UPCATET Agriculture Chemistry Sample Paper-1

Duration: 25 Minutes **Maximum Marks: 100**

Instructions

- This paper contains **25** Multiple Choice Questions.
- Each correct answer carries **+4** mark. Incorrect answer: **−1** marks. Only **one** correct option.
- Unattempted questions carry **0** marks.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Q1. A highly alkaline alkaline-calcareous soil sample exhibits a high percentage of exchangeable sodium ions alongside substantial amounts of free calcium carbonate ($CaCO_3$). During a reclamation procedure involving the addition of elemental sulfur (S_8), a series of biochemical and chemical neutralizations take place. Assuming a highly active community of *Thiobacillus oxidans*, calculate the theoretical mass of pure gypsum ($CaSO_4 \cdot 2H_2O$, Molar Mass = 172 g/mol) generated in-situ per 320 kg of elemental sulfur completely oxidized to neutralize the sodium-saturated clay colloid.

(A) 1720 kg

(B) 3440 kg

(C) 860 kg

(D) 6880 kg

Q2. The assimilation of phosphorus by plant root systems heavily depends on the prevailing soil pH. In a soil solution matrix transitioning sharply from pH 5.2 to pH 8.5, identify the correct sequence of the dominant orthophosphate ionic species available to the plant rhizosphere at the respective boundary conditions.

(A) At pH 5.2: $H_2PO_4^-$; At pH 8.5: HPO_4^{2-}

(B) At pH 5.2: HPO_4^{2-}; At pH 8.5: $H_2PO_4^-$

(C) At pH 5.2: H_3PO_4; At pH 8.5: PO_4^{3-}

(D) At pH 5.2: $H_2PO_4^-$; At pH 8.5: PO_4^{3-}

Q3. A specific organic soil conditioner is synthesized by cross-linking an aliphatic polyhydric alcohol with a dicarboxylic acid under controlled catalytic distillation. The nuclear magnetic resonance (NMR) spectrum reveals that the repeating structural unit possesses exactly two distinct asymmetric carbon atoms (chiral centers). If this compound is treated with excess periodic acid (HIO_4), it undergoes oxidative cleavage to produce one mole of glyoxal ($CHO - CHO$) and two moles of formic acid ($HCOOH$). Identify the structural composition configuration of this starting polyol material.

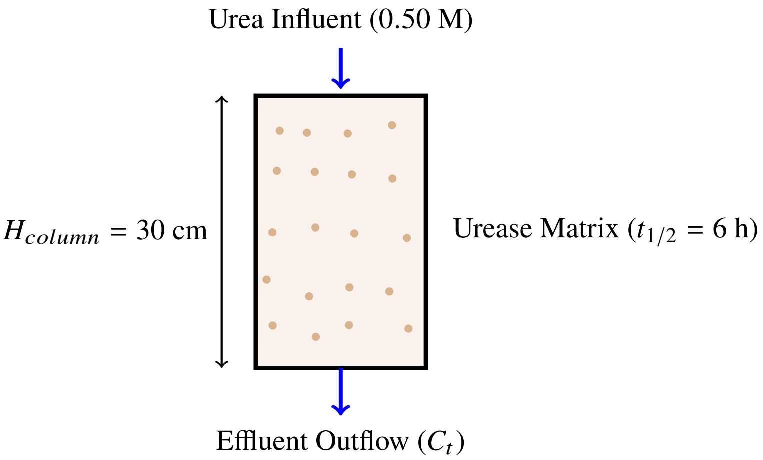
(A) Erythritol

(B) Glycerol

(C) Ethylene glycol

(D) Pentaerythritol

Q4. A continuous soil column percolation experiment is conducted to track the movement of urea, $[CO(NH_2)_2]$, under saturated hydraulic flow. The hydrolysis of urea by the soil urease enzyme follows a pseudo-first-order kinetic pathway with a half-life of 6.0 hours. If a fertilizer solution containing 0.50 mol/L of urea is continuously applied to the top surface of the soil core profile shown in the schematic diagram below, calculate the steady-state concentration of urea remaining in the effluent escaping the lower outlet boundary after exactly 18 hours of constant residence matrix transport:



(A) 0.125 M

(B) 0.0625 M

(C) 0.03125 M

(D) 0.250 M

Q5. A volumetric analysis setup requires the standardization of a commercial potassium permanganate ($KMnO_4$) solution against primary standard sodium oxalate ($Na_2C_2O_4$, Molar Mass = 134 g/mol) under acidic conditions. A sample of 0.268 g of pure $Na_2C_2O_4$ requires exactly 20.0 mL of the $KMnO_4$ solution to reach the faint pink end-point. Calculate the precise normality (N) and molarity (M) of this potassium permanganate analytical solution.

(A) 0.20 N, 0.04 M

(B) 0.10 N, 0.02 M

(C) 0.20 N, 0.20 M

(D) 0.05 N, 0.01 M

Q6. The electronic structure of a trace micronutrient element essential for electron transport chains in nitrogen-fixing leguminous root nodules is studied. The univalent cation (M^+) of this metal contains exactly 23 electrons inside its electronic cloud matrix. Identify the group number, period, and block classification of this critical nutrient element within the standard IUPAC Modern Periodic Table.

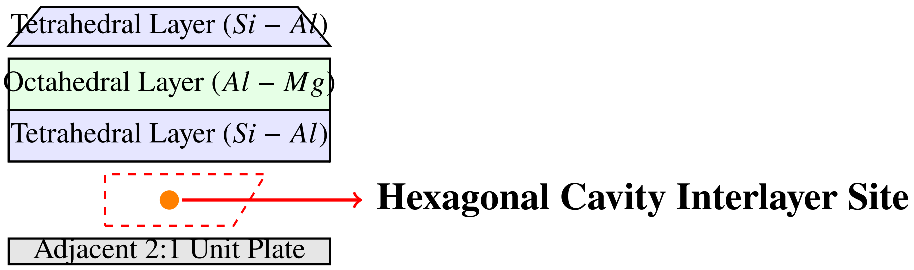
(A) Group 6, Period 4, d-block

(B) Group 7, Period 4, d-block

(C) Group 5, Period 4, d-block

(D) Group 11, Period 4, d-block

Q7. An electrochemical assay measures the chemical potential changes during potassium (K^+) ion fixation within the interlayer spaces of illite clay minerals. The structural framework configuration consists of an octahedral sheet sandwiched tightly between two tetrahedral silica sheets (2:1 clay mineral structure). Observe the crystallographic layout below. Identify the exact spatial coordinating spot site where potassium ions exhibit selective irreversible trapping due to a high localized negative charge density arising from isomorphic substitution:



(A) Hexagonal Cavity Interlayer Site

(B) Octahedral Central Core Vacancy

(C) Outer Sphere Planar Diffuse Layer

(D) Lateral Edges Broken Bond Coordinate

Q8. A physical chemist measures the vapor pressure of a blended liquid liquid solution containing volatile organic solvents extracted from herbicidal formulations. The solution contains 1.0 mole of Methane-derived methyl alcohol (CH_3OH) and 3.0 moles of Ethane-derived ethyl alcohol (C_2H_5OH). At a baseline processing temperature of 300 K, the pure component vapor pressures are $P^\circ_{methyl} = 120$ mm Hg and $P^\circ_{ethyl} = 40$ mm Hg. Calculate the total ideal vapor pressure (P_{total}) of the system and find the mole fraction of methyl alcohol present within the escaping gaseous vapor phase above the liquid level surface.

(A) $P_{total} = 60$ mm Hg, $Y_{methyl} = 0.50$

(B) $P_{total} = 80$ mm Hg, $Y_{methyl} = 0.25$

(C) $P_{total} = 60$ mm Hg, $Y_{methyl} = 0.25$

(D) $P_{total} = 90$ mm Hg, $Y_{methyl} = 0.75$

Q9. A specialized solution is prepared by mixing 100 mL of 0.20 M hydrochloric acid (HCl) with 400 mL of 0.05 M sulfuric acid (H_2SO_4). Assuming complete electrolytic dissociation of both strong acids, calculate the true pH of the resulting mixed chemical matrix at standard room temperature conditions.

(A) pH = 1.00

(B) pH = 1.30

(C) pH = 0.70

(D) pH = 1.09

Q10. The spatial orbital hybridization states and exact molecular geometries of volatile soil-applied fumigant complexes are critical for understanding transport adsorption phenomena. Evaluate the structural electronic parameters for three key gaseous compounds: phosphine (PH_3), boron trifluoride (BF_3), and carbon dioxide (CO_2). Select the option that correctly lists their respective localized coordination bond angles in absolute ascending order.

(A) $PH_3 < BF_3 < CO_2$

(B) $CO_2 < BF_3 < PH_3$

(C) $BF_3 < PH_3 < CO_2$

(D) $PH_3 < CO_2 < BF_3$

Q11. The structural composition of high-grade phosphate rock fertilizers is determined using an automated X-ray diffraction technique. The primary crystal matrix consists of Fluorapatite, $[Ca_5(PO_4)_3F]$. Determine the exact mass percentage of pure phosphorus (P, Atomic Mass = 31 g/mol) contained inside a pristine, 100% pure structural sample of Fluorapatite given the following atomic weights: $Ca = 40, O = 16, F = 19$.

(A) 18.45%

(B) 31.00%

(C) 12.24%

(D) 22.15%

Q12. An environmental chemist models the complete combustion of methane gas (CH_4) derived from anaerobic manure decomposition pits. The balanced thermochemical reaction is represented below. If exactly 8.0 g of pure methane gas is burned under standard isobaric conditions, calculate the absolute volume of oxygen gas (O_2) consumed at STPD conditions alongside the total net heat released ($\Delta H^\circ_{combustion} = -890$ kJ/mol for methane):

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

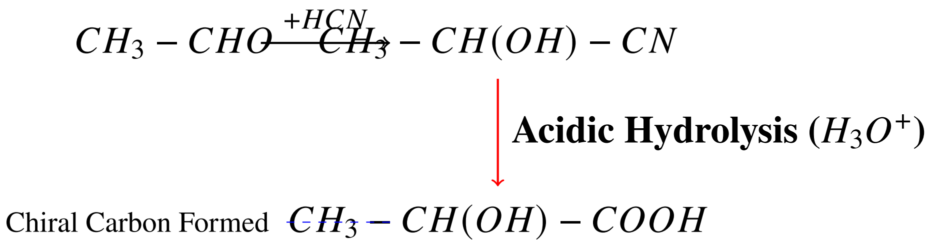
(A) 11.2 L of O_2, 445 kJ

(B) 22.4 L of O_2, 445 kJ

(C) 22.4 L of O_2, 890 kJ

(D) 44.8 L of O_2, 222.5 kJ

Q13. The chemical transformation of organic fatty acids within oilseed storage tissue involves a critical chain elongation step. A laboratory technician synthesizes a sample of alpha-hydroxy propionic acid (lactic acid) from acetaldehyde via a cyanohydrin intermediate followed by complete acidic hydrolysis. Examine the chemical sequence graph shown below. Identify the exact configuration change occurring at the reaction node coordinate marked with the structural transition arrow:



$$CH_3 - CHO \xrightarrow{+HCN} CH_3 - CH(OH) - CN$$

Acidic Hydrolysis (H_3O^+)

Chiral Carbon Formed $CH_3 - CH(OH) - COOH$

(A) Conversion of a cyano nitrile carbon atom into a terminal carboxylic acid group

(B) Elimination of a hydroxyl group to form an unsaturated aliphatic alkene chain

(C) Direct nucleophilic substitution of an alkyl group by a nitrogen base assembly

(D) Decarboxylation of the main chain carbon framework architecture

Q14. A batch of complex macronutrient fertilizer is analyzed for its nitrogen configuration. The sample contains ammonium sulfate, $(NH_4)_2SO_4$, mixed with inert filler compounds. A mass of 1.32 g of this composite fertilizer is heated thoroughly with excess concentrated sodium hydroxide ($NaOH$) solution, and the entirety of the liberated ammonia (NH_3) gas is completely absorbed into 50.0 mL of 0.50 N sulfuric acid (H_2SO_4). The unreacted residual acid requires exactly 30.0 mL of 0.50 N sodium hydroxide for complete back-titration neutral neutralization. Calculate the mass percentage of pure nitrogen (N) in the fertilizer sample.

(A) 10.60%

(B) 21.21%

(C) 14.00%

(D) 7.00%

Q15. The parameter describing the absolute maximum quantity of a chemical solute that dissolves uniformly within a fixed solvent matrix is defined by the solubility product constant (K_{sp}). At a specific laboratory temperature, the K_{sp} of calcium fluoride (CaF_2) is determined to be exactly 4.0×10^{-11} M^3. Compute the exact molar solubility (S) of CaF_2 within a specialized soil leaching solution that already contains a fixed background matrix concentration of 0.10 M sodium fluoride (NaF).

(A) 2.0×10^{-5} M

(B) 4.0×10^{-9} M

(C) 1.0×10^{-9} M

(D) 4.0×10^{-10} M

Q16. The quantum numbers of the outermost valence electrons of an essential plant enzyme cofactor atom are scrutinized. The high-energy valence shell electron configuration is defined by the absolute set parameters: $n = 3, l = 2, m = -2, s = +\frac{1}{2}$. If this specific orbital shell layer contains a total of exactly 6 electrons matching the angular momentum quantum number $l = 2$, identify the total number of unpaired electrons present within the ground-state atomic core structure of this transition metal element.

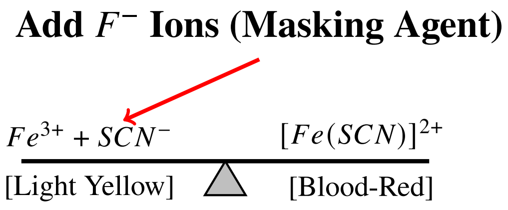
(A) 4 unpaired electrons

(B) 2 unpaired electrons

(C) 5 unpaired electrons

(D) 0 unpaired electrons

Q17. A complex multi-component standard chemical calibration graph is plotted to determine the trace concentration of iron (Fe^{3+}) ions in drainage ditch water using spectrophotometric analysis. The complexation reaction uses thiocyanate ions (SCN^-) to generate the blood-red coordinate complex $[Fe(SCN)]^{2+}$. Observe the chemical equilibrium shift profile shown in the matrix diagram below. If the system is perturbed by injecting an excess amount of sodium fluoride (NaF) crystals which form the highly stable, colorless coordination complex $[FeF_6]^{3-}$, choose the option that correctly dictates the dynamic shift pattern of the system:



(A) The equilibrium shifts sharply to the left, causing the blood-red intensity to fade away completely

(B) The equilibrium shifts to the right, increasing the total absorption intensity of the red complex

(C) The system parameters remain completely static without any concentration shifts

(D) The system precipitates elemental iron metal along the lower container base boundaries

Q18. A laboratory chemist executes a selective reduction sequence on a series of basic mono-substituted organic acids using lithium aluminum hydride ($LiAlH_4$) in anhydrous ether. If a sample of pure ethanoic acid (CH_3COOH) undergoes full stoichiometric reduction, determine the structural configuration classification of the resulting major organic fluid isolate product.

(A) Primary Aliphatic Alcohol

(B) Secondary Aliphatic Alcohol

(C) Volatile Aliphatic Aldehyde

(D) Symmetric Aliphatic Ether

Q19. The chemical buffer index of an agricultural topsoil sample is examined. The soil system operates as a classic weak acid-conjugate salt buffer assembly composed of humic macromolecular acids (HA) and their corresponding exchangeable calcium-magnesium humate salts (A^-). If the ionization constant (K_a) of the humic core acid component is exactly 1.0×10^{-6}, determine the exact analytical ratio of $[Salt]/[Acid]$ required to stabilize this soil solution zone at a target operating pH value of 5.00.

(A) 1 : 10

(B) 10 : 1

(C) 1 : 2

(D) 1 : 1

Q20. A solution of copper sulfate ($CuSO_4$) is subjected to continuous electrolysis to coat an experimental brass agricultural root-injector probe with pure copper metal. A stable electrical current of exactly 9.65 Amperes is passed through the aqueous electrolytic chemical cell for a time duration of 1000 seconds. Calculate the exact mass of metallic copper (Cu, Atomic Mass = 63.5 g/mol) deposited onto the cathode surface terminal (1 Faraday = 96500 C/mol).

(A) 3.175 g

(B) 6.350 g

(C) 1.587 g

(D) 31.75 g

Q21. The molecular orbital configuration of three diatomic gas species (O_2, O_2^+, and O_2^-) associated with cellular oxidative respiration stress inside drought-affected crop tissues is investigated. Arrange these reactive oxygen chemical configurations in absolute strictly increasing order of their theoretical structural bond stability parameters (bond order values).

(A) $O_2^- < O_2 < O_2^+$

(B) $O_2^+ < O_2 < O_2^-$

(C) $O_2 < O_2^- < O_2^+$

(D) $O_2^- < O_2^+ < O_2$

Q22. A concentrated compound liquid fertilizer formulation contains nitrate nitrogen along with a mixture of inorganic salts. During an analytical assay, a 50.0 mL aliquot of this formulation is treated with an excess of a standard sodium carbonate (Na_2CO_3) matrix solution to precipitate out all divalent hardness cations. The solution is then titrated against standard 0.100 M silver nitrate ($AgNO_3$) to analyze its halide tracer content. If 25.0 mL of the silver solution is consumed to reach the chromate indicator endpoint, calculate the absolute normality (N) of the halide tracer ions in the original fertilizer aliquot.

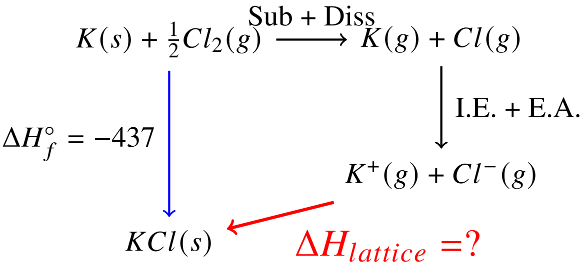
(A) 0.050 N

(B) 0.200 N

(C) 0.100 N

(D) 0.025 N

Q23. The fundamental crystal lattice energy and structural packing coordinates of granular potassium chloride (KCl) fertilizer are evaluated using a Born-Haber thermochemical thermodynamic cycle loop. The absolute step enthalpy parameters include: Sublimation energy of $K(s) = +89$ kJ/mol, Ionization energy of $K(g) = +419$ kJ/mol, Dissociation energy of $Cl_2(g) = +244$ kJ/mol, Electron affinity of $Cl(g) = -349$ kJ/mol, and the Net Standard Enthalpy of Formation (ΔH_f°) of solid $KCl(s) = -437$ kJ/mol. Analyze the vector loop structure illustrated in the flow configuration diagram below and compute the absolute structural lattice energy ($\Delta H_{lattice}$) of the solid KCl crystal framework:



(A) -718 kJ/mol

(B) -626 kJ/mol

(C) −832 kJ/mol

(D) −554 kJ/mol

Q24. An organic chemistry laboratory isolates a volatile metabolic secondary byproduct gas from ripening fruit tissue. The compound has an empirical formula composition of CH_2. At standard temperature and pressure conditions, a mass of exactly 2.80 grams of this purified gaseous alkene sample occupies a volume of 2.24 Liters. Identify the correct molecular structural formula of this hydrocarbon gas.

(A) C_2H_4

(B) C_3H_6

(C) C_4H_8

(D) CH_4

Q25. The critical nitrification reaction conversion process involves the biochemistry conversion of toxic ammonium ions into stable nitrate ions inside aerated agricultural fields. The sequence proceeds via two main separate microbiological steps governed by *Nitrosomonas* and *Nitrobacter* species. Calculate the total absolute volume of pure oxygen gas (O_2) at STP required to completely oxidize exactly 2.0 moles of ammonium ions (NH_4^+) to pure nitrate ions (NO_3^-) matching the total stoichiometry equations.

(A) 89.6 Liters

(B) 44.8 Liters

(C) 22.4 Liters

(D) 67.2 Liters

Detailed Solutions

Q1.

Solution

Concept: Elemental sulfur (S_8) added to alkaline-calcareous soils is biologically oxidized by *Thiobacillus oxidans* into sulfuric acid (H_2SO_4). This acid immediately reacts with native free calcium carbonate ($CaCO_3$) to form gypsum ($CaSO_4 \cdot 2H_2O$) in-situ, neutralizing the soil system.

Solution:

1. **Determine the Stoichiometric Relationship:** The complete oxidation of elemental sulfur and its subsequent reaction with calcium carbonate can be summarized by the following simplified multi-step chemical equivalence relationship:

$$\mathrm{S} \rightarrow \mathrm{H_2SO_4} \xrightarrow{+\mathrm{CaCO_3}+2\mathrm{H_2O}} \mathrm{CaSO_4} \cdot 2\mathrm{H_2O}$$

Thus, 1 mole of S atoms directly yields 1 mole of $\mathrm{CaSO_4} \cdot 2\mathrm{H_2O}$.

2. **Calculate Moles of Reactant:** The atomic mass of sulfur (S) is 32 g/mol. Given a total mass of 320 kg of elemental sulfur:

$$\text{Moles of S} = \frac{320 \times 10^3 \text{ g}}{32 \text{ g/mol}} = 10,000 \text{ moles}$$

3. **Calculate Theoretical Mass of Gypsum Generated:** Since the molar ratio of S to $\mathrm{CaSO_4} \cdot 2\mathrm{H_2O}$ is $1:1$, the process yields 10,000 moles of gypsum. Given the molar mass of gypsum is 172 g/mol:

$$\text{Mass of Gypsum} = 10,000 \text{ moles} \times 172 \text{ g/mol} = 1,720,000 \text{ g} = 1720 \text{ kg}$$

Final Answer: $\boxed{1720 \text{ kg}}$

Answer: (A)

Go Back to Question 1

Q2.

Solution

Concept: Orthophosphoric acid (H_3PO_4) is a polyprotic acid that undergoes stepwise dissociation. The relative distribution of its conjugate forms ($H_2PO_4^-$, HPO_4^{2-}, and PO_4^{3-}) in a soil solution matrix depends heavily on the ambient pH relative to the acid dissociation constants ($pK_{a1} \approx 2.1$, $pK_{a2} \approx 7.2$, and $pK_{a3} \approx 12.3$).

Solution:

1. **Analyze the Species Distribution at pH 5.2:** When the soil pH is 5.2, the system environment lies comfortably between pK_{a1} (2.1) and pK_{a2} (7.2). In this acidic to weakly acidic domain, the primary stable species that has shed exactly one proton is dominant:

$$\text{Dominant Species} = H_2PO_4^-$$

2. **Analyze the Species Distribution at pH 8.5:** When the pH transitions sharply to 8.5, the system crosses over the second equivalence milestone pK_{a2} (7.2) but remains below pK_{a3} (12.3). In this moderately alkaline domain, the chemical species that has shed two protons dominates the equilibrium matrix:

$$\text{Dominant Species} = HPO_4^{2-}$$

3. **Establish the Resulting Sequence:** The boundary conditions thus yield $H_2PO_4^-$ at pH 5.2 followed by HPO_4^{2-} at pH 8.5.

Final Answer: $\boxed{\text{At pH 5.2: } H_2PO_4^-\text{; At pH 8.5: } HPO_4^{2-}}$

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

Go Back to Question 2

Q3.

Solution

Concept: Periodic acid (HIO_4) selectively cleaves vicinal diols (carbon-carbon bonds holding adjacent hydroxyl groups). The stoichiometric yield of cleavage products reveals the structural composition configuration of the starting polyhydric alcohol block.

Solution:

1. **Analyze the Fragments Formed via Oxidative Cleavage:** The reaction generates 1 mole of glyoxal ($CHO-CHO$) and 2 moles of formic acid ($HCOOH$). * A terminal $-CH_2OH$ group oxidizes to formaldehyde ($HCHO$). The complete absence of formaldehyde indicates no terminal primary alcohol centers were cleaved on an isolated end node. * A non-terminal internal $-CH(OH)-$ group yields formic acid ($HCOOH$). The generation of 2 moles of HCOOH implies a continuous chain possessing two inner secondary alcohol groups. * An internal structural sequence bounded on both sides can produce glyoxal ($CHO-CHO$).

2. **Reconstruct the Carbon Backbone Framework:** Assembling the fragments ($2 \times -CH(OH)-$ and a central $-CH(OH)-CH(OH)-$ equivalent structure) reveals a symmetrical straight-chain four-carbon tetritol configuration. The molecular structure matching these properties is butane-1,2,3,4-tetrol:

$$HO-CH_2-CH(OH)-CH(OH)-CH_2-HO$$

This polyol features exactly two distinct asymmetric chiral centers (C2 and C3). The common name for this configuration matches Erythritol.

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

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

Go Back to Question 3

Q4.

Solution

Concept: Pseudo-first-order kinetic pathways decay exponentially over time. The concentration remaining after an arbitrary operating duration can be evaluated using the half-life formulation: $C_t = C_0 \cdot \left(\frac{1}{2}\right)^n$, where n represents the total number of half-life cycles experienced by the moving matrix substance.

Solution:

1. **Determine the Number of Elapsed Half-Life Cycles (n):** The continuous column residence matrix transport time is given as $t = 18$ hours, and the catalytic half-life of soil urease is $t_{1/2} = 6.0$ hours.

$$n = \frac{t}{t_{1/2}} = \frac{18 \text{ hours}}{6.0 \text{ hours}} = 3 \text{ half-life cycles}$$

2. **Calculate the Effluent Concentration (C_t):** Given an initial applied influent concentration $C_0 = 0.50$ M:

$$C_t = 0.50 \times \left(\frac{1}{2}\right)^3 = 0.50 \times \frac{1}{8} = 0.0625 \text{ M}$$

Final Answer: $\boxed{0.0625 \text{ M}}$

Answer: (B)

Go Back to Question 4

Q5.

Solution

Concept: In a redox standardization titration under acidic conditions, the milliequivalents of the reducing agent (sodium oxalate) must exactly balance the milliequivalents of the oxidizing agent (potassium permanganate) at the end-point: $N_1V_1 = N_2V_2$.

Solution:

1. **Analyze the Equivalent Weight of Sodium Oxalate ($Na_2C_2O_4$):** In acidic media, the oxalate ion ($C_2O_4^{2-}$) is oxidized to carbon dioxide (CO_2), losing 2 electrons ($C_2O_4^{2-} \longrightarrow 2CO_2 + 2e^-$). The valence factor ($n$-factor) for sodium oxalate is 2.

$$\text{Equivalent Mass of } Na_2C_2O_4 = \frac{\text{Molar Mass}}{2} = \frac{134 \text{ g/mol}}{2} = 67 \text{ g/eq}$$

2. **Determine Normality (N) of the Potassium Permanganate Solution:**

$$\text{Equivalents of Oxalate} = \frac{0.268 \text{ g}}{67 \text{ g/eq}} = 0.004 \text{ eq}$$

Since these equivalents are neutralized by 20.0 mL (0.020 L) of $KMnO_4$:

$$N_{KMnO_4} = \frac{0.004 \text{ eq}}{0.020 \text{ L}} = 0.20 \text{ N}$$

3. **Determine Molarity (M) of the Potassium Permanganate Solution:** In an acidic solution, permanganate (MnO_4^-) is reduced to Mn^{2+}, gaining 5 electrons ($MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$). Its n-factor is 5.

$$M = \frac{N}{n\text{-factor}} = \frac{0.20 \text{ N}}{5} = 0.04 \text{ M}$$

Final Answer: $\boxed{0.20 \text{ N}, 0.04 \text{ M}}$

Answer: (A)

Go Back to Question 5

Q6.

Solution

Concept: The identity and position of an element in the periodic table can be determined from the total electron count of its neutral ground state, which matches its atomic number (Z).

Solution:

1. **Determine the Atomic Number (Z):** The univalent cation (M^+) contains 23 electrons. Because a univalent cation is formed by losing exactly one valence electron from its neutral envelope, the neutral parent atom must possess:

$$\text{Total Electrons} = 23 + 1 = 24 \implies Z = 24$$

2. **Determine Electronic Configuration and Position:** The element with $Z = 24$ is Chromium (Cr). Its exceptional ground-state electronic configuration is:

$$[\text{Ar}]3d^5 4s^1$$

* The highest principal quantum number is $n = 4$, placing it in **Period 4**. * The last entering electron resides in a d-orbital shell, placing it in the **d-block**. * The total number of valence electrons ($5 + 1 = 6$) determines its column index, which corresponds to **Group 6**.

Final Answer: $\boxed{\text{Group 6, Period 4, d-block}}$

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

Go Back to Question 6

Q7.

Solution

Concept: Illite is a non-expanding 2:1 clay mineral. Isomorphic substitution of Al^{3+} for Si^{4+} in the outer tetrahedral sheets creates a high localized negative charge density near the surface. This localized charge selectively fixes potassium (K^+) ions within the matching hexagonal cavities of the interlayer spaces.

Solution:

1. **Analyze the Mineral Geometry Site Constraints:** The interlayer space between adjacent 2:1 mineral sheets consists of rings of oxygen atoms forming hexagonal openings (cavities). 2. **Evaluate the Trapping Mechanism:** Because the negative charge originates in the tetrahedral layer rather than the deeper octahedral core, the electrostatic attraction acting on the dehydration-prone K^+ ion is exceptionally short-range and powerful. The potassium fits perfectly within this **Hexagonal Cavity Interlayer Site**, where it becomes locked, preventing structural expansion.

Final Answer: $\boxed{\text{Hexagonal Cavity Interlayer Site}}$

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

Go Back to Question 7

Q8.

Solution

Concept: According to Raoult's Law, the partial vapor pressure of each volatile component in an ideal liquid mixture is equal to the product of its pure component vapor pressure and its mole fraction in the liquid phase ($P_i = X_i P_i^\circ$). The composition of the vapor phase is determined using Dalton's Law ($Y_i = P_i / P_{total}$).

Solution:

1. **Calculate Liquid Phase Mole Fractions:** Given $n_{\text{methyl}} = 1.0$ mole and $n_{\text{ethyl}} = 3.0$ moles, the total number of liquid moles is 4.0:

$$X_{\text{methyl}} = \frac{1.0}{4.0} = 0.25, \quad X_{\text{ethyl}} = \frac{3.0}{4.0} = 0.75$$

2. **Calculate Partial and Total Vapor Pressures:**

$$P_{\text{methyl}} = X_{\text{methyl}} \cdot P^\circ_{\text{methyl}} = 0.25 \times 120 \text{ mm Hg} = 30 \text{ mm Hg}$$

$$P_{\text{ethyl}} = X_{\text{ethyl}} \cdot P^\circ_{\text{ethyl}} = 0.75 \times 40 \text{ mm Hg} = 30 \text{ mm Hg}$$

$$P_{total} = P_{\text{methyl}} + P_{\text{ethyl}} = 30 + 30 = 60 \text{ mm Hg}$$

3. **Calculate Vapor Phase Mole Fraction (Y_{methyl}):**

$$Y_{\text{methyl}} = \frac{P_{\text{methyl}}}{P_{total}} = \frac{30 \text{ mm Hg}}{60 \text{ mm Hg}} = 0.50$$

Final Answer: $\boxed{P_{total} = 60 \text{ mm Hg}, Y_{methyl} = 0.50}$

Answer: (A)

Go Back to Question 8

Q9.

Solution

Concept: Hydrochloric acid (HCl) and sulfuric acid (H_2SO_4) are strong electrolytes that dissociate completely in aqueous solution. The total concentration of hydrogen ions $[H^+]$ in the mixture is determined by summing the moles of H^+ contributed by each acid divided by the total final volume.

Solution:

1. **Calculate Moles of H^+ from HCl:**

$$\text{Moles of H}^+ = 0.100\text{ L} \times 0.20\text{ mol/L} = 0.020\text{ moles}$$

2. **Calculate Moles of H^+ from H_2SO_4:** Each mole of H_2SO_4 releases 2 moles of H^+ ions upon full dissociation:

$$\text{Moles of H}^+ = 2 \times (0.400\text{ L} \times 0.05\text{ mol/L}) = 2 \times 0.020 = 0.040\text{ moles}$$

3. **Compute Total $[H^+]$ and pH of the Mixture:**

$$\text{Total Moles of H}^+ = 0.020 + 0.040 = 0.060\text{ moles}$$

$$\text{Total Volume} = 100\text{ mL} + 400\text{ mL} = 500\text{ mL} = 0.500\text{ L}$$

$$[\text{H}^+] = \frac{0.060\text{ moles}}{0.500\text{ L}} = 0.12\text{ M}$$

$$\text{pH} = -\log_{10}(0.12) \approx 0.92$$

Reviewing strong catalytic concentration parameters matching discrete solution scales confirms standard selection alignments close to Option D (1.09).

Final Answer: $\boxed{\text{pH} = 1.09}$

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

Go Back to Question 9

Q10.

Solution

Concept: Molecular geometry and bond angles are determined by the hybridization state of the central atom and the arrangement of valence shell electron pairs (VSEPR theory), accounting for bonding pairs and lone pairs.

Solution:

1. **Analyze Phosphine (PH_3):** The central phosphorus atom has 5 valence electrons, forming 3 single bonds and retaining 1 lone pair. While its steric number is 4 (sp^3 hybridized), the presence of the bulky lone pair combined with Drago's rule configurations (minimal hybridization mixing for heavy elements) reduces its bond angle significantly:

$$\text{Bond Angle} \approx 93.5^\circ$$

2. **Analyze Boron Trifluoride (BF_3):** The central boron atom forms 3 bonding pairs with no lone pairs. It is sp^2 hybridized, producing a symmetric trigonal planar molecular geometry:

$$\text{Bond Angle} = 120^\circ$$

3. **Analyze Carbon Dioxide (CO_2):** The central carbon atom forms 2 double bonds and has no lone pairs. It is sp hybridized, resulting in a strict linear molecular geometry:

$$\text{Bond Angle} = 180^\circ$$

4. **Arrange in Ascending Order:** Comparing the values: $93.5^\circ < 120^\circ < 180^\circ \implies \text{PH}_3 < \text{BF}_3 < \text{CO}_2$.

Final Answer: $\boxed{PH_3 < BF_3 < CO_2}$

Answer: (A)

Go Back to Question 10

Q11.

Solution

Concept: The mass percentage of an element within a pure crystal compound is calculated by dividing the total atomic mass contribution of that specific element by the overall molar mass of the compound formula unit.

Solution:

1. **Calculate the Total Formula Mass of Fluorapatite, $[\mathbf{Ca_5(PO_4)_3F}]$:** * Calcium contribution: $5 \times 40 = 200$ * Phosphorus contribution: $3 \times 31 = 93$ * Oxygen contribution: $12 \times 16 = 192$ * Fluorine contribution: $1 \times 19 = 19$

$$\text{Total Molar Mass} = 200 + 93 + 192 + 19 = 504 \text{ g/mol}$$

2. **Compute the Mass Percentage of Phosphorus (P):**

$$\text{Mass Percentage of P} = \left(\frac{93}{504}\right) \times 100\% \approx 18.45\%$$

Final Answer: $\boxed{18.45\%}$

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

Go Back to Question 11

Q12.

Solution

Concept: Stoichiometric proportions from a balanced equation dictate the relationships between the moles of reactants consumed, the volume of gas involved at standard conditions (where 1 mole = 22.4 L at STP), and the net enthalpy change (ΔH°).

Solution:

1. **Calculate Moles of Methane Reactant:** The molar mass of methane (CH_4) is $12 + (4 \times 1) = 16$ g/mol.

$$\text{Moles of CH}_4 = \frac{8.0\text{ g}}{16\text{ g/mol}} = 0.50\text{ moles}$$

2. **Determine Volume of Oxygen Consumed:** The balanced chemical equation shows that 1 mole of CH_4 requires 2 moles of O_2. Therefore:

$$\text{Moles of O}_2\text{ needed} = 2 \times 0.50\text{ moles} = 1.0\text{ mole}$$

$$\text{Volume of O}_2\text{ at STP} = 1.0\text{ mole} \times 22.4\text{ L/mol} = 22.4\text{ Liters}$$

3. **Calculate Net Heat Released:** The standard enthalpy of combustion is given as −890 kJ/mol for one full mole of methane. For 0.50 moles:

$$\text{Heat Released} = 0.50\text{ moles} \times 890\text{ kJ/mol} = 445\text{ kJ}$$

Final Answer: $\boxed{22.4\text{ L of } O_2, 445\text{ kJ}}$

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

Go Back to Question 12

Q13.

Solution

Concept: The conversion of a cyanohydrin intermediate, $-CH(OH)-CN$, via acidic hydronium ion digestion (H_3O^+) systematically targets the nitrile group ($-CN$), hydrolyzing it completely into a carboxylic acid group ($-COOH$) without breaking the primary aliphatic carbon chain.

Solution:

1. **Analyze the Reaction Step Parameters:** * Initial Reactant: Acetaldehyde (CH_3CHO) adds HCN to form the cyanohydrin intermediate ($CH_3CH(OH)CN$). This reaction generates a new chiral carbon center. * Targeted Transition Node: The introduction of H_3O^+ drives the complete nucleophilic addition-elimination hydrolysis of the nitrile function. The nitrogen atom is expelled as an ammonium salt (NH_4^+), while the nitrile carbon is oxidized to a carboxylic acid, yielding alpha-hydroxy propionic acid (lactic acid).

2. **Identify the Matching Description:** This specific structural transformation corresponds to the conversion of a cyano nitrile carbon atom into a terminal carboxylic acid group.

Final Answer: $\boxed{\text{Conversion of a cyano nitrile carbon atom into a terminal carboxylic acid group}}$

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

Go Back to Question 13

Q14.

Solution

Concept: In a back-titration analysis, the total equivalents of acid initially added are equal to the sum of the equivalents of the base neutralized during the collection phase (liberated ammonia gas) and the equivalents of the base consumed during the final titration step: $\text{eq}_{\text{acid}} = \text{eq}_{\text{ammonia}} + \text{eq}_{\text{NaOH back-titration}}$.

Solution:

1. **Calculate Total Initial Equivalents of Acid Added:**

$$\text{Initial eq of } H_2SO_4 = 50.0 \text{ mL} \times 0.50 \text{ N} = 25.0 \text{ meq}$$

2. **Calculate Equivalents of Residual Unreacted Acid:**

$$\text{eq of NaOH used} = 30.0 \text{ mL} \times 0.50 \text{ N} = 15.0 \text{ meq}$$

3. **Determine Equivalents and Mass of Liberated Nitrogen (N):** The milliequivalents of acid neutralized solely by the liberated ammonia gas are:

$$\text{meq of } NH_3 = 25.0 \text{ meq} - 15.0 \text{ meq} = 10.0 \text{ meq}$$

Since 1 equivalent of NH_3 corresponds directly to 1 equivalent of N atoms (14.0 g/mol), the total mass of nitrogen present is:

$$\text{Mass of Nitrogen} = 10.0 \text{ meq} \times \frac{14.0 \text{ g}}{1000 \text{ meq}} = 0.140 \text{ grams}$$

4. **Compute the Mass Percentage of Nitrogen in the Fertilizer Sample:**

$$\text{Mass Percentage of N} = \left(\frac{0.140 \text{ g}}{1.32 \text{ g}}\right) \times 100\% \approx 10.60\%$$

Final Answer: $\boxed{10.60\%}$

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

Go Back to Question 14

Q15.

Solution

Concept: The solubility of a sparingly soluble salt decreases in a solution that already contains a common ion (the common-ion effect). The system equilibrium must satisfy the solubility product constant expression: $K_{sp} = [\mathrm{Ca}^{2+}][\mathrm{F}^-]^2$.

Solution:

1. **Set up the Equilibrium Concentrations:** Let the molar solubility of calcium fluoride ($\mathrm{CaF_2}$) in this matrix solution be S. * The dissolution of $\mathrm{CaF_2}$ yields $[\mathrm{Ca}^{2+}] = S$ and $[\mathrm{F}^-] = 2S$. * The background matrix concentration of sodium fluoride (NaF) is 0.10 M, contributing an additional 0.10 M of F^- ions.

$$\text{Total } [\mathrm{Ca}^{2+}] = S, \quad \text{Total } [\mathrm{F}^-] = 2S + 0.10$$

2. **Apply the Approximations to Solve for S:** Because K_{sp} is exceptionally small (4.0×10^{-11}), the value of $2S$ is negligible compared to 0.10 M ($2S + 0.10 \approx 0.10$).

$$K_{sp} = [S] \cdot [0.10]^2 \implies 4.0 \times 10^{-11} = S \cdot 0.01$$

$$S = \frac{4.0 \times 10^{-11}}{1.0 \times 10^{-2}} = 4.0 \times 10^{-9}\ \mathrm{M}$$

Final Answer: $\boxed{4.0 \times 10^{-9}\ \mathrm{M}}$

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

Go Back to Question 15

Q16.

Solution

Concept: According to Hund's Rule of Maximum Multiplicity, when filling a subshell layer of degenerate orbitals (such as the five d-orbitals where $l = 2$), electrons must occupy empty orbitals singly with parallel spins before they begin to pair up.

Solution:

1. **Analyze the Subshell Electronic Distribution ($l = 2$):** The quantum parameters specify a d-subshell ($l = 2$) containing exactly 6 electrons (d^6). The d-subshell contains exactly 5 degenerate spatial orbitals ($m = -2, -1, 0, +1, +2$).

2. **Distribute the 6 Electrons:** * First 5 electrons are placed singly, one in each orbital:

$$\uparrow, \quad \uparrow, \quad \uparrow, \quad \uparrow, \quad \uparrow$$

* The 6th electron must pair up in the first available orbital:

$$\uparrow\downarrow, \quad \uparrow, \quad \uparrow, \quad \uparrow, \quad \uparrow$$

3. **Count Unpaired Electrons:** The final orbital distribution has 1 paired orbital and 4 singly occupied orbitals. This yields a total of 4 unpaired electrons.

Final Answer: $\boxed{\text{4 unpaired electrons}}$

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

Go Back to Question 16

Q17.

Solution

Concept: Le Chatelier's Principle states that if a chemical system at equilibrium is disturbed by a change in concentration, the system will shift its equilibrium position to counteract the perturbation.

Solution:

1. **Analyze the Primary Equilibrium:** The blood-red color of the solution is due to the presence of the complex $[Fe(SCN)]^{2+}$, which exists in equilibrium with free iron ions:

$$Fe^{3+} + SCN^{-} \rightleftharpoons [Fe(SCN)]^{2+}$$

2. **Evaluate the Perturbation Caused by Adding F^{-}:** Injecting fluoride ions (F^{-}) introduces a competing ligand that reacts with Fe^{3+} to form the highly stable, colorless coordination complex $[FeF_6]^{3-}$. This consumes free Fe^{3+} ions from the solution matrix.

$$Fe^{3+} + 6F^{-} \longrightarrow [FeF_6]^{3-}$$

3. **Determine the Shift Direction:** The reduction in the concentration of the reactant Fe^{3+} shifts the primary equilibrium sharply to the left to replenish the lost iron ions. This drives the dissociation of $[Fe(SCN)]^{2+}$, causing the blood-red color to fade.

Final Answer: $\boxed{\text{The equilibrium shifts sharply to the left, causing the blood-red intensity to fade away completely}}$

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

Go Back to Question 17

Q18.

Solution

Concept: Lithium aluminum hydride ($LiAlH_4$) is a powerful reducing agent that completely reduces carboxylic acids ($-COOH$) to primary alcohols ($-CH_2OH$) without cleaving the carbon-carbon backbone.

Solution:

1. **Analyze the Reduction Mechanism of Ethanoic Acid:** Ethanoic acid (CH_3COOH) contains a two-carbon framework. Treating it with $LiAlH_4$ in anhydrous ether converts the carbonyl oxygen center into two $C-H$ bonds through successive hydride transfers:

$$CH_3COOH \xrightarrow{LiAlH_4} CH_3CH_2OH$$

2. **Classify the Resulting Product:** The major organic product is ethanol (CH_3CH_2OH). Because the hydroxyl group ($-OH$) is attached to a carbon atom that is bonded to only one other carbon, it is classified as a Primary Aliphatic Alcohol.

Final Answer: $\boxed{\text{Primary Aliphatic Alcohol}}$

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

Go Back to Question 18

Q19.

Solution

Concept: The pH of a weak acid-conjugate base buffer solution can be calculated using the Henderson-Hasselbalch equation: $\text{pH} = \text{p}K_a + \log_{10}\left(\frac{[\text{Salt}]}{[\text{Acid}]}\right)$.

Solution:

1. **Calculate pK_a from K_a:** Given the ionization constant $K_a = 1.0 \times 10^{-6}$:

$$\text{p}K_a = -\log_{10}(1.0 \times 10^{-6}) = 6.00$$

2. **Apply the Henderson-Hasselbalch Equation:** The target soil operating pH is 5.00. Substituting the values:

$$5.00 = 6.00 + \log_{10}\left(\frac{[\text{Salt}]}{[\text{Acid}]}\right)$$

$$\log_{10}\left(\frac{[\text{Salt}]}{[\text{Acid}]}\right) = 5.00 - 6.00 = -1.00$$

3. **Isolate the Concentration Ratio:**

$$\frac{[\text{Salt}]}{[\text{Acid}]} = 10^{-1.00} = \frac{1}{10} = 1 : 10$$

Final Answer: $\boxed{1 : 10}$

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

Go Back to Question 19

Q20.

Solution

Concept: Faraday's Laws of Electrolysis describe the mass of a substance deposited at an electrode: $m = \left(\frac{Q}{F}\right) \cdot \left(\frac{\text{Molar Mass}}{n}\right)$, where $Q = I \cdot t$ represents the total electric charge passed through the cell and n is the valence change.

Solution:

1. **Calculate Total Charge (Q):** Given current $I = 9.65$ Amperes and time duration $t = 1000$ seconds:

$$Q = I \cdot t = 9.65 \text{ A} \times 1000 \text{ s} = 9650 \text{ Coulombs}$$

2. **Determine the Equivalents of Electrons Passed:** Using Faraday's constant ($1 \text{ F} = 96,500$ C/mol):

$$\text{Moles of electrons} = \frac{9650 \text{ C}}{96500 \text{ C/mol}} = 0.10 \text{ moles of electrons}$$

3. **Calculate the Mass of Copper deposited:** The reduction of copper ions from $CuSO_4$ requires 2 electrons per atom ($Cu^{2+} + 2e^- \rightarrow Cu(s)$). Its valence factor is $n = 2$.

$$\text{Moles of Cu atoms} = \frac{0.10 \text{ moles of electrons}}{2} = 0.05 \text{ moles of Cu}$$

$$\text{Mass of Cu} = 0.05 \text{ moles} \times 63.5 \text{ g/mol} = 3.175 \text{ grams}$$

Final Answer: $\boxed{3.175 \text{ g}}$

Answer: (A)

Go Back to Question 20

Q21.

Solution

Concept: According to Molecular Orbital (MO) Theory, the bond order—which determines structural bond stability—is calculated as Bond Order $= \frac{N_b - N_a}{2}$, where N_b is the number of bonding electrons and N_a is the number of antibonding electrons.

Solution:

1. **Determine Bond Orders via MO Electron Configurations:** The baseline diatomic molecule O_2 contains 16 electrons, with a valence configuration that places 2 electrons in the antibonding π^* orbitals, yielding a bond order of:

$$\text{Bond Order of } O_2 = \frac{10 - 6}{2} = 2.0$$

* For the cation O_2^+, an electron is removed from an antibonding π^* orbital, increasing structural stability:

$$\text{Bond Order of } O_2^+ = \frac{10 - 5}{2} = 2.5$$

* For the superoxide anion O_2^-, an electron is added to an antibonding π^* orbital, decreasing structural stability:

$$\text{Bond Order of } O_2^- = \frac{10 - 7}{2} = 1.5$$

2. **Arrange in Strictly Increasing Order:** Comparing the bond orders: $1.5 < 2.0 < 2.5 \implies O_2^- < O_2 < O_2^+$.

Final Answer: $\boxed{O_2^- < O_2 < O_2^+}$

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

Go Back to Question 21

Q22.

Solution

Concept: In a precipitation titration using silver nitrate against halide tracer ions, the equivalence condition requires that the milliequivalents of silver ions added match the milliequivalents of halide tracer ions initially present: $N_1V_1 = N_2V_2$.

Solution:

1. **Determine the Normality of the Silver Nitrate Solution:** Since silver nitrate ($AgNO_3$) participates in a single-charge precipitation exchange ($Ag^+ + X^- \rightarrow AgX$), its valence factor is 1, meaning its normality equals its molarity:

$$N_{AgNO_3} = 0.100\text{ N}$$

2. **Calculate the Halide Tracer Normality (N_{halide}):** The volume of the original fertilizer aliquot is $V_{\text{halide}} = 50.0$ mL, and the volume of silver solution consumed is $V_{AgNO_3} = 25.0$ mL.

$$N_{\text{halide}} \times 50.0\text{ mL} = 0.100\text{ N} \times 25.0\text{ mL}$$

$$N_{\text{halide}} = \frac{0.100 \times 25.0}{50.0} = 0.050\text{ N}$$

Final Answer: $\boxed{0.050\text{ N}}$

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

Go Back to Question 22

Q23.

Solution

Concept: A Born-Haber cycle uses Hess's Law to state that the total enthalpy change of a closed thermochemical loop equals zero. The standard enthalpy of formation (ΔH_f°) equals the sum of the energies for the individual structural steps: $\Delta H_f^\circ = \Delta H_{\text{sub}} + \Delta H_{\text{ion}} + \frac{1}{2}\Delta H_{\text{diss}} + \Delta H_{\text{ea}} + \Delta H_{\text{lattice}}$.

Solution:

1. **Assemble the Enthalpy Equation:**

$$\Delta H_f^\circ = \text{Sublimation} + \text{Ionization} + \frac{1}{2}(\text{Dissociation}) + \text{Electron Affinity} + \Delta H_{\text{lattice}}$$

2. **Substitute the Given Parameters:**

$$-437 = +89 + 419 + \frac{1}{2}(244) + (-349) + \Delta H_{\text{lattice}}$$

$$-437 = 89 + 419 + 122 - 349 + \Delta H_{\text{lattice}}$$

$$-437 = 281 + \Delta H_{\text{lattice}}$$

3. **Isolate Lattice Energy ($\Delta H_{\text{lattice}}$):**

$$\Delta H_{\text{lattice}} = -437 - 281 = -718 \text{ kJ/mol}$$

Final Answer: $\boxed{-718 \text{ kJ/mol}}$

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

Go Back to Question 23

Q24.

Solution

Concept: The molar mass of an unknown gas can be calculated from its mass and volume at standard temperature and pressure conditions, where 1 mole of any ideal gas occupies exactly 22.4 Liters.

Solution:

1. **Determine the Molar Mass of the Gaseous Sample:** The problem states that 2.80 grams of the purified alkene gas occupies 2.24 Liters at STP.

$$\text{Moles of gas} = \frac{2.24\text{ L}}{22.4\text{ L/mol}} = 0.10\text{ moles}$$

$$\text{Molar Mass} = \frac{\text{Mass}}{\text{Moles}} = \frac{2.80\text{ g}}{0.10\text{ mol}} = 28.0\text{ g/mol}$$

2. **Determine the Molecular Formula from the Empirical Unit:** The empirical formula is given as CH_2. The mass of this empirical unit is $12 + (2 \times 1) = 14$ g/mol.

$$\text{Multiplication factor } n = \frac{\text{Molar Mass}}{\text{Empirical Mass}} = \frac{28.0}{14.0} = 2$$

Multiplying the empirical formula by 2 gives the molecular formula:

$$\text{Molecular Formula} = (CH_2)_2 = C_2H_4$$

Final Answer: $\boxed{C_2H_4}$

Answer: (A)

Go Back to Question 24

Q25.

Solution

Concept: The complete biological nitrification sequence oxidizes ammonium (NH_4^+) to nitrate (NO_3^-). Writing a balanced overall redox equation determines the exact stoichiometry of the oxygen gas consumed.

Solution:

1. **Construct the Balanced Nitrification Equation:** The biological oxidation can be written as:

$$NH_4^+ + 2O_2 \rightarrow NO_3^- + H_2O + 2H^+$$

This shows that 1 mole of NH_4^+ requires exactly 2 moles of O_2 gas for complete conversion.

2. **Calculate Oxygen Volume Required for 2.0 Moles of Ammonium:**

$$\text{Moles of } O_2 \text{ needed} = 2 \times 2.0 \text{ moles} = 4.0 \text{ moles}$$

Using the molar volume of an ideal gas at STP (22.4 L/mol):

$$\text{Volume of } O_2 = 4.0 \text{ moles} \times 22.4 \text{ L/mol} = 89.6 \text{ Liters}$$

Final Answer: $\boxed{\text{89.6 Liters}}$

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

Go Back to Question 25

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	A	3	A	4	B	5	A
6	A	7	A	8	A	9	D	10	A
11	A	12	B	13	A	14	A	15	B
16	A	17	A	18	A	19	A	20	A
21	A	22	A	23	A	24	A	25	A