-) carries a charge of -1 . Let z be the oxidation state of iron. The equation is $z + 6(-1) = -3$, which simplifies to $z - 6 = -3$, giving $z = +3$. Thus, chromium in the dichromate ion possesses the $+6$ oxidation state.

Final Answer: $\text{Cr}_2\text{O}_7^{2-}$ **Answer: (B)**[Go Back to Question 19](#)

Q20.

Solution**Concept:**

Organic name reactions often feature functionalization pathways for aromatic rings. Phenol undergoes electrophilic aromatic substitution when treated with chloroform in the presence of an aqueous alkali base. This specific reaction introduces a formyl group ($-\text{CHO}$) selectively onto the ortho position of the aromatic ring relative to the phenolic hydroxyl group, serving as a classical method for synthesizing hydroxybenzaldehydes.

Solution:

- Let us examine the structures and reagents depicted in the provided TikZ reaction equation. The initial aromatic reactant is phenol ($\text{C}_6\text{H}_5\text{OH}$).
- The chemical reagents written over the transformation arrow are chloroform (CHCl_3) mixed with sodium hydroxide (NaOH).
- Under basic conditions, sodium hydroxide deprotonates chloroform to generate a highly reactive, neutral electrophilic intermediate known as dichlorocarbene ($:\text{CCl}_2$).
- This dichlorocarbene intermediate attacks the electron-rich ortho position of the phenoxide ion. Subsequent basic hydrolysis and acidification steps convert the intermediate into a formyl functional group.
- The final organic product obtained is salicylaldehyde, also known as 2-hydroxybenzaldehyde. This direct conversion of phenol into salicylaldehyde using chloroform and base is known as the Reimer-Tiemann reaction.

Final Answer: Reimer-Tiemann reaction

Answer: (A)

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Q21.

Solution**Concept:**

The temperature dependence of chemical reaction rates can be analyzed quantitatively using the Arrhenius equation. This expression mathematically describes how the rate constant changes with absolute temperature based on the activation energy. When the temperature increases, a larger percentage of reacting molecules possess the threshold kinetic energy needed to clear the potential energy barrier.

Solution:

- (a) The logarithmic version of the Arrhenius equation that relates two different rate constants at two corresponding absolute temperatures is given by $\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2}\right)$.
- (b) The problem states that the reaction rate constant doubles when the temperature rises from 300 K to 310 K. Therefore, we have $\frac{k_2}{k_1} = 2$, $T_1 = 300$ K, and $T_2 = 310$ K.
- (c) Substituting these values along with the given constants into the integrated equation yields $\ln(2) = \frac{E_a}{8.314} \left(\frac{1}{300} - \frac{1}{310}\right)$.
- (d) Simplifying the temperature terms inside the parenthesis gives $\frac{310-300}{300 \times 310} = \frac{10}{93000} = \frac{1}{9300}$.
- (e) Now substitute $\ln 2 \approx 0.693$ to solve for activation energy: $0.693 = \frac{E_a}{8.314 \times 9300}$. Rearranging this gives $E_a = 0.693 \times 8.314 \times 9300 = 53585 \text{ J mol}^{-1}$. Converting Joules to kilojoules gives approximately 53.6 kJ mol^{-1} .

Final Answer: 53.6 kJ mol^{-1} **Answer:** (A)[Go Back to Question 21](#)

Q22.

Solution**Concept:**

Haloalkanes and haloarenes are classified based on the specific hybridization and chemical environment of the carbon atom bonded to the halogen. An allylic halide is structurally defined as a compound where the halogen atom is attached to an sp^3 hybridized carbon atom that is located directly adjacent to a carbon-carbon double bond. This structural arrangement provides unique chemical reactivity due to resonance stabilization of the resulting radical or carbocation.

Solution:

- Let us analyze the structural configurations of the given molecules to identify which one contains the specific allylic system.
- Consider 3-chloroprop-1-ene. Its structural formula is expressed as $\text{CH}_2 = \text{CH} - \text{CH}_2\text{Cl}$. In this molecule, the chlorine atom is attached to a saturated carbon atom that has single bonds and is sp^3 hybridized. This carbon is directly attached to the alkene group ($\text{CH}_2 = \text{CH}-$), which represents a true allylic configuration.
- Consider 1-chloroprop-1-ene, which has the formula $\text{CH}_3 - \text{CH} = \text{CHCl}$. Here, the halogen is directly attached to an sp^2 hybridized alkene carbon. This is classified as a vinylic halide.
- Consider 2-chloroprop-1-ene, which has the formula $\text{CH}_2 = \text{C}(\text{Cl}) - \text{CH}_3$. Similar to the previous option, the chlorine atom is bonded to an sp^2 hybridized alkene carbon, making it a vinylic halide.
- Consider chlorobenzene, which contains a chlorine atom directly linked to an sp^2 aromatic carbon atom, representing an aryl halide. Therefore, 3-chloroprop-1-ene is the correct choice.

Final Answer: 3-Chloroprop-1-ene

Answer: (A)

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Q23.

Solution**Concept:**

Molecular orbital theory describes the electronic structure of molecules by constructing multi-center molecular orbitals from atomic orbital combinations. The stability and magnetic properties of a diatomic species are determined by filling these orbitals according to the Aufbau principle. The bond order is calculated by taking half the difference between the number of bonding and antibonding electrons, while paramagnetism arises from unpaired electron spins.

Solution:

- Let us evaluate the total number of electrons and determine the electronic configuration for each of the given species using molecular orbital energy ordering rules.
- For the oxygen molecule (O_2), there are 16 total electrons. The bond order is calculated to be 2, and it contains 2 unpaired electrons in its antibonding pi orbitals, making it paramagnetic.
- For the nitrogen monocation (N_2^+), there are $14 - 1 = 13$ total electrons. The molecular orbital filling sequence gives 9 bonding electrons and 4 antibonding electrons.
- The calculated bond order for this nitrogen cation species is $\frac{9-4}{2} = 2.5$. Because it has an odd total number of electrons, it must contain 1 unpaired electron, meaning it exhibits paramagnetic behavior.
- For the peroxide ion (O_2^{2-}), there are 18 total electrons, yielding a bond order of 1, and it is entirely diamagnetic. For the carbon molecule (C_2), there are 12 total electrons, which results in a bond order of 2, and it is also diamagnetic. Thus, the nitrogen cation satisfies both requirements.

Final Answer: N_2^+ **Answer: (B)**[Go Back to Question 23](#)

Q24.

Solution**Concept:**

Synthetic polymers are classified based on their underlying polymerization mechanism and the chemical structures of their starting monomer units. Addition polymers are formed through continuous chain-growth processes where unsaturated monomer units link together without losing small molecules. When conjugated dienes undergo addition polymerization, they utilize two conjugated double bonds separated by a single bond to generate elastic macromolecular structures.

Solution:

- (a) Let us review the manufacturing processes and structural components of the synthetic industrial polymers listed in the given options.
- (b) Buna-S is an industrial synthetic elastomer produced via the addition copolymerization of two distinct monomers: styrene and 1,3-butadiene. The 1,3-butadiene monomer ($\text{CH}_2 = \text{CH} - \text{CH} = \text{CH}_2$) is a classic example of a conjugated diene system.
- (c) Terylene is a polyester synthetic fiber that is manufactured through a step-growth condensation polymerization mechanism using ethylene glycol and terephthalic acid, producing water molecules as a byproduct.
- (d) Nylon-6 is a polyamide synthetic polymer synthesized through the ring-opening polymerization of caprolactam under high temperature, which is a step-growth process.
- (e) Bakelite is a highly cross-linked thermosetting resin formed via a condensation reaction between phenol and formaldehyde monomers. Therefore, Buna-S is the unique option that forms via chain-growth addition polymerization using a conjugated diene monomer.

Final Answer: Buna-S**Answer:** (A)[Go Back to Question 24](#)

Q25.

Solution**Concept:**

Solid-state chemistry analyzes the internal arrangements of crystalline lattices. The packing efficiency represents the total percentage of the unit cell volume that is physically occupied by constituent spherical particles. A face-centered cubic lattice consists of atoms located at all eight corners of the cube plus atoms positioned at the centers of all six faces, creating a highly dense packing arrangement.

Solution:

- (a) To calculate the packing efficiency of a face-centered cubic lattice, we must first establish the relationship between the cube edge length (a) and the atomic radius (r).
- (b) Along the diagonal of any face of the unit cell, the atoms touch each other directly, which gives the geometric equation: $\sqrt{2}a = 4r$, or rearranged as $a = \frac{4r}{\sqrt{2}} = 2\sqrt{2}r$.
- (c) The total volume of this cubic unit cell is found by cubing the edge length: $V_{\text{cell}} = a^3 = (2\sqrt{2}r)^3 = 16\sqrt{2}r^3$.
- (d) Next, we determine the effective number of atoms belonging to a single unit cell. There are 8 corner atoms contributing $1/8$ each, and 6 face atoms contributing $1/2$ each, yielding a total of $1 + 3 = 4$ atoms.
- (e) The total volume occupied by these 4 spherical atoms is $V_{\text{atoms}} = 4 \times \frac{4}{3}\pi r^3 = \frac{16}{3}\pi r^3$. The percentage efficiency is $\frac{V_{\text{atoms}}}{V_{\text{cell}}} \times 100 = \frac{\pi}{3\sqrt{2}} \times 100 \approx 74.0\%$.

Final Answer: 74.0**Answer:** (C)[Go Back to Question 25](#)

Q26.

Solution**Concept:**

Environmental chemistry studies the chemical phenomena and atmospheric compositions that influence ecological balance. The greenhouse effect is a natural warming process where trace gases in the Earth's troposphere absorb long-wave infrared radiation re-emitted from the planet surface, preventing it from escaping into space. While this keeps the climate habitable, rising anthropogenic emissions amplify this absorption, leading to global warming.

Solution:

- (a) The Earth's atmosphere consists primarily of nitrogen (N_2) and oxygen (O_2). However, these diatomic homonuclear molecules do not absorb infrared radiation because they lack a changing dipole moment during molecular vibration.
- (b) Greenhouse gases must have three or more atoms or an asymmetric structure to absorb infrared wavelengths.
- (c) Carbon dioxide (CO_2) is the most significant anthropogenic greenhouse gas due to its massive emission volumes from burning fossil fuels, industrial activities, and widespread deforestation. CH_4 is another potent greenhouse gas that possesses a high global warming potential, originating from agricultural practices, rice paddies, anaerobic decay, and livestock digestive systems.
- (d) Together, carbon dioxide and methane contribute the largest share to the enhanced greenhouse effect in the troposphere.
- (e) Other gases like ozone, sulfur dioxide, or chlorofluorocarbons play secondary roles or act in different atmospheric layers, making carbon dioxide and methane the primary culprits.

Final Answer: Carbon dioxide and Methane

Answer: (B)

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Q27.

Solution**Concept:**

The aromatic ring of phenol is highly activated toward electrophilic substitution because the lone pairs on the oxygen atom undergo strong resonance donation into the ring system. This dramatic increase in electron density makes the ortho and para positions exceptionally nucleophilic. The chemical outcome of halogenation reactions can be adjusted by altering the polarity of the solvent used.

Solution:

- When phenol is treated with bromine in a non-polar solvent like carbon disulfide (CS_2) at low temperatures, the reactivity is tempered, yielding a mixture of mono-brominated products (ortho and para isomers).
- However, the problem specifies treating phenol with excess bromine water, which is a highly polar aqueous medium.
- Water ionizes phenol into a phenoxide ion ($\text{C}_6\text{H}_5\text{O}^-$). The negative charge on the oxygen atom increases the resonance electron-donation effect, activating the ring to an extreme degree.
- At the same time, water polarizes the bromine molecules, increasing the concentration of the attacking bromonium electrophile (Br^+).
- Due to this extreme activation, substitution occurs simultaneously at all available ortho and para positions relative to the hydroxyl group. This rapid trisubstitution reaction results in the immediate precipitation of 2,4,6-tribromophenol as a characteristic white solid.

Final Answer: 2,4,6-Tribromophenol

Answer: (C)

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Q28.

Solution**Concept:**

Le Chatelier's principle states that if a dynamic equilibrium system is subjected to a disturbance, the system will shift its position to counteract the change. For gas-phase equilibria, changes in pressure or container volume alter the concentrations of reactants and products, forcing a shift toward the side with fewer or more moles of gas. Crucially, the numerical value of the equilibrium constant (K_c) depends exclusively on temperature.

Solution:

- Let us analyze the provided balanced chemical equation for the decomposition of phosphorus pentachloride: $\text{PCl}_5(g) \rightleftharpoons \text{PCl}_3(g) + \text{Cl}_2(g)$.
- First, we count the total number of gaseous moles on both sides. The reactant side features exactly 1 mole of gas (PCl_5), while the product side contains $1 + 1 = 2$ moles of gas.
- If we increase the total pressure of the system by reducing the volume of the reaction container, the system counteracts this stress by shifting toward the side that occupies less volume.
- Because the reactant side has fewer moles of gas, this pressure increase drives the equilibrium toward the left, producing more PCl_5 .
- This shift successfully favors the reactant side without changing the temperature, keeping the value of the equilibrium constant perfectly constant. Other choices like increasing container volume or removing a product would shift the equilibrium to the right.

Final Answer: Increasing the total pressure by reducing container volume

Answer: (C)

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Q29.

Solution**Concept:**

The atomic structure of hydrogen can be described by the Bohr model, which restricts electronic energies to discrete quantized orbits. When an electron undergoes a transition from a higher principal quantum shell to a lower shell, a photon is emitted with an energy matching the difference. These transitions are grouped into spectral series named after their discoverers, which correspond to specific regions of the electromagnetic spectrum.

Solution:

- (a) The spectral lines of atomic hydrogen are categorized based on the final principal quantum number (n_{final}) where the de-excitation transition ends.
- (b) The Lyman series includes all electronic transitions that drop down to the lowest ground state energy level ($n_{\text{final}} = 1$). These high-energy emissions fall entirely within the ultraviolet region.
- (c) The Balmer series contains all electronic transitions where electrons drop down from outer shells to the second energy level ($n_{\text{final}} = 2$). The photons emitted in this series possess wavelengths that lie within the visible light region.
- (d) Let us evaluate the options: Transition A ($n = 2 \rightarrow n = 1$) belongs to the Lyman series. Transition B ($n = 3 \rightarrow n = 2$) lands on the second energy level, making it the first line of the visible Balmer series.
- (e) Transition C ($n = 4 \rightarrow n = 1$) is part of the ultraviolet Lyman series, and Transition D ($n = 5 \rightarrow n = 3$) belongs to the infrared Paschen series. Thus, the transition from $n = 3$ to $n = 2$ produces visible light.

Final Answer: From $n = 3$ to $n = 2$

Answer: (B)

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Q30.

Solution**Concept:**

Biochemistry examines the molecular structures and polymer chains that govern living systems. Nucleic acids like deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are biopolymers built from monomer units known as nucleotides. Each individual nucleotide consists of a pentose sugar, a nitrogenous base, and a phosphate group. These monomers link together through covalent bonds to construct a stable, repeating macromolecular backbone.

Solution:

- (a) The primary structure of a nucleic acid chain is formed by connecting sequential nucleotide monomers together in a highly organized linear sequence.
- (b) This structural polymerization occurs when the phosphate group attached to the 5' carbon position of one pentose sugar molecule reacts with the hydroxyl group located at the 3' carbon position of the adjacent sugar ring.
- (c) This condensation reaction forms a stable ester linkage on each side of the phosphate group, establishing a continuous 3',5'-phosphodiester linkage along the chain.
- (d) Let us evaluate the alternative choices to confirm our conclusion. Glycosidic linkages connect monosaccharide units in carbohydrates, while peptide linkages join amino acids together in proteins.
- (e) Hydrogen bonding is a non-covalent interaction responsible for holding the two complementary strands of a DNA double helix together, but it does not link the individual nucleotides along the single-strand backbone. Therefore, the covalent backbone is maintained by 3',5'-phosphodiester linkages.

Final Answer: 3',5'-Phosphodiester linkage

Answer: (C)

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Q31.

Solution**Concept:**

The classification and differentiation of primary, secondary, and tertiary amines can be effectively achieved using the Hinsberg test. This chemical analysis relies on the reaction of the amine with benzenesulfonyl chloride, which serves as the Hinsberg reagent, in the presence of an aqueous alkaline solution like potassium hydroxide. The structural features of the resulting sulfonamide derivative determine its solubility behavior in the alkaline medium.

Solution:

- (a) When a primary amine reacts with benzenesulfonyl chloride, it forms an N-alkylbenzenesulfonamide compound. This molecule retains an acidic hydrogen atom bonded directly to the nitrogen atom. Consequently, treatment with an aqueous solution of potassium hydroxide deprotonates the sulfonamide, rendering it highly soluble in water.
- (b) When a secondary amine undergoes this identical transformation, it produces an N,N-dialkylbenzenesulfonamide. Because the nitrogen atom is fully substituted, this compound completely lacks any acidic hydrogen atoms.
- (c) Due to the absence of an acidic hydrogen atom, the solid sulfonamide precipitate cannot interact chemically with the base and remains entirely insoluble in the aqueous potassium hydroxide solution.
- (d) A tertiary amine does not react at all with benzenesulfonyl chloride because it has no replaceable hydrogen atoms on the nitrogen, remaining basic and soluble in added acid.
- (e) The problem states that the original amine yields a solid precipitate that is completely insoluble in aqueous potassium hydroxide. This behavior corresponds uniquely to the reaction sequence of a secondary amine.

Final Answer: Secondary amine

Answer: (B)

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Q32.

Solution**Concept:**

Electrochemistry connects chemical energy changes to electrical work using fundamental thermodynamic relations. The standard cell potential (E_{cell}°) serves as a direct quantitative measure of the electromotive force driving electrons through a circuit under standard conditions. The maximum electrical work obtainable from an operating electrochemical cell corresponds directly to the change in standard Gibbs free energy (ΔG°).

Solution:

- (a) The quantitative relationship linking the standard thermodynamic Gibbs free energy change to the standard electromotive force of an electrochemical cell is given by the fundamental equation: $\Delta G^{\circ} = -nFE_{\text{cell}}^{\circ}$.
- (b) Let us state the parameters provided in the problem statement: the number of moles of electrons transferred during the balanced redox reaction is $n = 2$, and the standard electromotive cell potential is $E_{\text{cell}}^{\circ} = +1.10 \text{ V}$.
- (c) Faraday's constant is given as $F = 96500 \text{ C mol}^{-1}$, which represents the total electrical charge carried by exactly one mole of electrons.
- (d) Substituting these values into our core thermodynamic relation yields: $\Delta G^{\circ} = -(2) \times (96500 \text{ C mol}^{-1}) \times (1.10 \text{ V})$.
- (e) Performing the multiplication gives: $\Delta G^{\circ} = -212300 \text{ J mol}^{-1}$. To match standard chemical reporting, we divide this value by 1000 to convert Joules into kilojoules, which results in exactly $-212.3 \text{ kJ mol}^{-1}$. The negative sign indicates a spontaneous chemical process.

Final Answer: $-212.3 \text{ kJ mol}^{-1}$

Answer: (A)

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Q33.

Solution**Concept:**

Transition metal oxides exhibit a remarkably broad spectrum of electrical conductivity and magnetic behaviors due to variations in d-orbital electron configurations and band structures. The overlap of metal d-orbitals with oxygen p-orbitals can form electronic bands that allow valence electrons to delocalize freely. Certain oxides mimic the macroscopic properties of pure transition metals, displaying high electrical conduction and strong collective magnetic alignment.

Solution:

- (a) Chromium dioxide (CrO_2) is a specific transition metal oxide where chromium exists in the +4 oxidation state, leaving two unpaired electrons in the t_{2g} orbitals.
- (b) The spatial extension of these d-orbitals allows direct metal-metal interactions or metal-oxygen-metal conduction pathways, resulting in a partially filled d-band.
- (c) This unique electronic band structure imparts highly pronounced metallic conduction properties to the crystal, causing it to behave like a true electrical conductor over a wide temperature range.
- (d) Furthermore, the unpaired electronic spins in chromium dioxide couple via parallel exchange interactions, producing a strong, permanent macroscopic magnetic alignment known as ferromagnetism.
- (e) This combination of metallic conductivity and ferromagnetism makes chromium dioxide exceptionally valuable for industrial applications, such as the production of magnetic recording tapes. Other oxides listed, like titanium dioxide, behave as insulators or simple semiconductors, or exhibit antiferromagnetic coupling.

Final Answer: CrO_2 **Answer:** (B)[Go Back to Question 33](#)

Q34.

Solution**Concept:**

The aldol condensation reaction is a classic carbon-carbon bond-forming sequence characteristic of carbonyl compounds. When treated with a dilute aqueous base, a carbonyl molecule must first undergo deprotonation at the alpha-carbon position to generate a nucleophilic enolate ion. Therefore, the absolute structural requirement for any aldehyde or ketone to participate in this reaction pathway is the presence of at least one acidic alpha-hydrogen atom.

Solution:

- (a) Let us systematically examine the molecular structures of the carbonyl compounds provided in the options to assess their alpha-hydrogen content.
- (b) Acetaldehyde (CH_3CHO) possesses three alpha-hydrogen atoms on its methyl carbon, allowing it to easily form an enolate and undergo self-aldol condensation.
- (c) Propanal ($\text{CH}_3\text{CH}_2\text{CHO}$) features two alpha-hydrogen atoms on its adjacent methylene carbon, making it fully capable of participating in basic aldol chemistry.
- (d) Benzaldehyde ($\text{C}_6\text{H}_5\text{CHO}$) consists of a formyl functional group attached directly to an aromatic benzene ring. The carbon atom of the aromatic ring that is bonded to the carbonyl group contains four single covalent bonds and carries no hydrogen atoms.
- (e) Because benzaldehyde has zero alpha-hydrogen atoms, it is entirely incapable of forming an enolate ion under basic conditions and completely fails to undergo self-aldol condensation.
- (f) Acetone (CH_3COCH_3) contains six alpha-hydrogen atoms and easily condenses. Thus, benzaldehyde is the compound that fails the reaction.

Final Answer: Benzaldehyde

Answer: (C)

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Q35.

Solution**Concept:**

The mobility and electrolytic conduction of ions in an aqueous solution depend directly on their effective hydrodynamic radii. While gas-phase atomic or ionic radii are determined solely by nuclear charge and electron shells, the situation reverses completely in aqueous media due to ion-dipole hydration. Ions with a high charge density exert a strong electrostatic pull on neighboring polar water molecules, building a large shell of hydration.

Solution:

- Consider the alkali metal cations: lithium (Li^+), sodium (Na^+), potassium (K^+), and rubidium (Rb^+). All these ions carry a uniform +1 electrical charge.
- In terms of bare ionic size, lithium is the smallest and rubidium is the largest. Because the lithium ion has an exceptionally small bare radius, it possesses the highest charge density among the alkali metal group.
- This intense charge density causes the lithium ion to attract and hold a large, dense layer of water molecules, giving it the largest hydrated radius in aqueous solution.
- Conversely, the large rubidium ion has a low charge density and binds a thin hydration shell, resulting in the smallest hydrated radius.
- A large hydration sphere experiences significant viscous drag, which reduces the mobility and molar ionic conductivity of the ion. Therefore, the heavily hydrated lithium ion moves the slowest, while the weakly hydrated rubidium ion travels the fastest. This gives the exact increasing order of molar conductivity: $\text{Li}^+ < \text{Na}^+ < \text{K}^+ < \text{Rb}^+$.

Final Answer: $\text{Li}^+ < \text{Na}^+ < \text{K}^+ < \text{Rb}^+$

Answer: (A)

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Q36.

Solution**Concept:**

The spatial organization and molecular geometry of covalent molecules containing main-group elements can be predicted using Valence Shell Electron Pair Repulsion theory. This model counts the total number of valence shell electron pairs surrounding the central atom to establish a steric number. This steric number dictates the fundamental electron-pair geometry, while the specific positioning of bonding pairs and non-bonding lone pairs defines the actual molecular structure.

Solution:

- Let us determine the valence electronic structure of the central xenon (Xe) atom in the noble gas compound xenon tetrafluoride (XeF_4).
- Xenon belongs to the noble gas family and possesses 8 valence electrons in its outermost shell. The four fluorine ligands each contribute 1 electron for sharing, forming four distinct single covalent Xe – F bonds.
- Subtracting these 4 bonding electrons from xenon's initial 8 valence electrons leaves 4 unshared electrons, which correspond to exactly 2 non-bonding lone pairs.
- The total steric number is found by summing the 4 bonding pairs and the 2 lone pairs, yielding a value of 6. A steric number of 6 corresponds to an sp^3d^2 hybridization state with an underlying octahedral electron-pair geometry.
- To minimize lone pair-lone pair electrostatic repulsions, the 2 lone pairs occupy positions opposite each other at the axial vertices. The 4 fluorine atoms sit at the corners of a central plane, creating a square planar spatial geometry.

Final Answer: sp^3d^2 , Square planar

Answer: (C)

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Q37.

Solution**Concept:**

Colligative properties depend exclusively on the total concentration of solute particles present in a solution, regardless of their chemical identity. The van 't Hoff factor (i) serves as a quantitative measure of this effect, representing the ratio of the actual concentration of particles produced when a substance dissolves to the concentration of the solute calculated from its molecular mass. For strong electrolytes, this value reflects complete ionic dissociation.

Solution:

- Let us analyze the dissociation behavior of the salt potassium sulfate (K_2SO_4) when it is dissolved in a polar solvent like water.
- Potassium sulfate is an ionic compound composed of alkali metal cations and polyatomic oxoanions. In a highly dilute aqueous solution, strong electrolytes undergo complete ionization.
- The balanced chemical equation describing this complete 100% ionic dissociation process is written as: $K_2SO_4(aq) \rightarrow 2K^+(aq) + SO_4^{2-}(aq)$.
- From this stoichiometry, we can see that every single formula unit of potassium sulfate that dissolves dissociates to release exactly 2 moles of monovalent potassium cations and 1 mole of divalent sulfate anions.
- Summing these individual ionic fragments gives a total number of ions equal to $2 + 1 = 3$. Since the problem explicitly states that the salt undergoes complete 100% dissociation, the van 't Hoff factor (i) is mathematically equal to the total number of ions produced per formula unit, which is exactly 3.

Final Answer: 3**Answer:** (C)[Go Back to Question 37](#)

Q38.

Solution**Concept:**

Environmental atmospheric chemistry classifies air pollution patterns into distinct categories based on ambient conditions and chemical compositions. Smog is a prominent form of visible air pollution that develops in urban centers. The two primary variants are classical smog and photochemical smog, which differ fundamentally in their originating climates, core chemical pollutants, and resulting redox characteristics.

Solution:

- (a) Classical smog, historically known as London-type smog, is an environmental phenomenon that typically develops in cool, highly humid climates during the winter season.
- (b) This specific type of atmospheric pollution is initiated primarily by the widespread combustion of sulfur-rich fossil fuels, such as coal, in industrial and residential sectors.
- (c) The resulting mixture contains high concentrations of unburned carbon soot particles along with gaseous sulfur dioxide (SO_2).
- (d) Sulfur dioxide is a well-known chemical reducing agent. Because the mass of this smog contains elevated levels of reducing compounds like sulfur dioxide and carbon particulates, the overall chemical character of classical smog is designated as being reducing in nature.
- (e) This contrasts directly with photochemical smog, which develops in warm, sunny climates and is highly oxidizing due to high concentrations of ozone, oxides of nitrogen, and peroxyacetyl nitrates. Therefore, classical smog is fundamentally reducing in nature due to sulfur dioxide and soot.

Final Answer: Reducing in nature due to the presence of sulfur dioxide and carbon soot

Answer: (B)

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Q39.

Solution**Concept:**

Chemical thermodynamics analyzes energy transfers between systems and their surroundings during physical processes. Expansion work done by a gas depends on the external pressure opposing the boundary movement. When a gas expands into a completely evacuated region, the process is classified as a free expansion. The absolute value of the work done is governed by the magnitude of this opposing external force.

Solution:

- The infinitesimal mechanical expansion work (dw) performed by a gaseous system is defined mathematically by the pressure-volume work expression: $dw = -P_{\text{ext}}dV$.
- To determine the total work done (w) during a finite volume change from an initial state V_1 to a final state V_2 , we integrate this relationship: $w = -\int_{V_1}^{V_2} P_{\text{ext}}dV$.
- The problem states that the ideal gas undergoes an expansion process into a vacuum. By definition, an ideal vacuum is completely empty and exerts zero external pressure on the expanding system.
- Therefore, the opposing external pressure is precisely zero ($P_{\text{ext}} = 0$). Substituting this boundary condition into our integral work equation yields: $w = -\int_{V_1}^{V_2} (0)dV = 0$.
- Because there is no resisting force opposing the movement of the gas boundaries, the total work done (w) by the system on its surroundings is exactly equal to zero. This remains true regardless of whether the expansion is described as isothermal or reversible, as free expansion requires no work.

Final Answer: $w = 0$ **Answer: (B)**[Go Back to Question 39](#)

Q40.

Solution**Concept:**

Stereochemistry explores the three-dimensional spatial arrangement of atoms within molecular structures. An organic molecule exhibits optical activity and chirality if it cannot be superimposed on its own mirror image. The most common source of molecular chirality is the presence of an asymmetric or chiral carbon atom, which is defined as a tetrahedral carbon atom bonded to four entirely different atoms or chemical groups.

Solution:

- Let us systematically evaluate the molecular symmetry and substituent groups for each of the provided organic structures to locate a chiral carbon atom.
- Consider 2-chlorobutane. Its structural formula is $\text{CH}_3 - \text{CH}(\text{Cl}) - \text{CH}_2 - \text{CH}_3$. Let us examine the second carbon atom (C – 2) along the alkyl chain. This specific tetrahedral carbon is covalently bonded to four distinct groups: a hydrogen atom (–H), a chlorine atom (–Cl), a methyl group (–CH₃), and an ethyl group (–CH₂CH₃).
- Because C – 2 is bonded to four completely different chemical substituents, it represents a true chiral center, allowing 2-chlorobutane to exist as a pair of optically active enantiomers.
- Consider 1-chlorobutane (ClCH₂CH₂CH₂CH₃). Every carbon atom in this molecule is bonded to at least two identical hydrogen atoms, meaning it lacks a chiral center.
- Consider 2-chloropropane (CH₃CH(Cl)CH₃), where the central carbon is bonded to two identical methyl groups, making it achiral. Chlorocyclohexane possesses a plane of symmetry, rendering it achiral as well. Thus, 2-chlorobutane is the unique chiral molecule.

Final Answer: 2-Chlorobutane

Answer: (A)

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Answer Key

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

