Rajasthan JET Chemistry Sample Paper-12

Duration: 40 Minutes **Maximum Marks: 160**

Instructions

- This paper contains **40** Multiple Choice Questions (Single Correct).
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries: **−1 marks**.
- Use of mobile phones, smartwatches, calculators, or any electronic gadgets is strictly prohibited.

Q1. A soil sample has a high concentration of sodium ions (Na^+) adsorbed on the soil exchange complex, resulting in a poor, compacted soil structure. Which of the following soil amendments is most effective to replace sodium and improve soil aggregation?

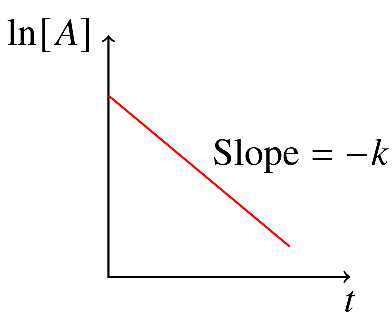
(A) Calcium Carbonate ($CaCO_3$)

(B) Gypsum ($CaSO_4 \cdot 2H_2O$)

(C) Sodium Silicate (Na_2SiO_3)

(D) Ammonium Nitrate (NH_4NO_3)

Q2. For a certain first-order reaction, the rate constant k is given as $2.303 \times 10^{-3}\ s^{-1}$. What is the time required for the initial concentration of the reactant to reduce to exactly 10% of its initial value?



(A) 100 s

(B) 460 s

(C) 1000 s

(D) 2303 s

Q3. The dynamic equilibrium $A(g) + 2B(g) \rightleftharpoons C(g) + \text{Heat}$ is established in a closed container. Which of the following changes will shift the equilibrium position to favor the formation of more products?

(A) Increasing the temperature of the system

(B) Decreasing the total pressure by increasing container volume

(C) Introducing an inert gas at constant volume

(D) Increasing the concentration of reactant B

Q4. Identify the major product obtained when propene undergoes hydroboration followed by oxidation with alkaline hydrogen peroxide (H_2O_2/OH^-).

$$CH_3 - CH = CH_2 \xrightarrow[2.\ H_2O_2/OH^-]{1.\ B_2H_6} \quad ?$$

(A) Propan-2-ol

(B) Propan-1-ol

(C) Propanone

(D) 1,2-Propanediol

Q5. An organic compound with the molecular formula C_3H_6O forms a yellow precipitate when treated with iodine and sodium hydroxide solution, but it does not reduce Tollens' reagent. Identify the compound.

$$CH_3-\overset{\overset{\displaystyle O}{|}}{C}-CH_3$$

(A) Propanal

(B) Propan-1-ol

(C) Propanone

(D) Propanoic acid

Q6. What is the total number of σ (sigma) and π (pi) bonds present in a molecule of But-1-en-3-yne?

$$CH_2 \vdots CH - C - CH$$

(A) 7σ and 3π

(B) 6σ and 4π

(C) 8σ and 2π

(D) 5σ and 4π

Q7. In an aqueous solution at 25°C, the concentration of hydroxide ions (OH^-) is found to be 1.0×10^{-9} mol/L. What is the pH of this solution?

(A) 9.0

(B) 5.0

(C) 7.0

(D) 4.0

Q8. Which of the following chemical fertilizers is classified as a complex fertilizer that simultaneously provides two primary macronutrients to plants?

(A) Urea

(B) Single Superphosphate (SSP)

(C) Diammonium Phosphate (DAP)

(D) Muriate of Potash (MOP)

Q9. In a milk processing laboratory, the fat percentage of a buffalo milk sample is determined using the Gerber method. Which of the following reagents is specifically used to separate and clear the fat column by dissolving the milk proteins?

(A) Concentrated Nitric Acid

(B) 90% Ethyl Alcohol

(C) Gerber Amyl Alcohol

(D) Concentrated Sulfuric Acid (d = 1.82 g/mL)

Q10. An aqueous solution contains a mixture of 0.1 M acetic acid and 0.1 M sodium acetate. If the pK_a of acetic acid is 4.76, what is the pH of this buffer system after the addition of a negligible volume of water?

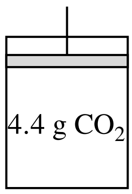
(A) 3.76

(B) 4.76

(C) 5.76

(D) 7.00

Q11. When 4.4 grams of carbon dioxide (CO_2) gas is measured at Standard Temperature and Pressure (STP), what is the total volume occupied by the gas sample? (Atomic mass: C = 12, O = 16)



STP Condition

(A) 22.4 Liters

(B) 11.2 Liters

(C) 2.24 Liters

(D) 4.4 Liters

Q12. Which of the following elements belongs to the 3d transition series (D-block) and exhibits the highest possible oxidation state of +7 in its chemical compounds?


$3d^5$ configuration

(A) Iron (Fe)

(B) Chromium (Cr)

(C) Manganese (Mn)

(D) Cobalt (Co)

Q13. According to the IUPAC nomenclature system, what is the correct name for the organic compound $(CH_3)_2CH - CH(CH_3) - CH_2 - CH_3$?

(A) 2,3-Dimethylbutane

(B) 2,3-Dimethylpentane

(C) 3,4-Dimethylpentane

(D) Isoheptane

Q14. Plant micronutrients play vital roles in enzymatic reactions. Which of the following metallic micronutrients is an essential structural component of the enzyme urease and is critical for nitrogen metabolism in crops?

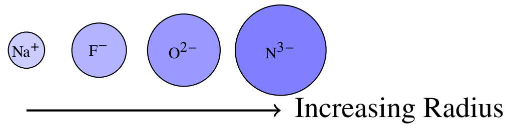
(A) Zinc (Zn)

(B) Copper (Cu)

(C) Nickel (Ni)

(D) Boron (B)

Q15. The ionic radius of isoelectronic species is governed by nuclear charge. Arrange the following isoelectronic ions in the correct increasing order of their ionic radii: N^{3-}, O^{2-}, F^-, Na^+.



(A) $Na^+ < F^- < O^{2-} < N^{3-}$

(B) $N^{3-} < O^{2-} < F^- < Na^+$

(C) $F^- < Na^+ < O^{2-} < N^{3-}$

(D) $Na^+ < O^{2-} < F^- < N^{3-}$

Q16. What type of polymer is Nylon-6,6 based on its mode of polymerization and mechanical properties?

(A) Addition polymer, Elastomer

(B) Condensation polymer, Fiber

(C) Condensation polymer, Thermoplastic

(D) Addition polymer, Thermosetting plastic

Q17. A commercial sample of Single Superphosphate (SSP) fertilizer is purchased by a farmer in Rajasthan. What is the standard percentage of water-soluble available phosphorus (%P_2O_5) typically present in standard SSP?

(A) 46%

(B) 18%

(C) 16%

(D) 60%

Q18. The electronic configuration of an element is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$. To which group and period of the modern periodic table does this element belong?

(A) Group 6, Period 4

(B) Group 5, Period 4

(C) Group 1, Period 4

(D) Group 6, Period 3

Q19. Which of the following chemical compounds is primarily responsible for the temporary hardness of groundwater samples drawn from semi-arid regions?

(A) Calcium Sulfate ($CaSO_4$)

(B) Magnesium Chloride ($MgCl_2$)

(C) Magnesium Bicarbonate ($Mg(HCO_3)_2$)

(D) Sodium Carbonate (Na_2CO_3)

Q20. In the formal redox reaction: $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$, what is the total change in the oxidation number of a single manganese atom?

(A) Decreases by 5

(B) Increases by 2

(C) Decreases by 3

(D) Increases by 5

Q21. Lyophilic colloidal sols are inherently more stable than lyophobic colloidal sols. This exceptional stability of lyophilic sols is primarily attributed to:

(A) The presence of strong electrical charge on the particles alone

(B) High Brownian movement of the dispersed phase

(C) Extensive solvation (hydration) of the colloidal particles

(D) Low surface tension of the dispersion medium

Q22. Soil organic matter contains stable humic substances. Which fraction of humus is characteristically soluble in both dilute alkali solutions and dilute acid solutions?

(A) Humic acid

(B) Fulvic acid

(C) Humin

(D) Clay-humus complex

Q23. An organic reaction involves the treatment of benzaldehyde with concentrated sodium hydroxide solution, resulting in the simultaneous formation of benzyl alcohol and sodium benzoate. This transformation is known as:

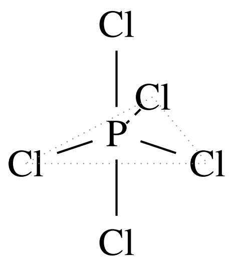
(A) Aldol Condensation

(B) Cannizzaro Reaction

(C) Rosenmund Reduction

(D) Clemmensen Reduction

Q24. Predict the shape and the type of hybridisation of the central atom in a molecule of Phosphorus Pentachloride (PCl_5) in its gaseous state.



(A) Square pyramidal, sp^3d^2

(B) Trigonal bipyramidal, sp^3d

(C) Octahedral, sp^3d^2

(D) Trigonal planar, sp^2

Q25. Alkaline soils prevalent in western Rajasthan typically possess a pH value within which of the following ranges?

(A) 4.5 – 5.5

(B) 6.0 – 6.5

(C) 7.0 – 7.5

(D) 8.5 – 10.0

Q26. For a chemical reaction, the rate constant k doubles when the temperature is raised from 300 K to 310 K. This temperature dependence of the rate constant is described mathematically by which equation?

(A) Kirchhoff's Equation

(B) Arrhenius Equation

(C) Van 't Hoff Equation

(D) Gibbs-Duhem Equation

Q27. Carbohydrates are stored in the animal body as a specific polysaccharide reserve. Name this highly branched glucose polymer found in the liver and muscle tissues?

(A) Starch

(B) Cellulose

(C) Glycogen

(D) Amylose

Q28. When secondary butyl chloride (2-chlorobutane) is treated with hot alcoholic potassium hydroxide (KOH), the major organic elimination product formed is:

(A) But-1-ene

(B) Butan-2-ol

(C) trans-But-2-ene

(D) cis-But-2-ene

Q29. Which of the following elements is classified as an essential "Beneficial Element" for specific crops like rice, although it is not included in the classic 17 essential plant nutrients?

(A) Silicon (Si)

(B) Iron (Fe)

(C) Copper (Cu)

(D) Magnesium (Mg)

Q30. What is the correct value of the total spin-only magnetic moment (μ) for a gaseous Fe^{2+} ion in its ground state? (Atomic number of Fe = 26)

(A) 5.92 BM

(B) 4.90 BM

(C) 2.84 BM

(D) 1.73 BM

Q31. The structural formula of the pesticide Malathion falls under which broad chemical class of plant protection agrochemicals?

(A) Organochlorines

(B) Organophosphates

(C) Carbamates

(D) Synthetic Pyrethroids

Q32. In the estimation of nitrogen in an agricultural soil sample using Kjeldahl's method, the ammonia evolved from the digested soil is neutralized by absorbing it into a known excess of which standard solution?

(A) Sodium Hydroxide (NaOH)

(B) Sulfuric Acid (H_2SO_4)

(C) Boric Acid containing indicator

(D) Hydrochloric Acid (HCl)

Q33. Which of the following functional group priorities is correct according to the IUPAC rules when numbering a principal carbon chain?

(A) $-COOH > -CHO > -OH > -NH_2$

(B) $-CHO > -COOH > -NH_2 > -OH$

(C) $-OH > -CHO > -COOH > -NH_2$

(D) $-COOH > -OH > -CHO > -NH_2$

Q34. According to the molecular orbital theory (MOT), which of the following homonuclear diatomic species is unstable and cannot exist under ordinary conditions due to a bond order of zero?

(A) Li_2

(B) Be_2

(C) B_2

(D) C_2

Q35. The synthesis of alkyl fluorides is best achieved efficiently by heating an alkyl chloride or bromide in the presence of metallic fluorides like AgF or SbF_3. This specific halogen exchange pathway is called:

(A) Finkelstein Reaction

(B) Swarts Reaction

(C) Wurtz Reaction

(D) Gattermann Reaction

Q36. Which of the following nitrogenous fertilizers produces the highest residual acidity in the soil per unit of nitrogen applied, requiring careful monitoring in acidic soil patches?

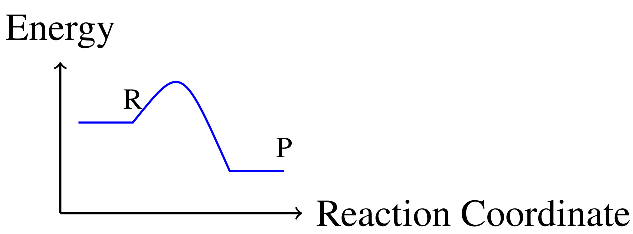
(A) Urea

(B) Ammonium Sulfate

(C) Calcium Ammonium Nitrate (CAN)

(D) Potassium Nitrate

Q37. An industrial process synthesizes ammonia gas according to the exothermic equation: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$. What is the exact mathematical relationship between the equilibrium constants K_p and K_c for this system?



(A) $K_p = K_c(RT)$

(B) $K_p = K_c(RT)^{-1}$

(C) $K_p = K_c(RT)^{-2}$

(D) $K_p = K_c(RT)^2$

Q38. When an ideal gas undergoes an isothermal and reversible expansion against a finite external pressure, what are the respective values for the change in internal energy (ΔU) and the change in enthalpy (ΔH)?

(A) $\Delta U > 0, \Delta H = 0$

(B) $\Delta U = 0, \Delta H = 0$

(C) $\Delta U = 0, \Delta H < 0$

(D) $\Delta U < 0, \Delta H < 0$

Q39. Identify the structural monomer units that compose the biopolymer Lac (Lakh), a natural resin secreted by the insect *Kerria lacca* found in India.

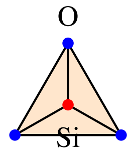
(A) Isoprene units

(B) Glucose and Fructose

(C) Hydroxy fatty acids and sesquiterpene acids

(D) Amino acids joined by peptide links

Q40. What is the fundamental chemical composition of the primary mineral known as Quartz, which dominates the sand fraction of most agricultural soils?



(A) Calcium Carbonate ($CaCO_3$)

(B) Silicon Dioxide (SiO_2)

(C) Aluminum Oxide (Al_2O_3)

(D) Potassium Feldspar ($KAlSi_3O_8$)

Detailed Solutions

Q1.

Solution

Concept: The problem is based on reclamation of alkali soils. Alkali soils are characterized by an excess of exchangeable sodium ions (Na^+) on the clay complex, which causes soil dispersion, column collapse, and poor physical structure. To improve structure, a source of soluble calcium (Ca^{2+}) is added to replace the adsorbed Na^+ via cation exchange, allowing the sodium to be leached out.

Solution: Step 1: Identify the primary cause of poor soil structure. High concentration of exchangeable sodium causes soil particles to disperse, leading to low permeability and high compaction.
Step 2: Evaluate the available amendments. Gypsum ($CaSO_4 \cdot 2H_2O$) is a moderately soluble salt that provides abundant divalent calcium (Ca^{2+}) ions in the soil solution.
Step 3: Formulate the chemical exchange reaction on the soil matrix:

$$\text{Soil} \cdot 2Na^+ + CaSO_4 \longrightarrow \text{Soil} \cdot Ca^{2+} + Na_2SO_4$$

Step 4: The flocculating power of Ca^{2+} is much higher than Na^+. Once Ca^{2+} replaces Na^+, it promotes the aggregation of soil particles into stable crumbs, opening up pore spaces.
Step 5: The byproduct, soluble sodium sulfate (Na_2SO_4), is subsequently removed from the root zone by irrigation and drainage. Calcium carbonate ($CaCO_3$) is ineffective in alkaline conditions due to its extreme insolubility at high pH.

Final Answer: $\boxed{\text{Gypsum } (CaSO_4 \cdot 2H_2O)}$

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

Go Back to Question 1

Q2.

Solution

Concept: The kinetics of a first-order reaction can be quantitatively described using the integrated rate law expression. The time required for a specific percentage completion depends solely on the rate constant k and is independent of the initial concentration of the reacting species.

Solution: Step 1: Write down the integrated rate equation for a standard first-order reaction:

$$t = \frac{2.303}{k} \log_{10}\left(\frac{[A]_0}{[A]_t}\right)$$

Step 2: Substitute the given parameters into the expression. The rate constant k is 2.303×10^{-3} s^{-1}.
Step 3: Determine the final concentration ratio. Since the reactant concentration reduces to 10% of its initial value, we have:

$$[A]_t = 0.10 \times [A]_0 \implies \frac{[A]_0}{[A]_t} = \frac{[A]_0}{0.10 \times [A]_0} = 10$$

Step 4: Substitute these values into the integrated formula:

$$t = \frac{2.303}{2.303 \times 10^{-3}} \log_{10}(10)$$

Step 5: Simplify the mathematical terms. Since $\log_{10}(10) = 1$, the expression evaluates to:

$$t = \frac{1}{10^{-3}} \times 1 = 10^3 = 1000 \text{ s}$$

Thus, it requires exactly 1000 seconds for the concentration to fall to 10% of its original value.

Final Answer: $\boxed{1000 \text{ s}}$

Answer: (C)

Go Back to Question 2

Q3.

Solution

Concept: Le Chatelier's principle states that if a dynamic equilibrium system is subjected to a change in concentration, temperature, or total pressure, the position of the equilibrium shifts in a direction that tends to counteract or undo the effect of the applied change.

Solution: Step 1: Analyze the given chemical equation:

$$\mathrm{A}(g) + 2\mathrm{B}(g) \rightleftharpoons \mathrm{C}(g) + \text{Heat}$$

The forward reaction is exothermic ($\Delta H < 0$) and involves a decrease in the total number of gaseous moles ($\Delta n_g = 1 - (1 + 2) = -2$).
Step 2: Evaluate the temperature effect. Because the reaction releases heat, increasing the temperature will shift the equilibrium in the reverse direction to absorb heat.
Step 3: Evaluate the pressure effect. Increasing volume decreases pressure. A drop in pressure shifts equilibrium toward more gas moles (reverse).
Step 4: Evaluate the inert gas addition. Adding an inert gas at constant volume does not change the partial pressures of the reactants or products, hence no shift occurs.
Step 5: Evaluate concentration changes. Increasing the concentration of reactant B disturbs the ratio. To consume the added reactant, the system shifts forward, producing more product C.

Final Answer: $\boxed{\text{Increasing the concentration of reactant B}}$

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

Go Back to Question 3

Q4.

Solution

Concept: Hydroboration-oxidation is a two-step organic reaction sequence that converts an alkene into an alcohol. The overall transformation results in the net addition of water (H_2O) across the carbon-carbon double bond with regioselectivity corresponding to anti-Markovnikov addition and stereo-specific syn-addition.

Solution: Step 1: Identify the starting material, which is propene ($CH_3 - CH = CH_2$), an unsymmetrical alkene.
Step 2: Analyze the first step, hydroboration. Borane (BH_3 or B_2H_6) adds across the double bond. The boron atom, being electrophilic, attaches preferentially to the less hindered terminal carbon atom, while the hydride attaches to the secondary carbon. This yields a trialkylborane intermediate:

$$3CH_3 - CH = CH_2 + BH_3 \longrightarrow (CH_3 - CH_2 - CH_2)_3B$$

Step 3: Analyze the second step, oxidation. Treating the trialkylborane with basic hydrogen peroxide (H_2O_2/OH^-) cleaves the carbon-boron bonds, replacing them with hydroxyl ($-OH$) functional groups.
Step 4: Determine the identity of the product. The hydroxyl group ends up on the terminal carbon atom. Therefore, the transformation avoids rearranging carbocations and produces Propan-1-ol exclusively as the major product.

Final Answer: $\boxed{\text{Propan-1-ol}}$

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

Go Back to Question 4

Q5.

Solution

Concept: The problem involves qualitative chemical tests for functional groups in carbonyl compounds. Compounds containing a methyl ketone structure ($R-CO-CH_3$) react with iodine in the presence of a base (NaOH) to yield a yellow precipitate of iodoform (CHI_3). Aldehydes reduce Tollens' reagent to form a silver mirror, whereas ketones do not.

Solution: Step 1: Analyze the molecular formula C_3H_6O. The degree of unsaturation is $3 - \frac{6}{2} + 1 = 1$, indicating either a cyclic structure or a double bond (like a carbonyl group).
Step 2: Interpret the negative Tollens' test. The compound does not reduce Tollens' reagent ($[Ag(NH_3)_2]^+$, implying that it is not an aldehyde. Thus, Propanal is eliminated.
Step 3: Interpret the positive iodoform test. The formation of a yellow precipitate with $I_2/NaOH$ reveals the presence of a $CH_3C=O$ unit.
Step 4: Evaluate Propanone ($CH_3-CO-CH_3$). It is a ketone with a methyl group directly bound to the carbonyl carbon. It fits the formula C_3H_6O and satisfies all chemical behaviors.
Step 5: Conclude that the compound must be propanone (acetone), as alcohols and acids with this formula fail to match these specific chemical reactivity parameters.

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

Answer: (C)

Go Back to Question 5

Q6.

Solution

Concept: Covalent chemical bonds are classified based on orbital overlap. A single covalent bond consists of one σ bond. A double bond contains one σ and one π bond. A triple bond consists of one σ bond and two π bonds. The total count requires accounting for both carbon-carbon and carbon-hydrogen linkages.

Solution: Step 1: Write out the complete, expanded structural formula of But-1-en-3-yne to clearly see all individual atomic connections:

$$H - C(H) = C(H) - C \equiv C - H$$

Step 2: Enumerate the carbon-hydrogen $(C - H)$ single bonds. There are two on C_1, one on C_2, and one on C_4, making a total of $2 + 1 + 1 = 4$ individual $C - H$ σ bonds.
Step 3: Analyze the carbon-carbon framework. Between C_1 and C_2, there is a double bond $(1\sigma + 1\pi)$. Between C_2 and C_3, there is a single bond (1σ). Between C_3 and C_4, there is a triple bond $(1\sigma + 2\pi)$.
Step 4: Sum all the σ bonds together:

$$\text{Total } \sigma = 4 \text{ (from C-H)} + 1 \text{ (from double bond)} + 1 \text{ (from single bond)} + 1 \text{ (from triple bond)} = 7$$

Step 5: Sum all the π bonds together:

$$\text{Total } \pi = 1 \text{ (from double bond)} + 2 \text{ (from triple bond)} = 3$$

Thus, the molecule possesses exactly 7σ and 3π bonds.

Final Answer: $\boxed{7\sigma \text{ and } 3\pi}$

Answer: (A)

Go Back to Question 6

Q7.

Solution

Concept: The pH and pOH of aqueous solutions are logarithmic scales representing hydronium and hydroxide ion activities. At 25°C, the autoionization constant of water (K_w) is exactly 1.0×10^{-14}, which leads to the foundational relationship: pH + pOH = 14.

Solution: Step 1: Given the hydroxide ion concentration $[OH^-] = 1.0 \times 10^{-9}$ mol/L.
Step 2: Calculate the pOH of the solution using its negative logarithmic definition:

$$\text{pOH} = -\log_{10}[\text{OH}^-] = -\log_{10}(1.0 \times 10^{-9}) = 9$$

Step 3: Use the standard relation valid at 25°C to find the pH value:

$$\text{pH} + \text{pOH} = 14 \implies \text{pH} = 14 - \text{pOH}$$

Step 4: Substitute the computed pOH value into the mathematical equation:

$$\text{pH} = 14 - 9 = 5.0$$

Step 5: Double-check the answer using hydronium concentration:

$$[\text{H}^+] = \frac{K_w}{[\text{OH}^-]} = \frac{10^{-14}}{10^{-9}} = 10^{-5}\text{ M} \implies \text{pH} = 5.0$$

The solution has a pH of 5.0, which corresponds to an acidic environment.

Final Answer: $\boxed{5.0}$

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept: Chemical fertilizers are categorized based on their nutrient composition. A straight fertilizer provides only one primary macronutrient (N, P, or K). A complex or compound fertilizer contains two or more primary macronutrients chemically combined in its manufacture.

Solution: Step 1: Analyze option A. Urea [$CO(NH_2)_2$] contains approximately 46% Nitrogen. It provides only a single nutrient (N), so it is a straight fertilizer.
Step 2: Analyze option B. Single Superphosphate (SSP) primarily supplies Phosphorus (16% P_2O_5) along with calcium and sulfur. It acts as a single nutrient source for primary macronutrients.
Step 3: Analyze option C. Diammonium Phosphate [$(NH_4)_2HPO_4$] is manufactured by reacting ammonia with phosphoric acid. It explicitly contains about 18% Nitrogen and 46% Phosphorus (P_2O_5). Since it provides two primary macronutrients simultaneously, it is classified as a complex fertilizer.
Step 4: Analyze option D. Muriate of Potash (KCl) contains 60% K_2O, providing only Potassium, making it a straight fertilizer.

Final Answer: Diammonium Phosphate (DAP)

Answer: (C)

Go Back to Question 8

Q9.

Solution

Concept: The Gerber method is a standard volumetric test used globally to estimate the fat content in milk and dairy products. It involves adding specific chemicals to a butyrometer to digest the non-fat solid matrix, liberating the suspended fat globules so they can form a clear, readable column.

Solution: Step 1: Understand the physical composition of milk. Milk is an emulsion where fat globules are stabilized by a surrounding membrane of proteins (casein).
Step 2: To measure the fat, this protein barrier must be broken. Concentrated sulfuric acid (H_2SO_4) with a specific density of 1.82 g/mL is mixed with the sample.
Step 3: The concentrated sulfuric acid chemically hydrolyzes and dissolves the milk proteins (casein) and generates heat, which liquifies the fat.
Step 4: Amyl alcohol is also added to reduce charring and help create a distinct, clear demarcation line for the fat column during centrifugation. However, it is the dense sulfuric acid that physically acts as the primary protein-dissolving and clearing agent.

Final Answer: Concentrated Sulfuric Acid (d = 1.82 g/mL)

Answer: (D)

Go Back to Question 9

Q10.

Solution

Concept: An aqueous mixture of a weak acid and its conjugate salt forms an acidic buffer solution. The pH of such a system is quantitatively described by the Henderson-Hasselbalch equation: $\text{pH} = \text{p}K_a + \log_{10}\left(\frac{[\text{Salt}]}{[\text{Acid}]}\right)$.

Solution: Step 1: Identify the components of the buffer system. The weak acid is acetic acid (CH_3COOH) at 0.1 M concentration, and the salt is sodium acetate (CH_3COONa) at 0.1 M concentration.

Step 2: Set up the Henderson-Hasselbalch equation for an acidic buffer:

$$\text{pH} = \text{p}K_a + \log_{10}\left(\frac{[CH_3COONa]}{[CH_3COOH]}\right)$$

Step 3: Substitute the concentrations into the logarithmic ratio:

$$\text{Ratio} = \frac{0.1}{0.1} = 1$$

Step 4: Compute the logarithm of the ratio:

$$\log_{10}(1) = 0$$

Step 5: Add this value to the given pK_a value (4.76):

$$\text{pH} = 4.76 + 0 = 4.76$$

Adding a negligible amount of water shifts the absolute volumes but preserves the strict molar ratio of salt to acid, maintaining a constant pH of 4.76.

Final Answer: $\boxed{4.76}$

Answer: (B)

Go Back to Question 10

Q11.

Solution

Concept: According to Avogadro's hypothesis, one mole of any ideal gas occupies a standard molar volume of 22.4 Liters at Standard Temperature and Pressure (STP, defined at 0°C and 1 atm). Stoichiometric calculations allow us to link the mass of a gas to its volume via the number of moles.

Solution: Step 1: Determine the molecular mass of carbon dioxide (CO_2).

$$\text{Molar Mass} = \text{Mass of C} + 2 \times \text{Mass of O} = 12 + 2(16) = 44 \text{ g/mol}$$

Step 2: Calculate the number of moles present in the given 4.4 grams sample:

$$\text{Moles of } CO_2 = \frac{\text{Given Mass}}{\text{Molar Mass}} = \frac{4.4 \text{ g}}{44 \text{ g/mol}} = 0.1 \text{ mole}$$

Step 3: Convert the calculated moles into volume at STP conditions using the molar volume factor:

$$\text{Volume} = \text{Number of Moles} \times 22.4 \text{ L/mol}$$

$$\text{Volume} = 0.1 \text{ mole} \times 22.4 \text{ L/mol} = 2.24 \text{ Liters}$$

Hence, the 4.4 grams sample of CO_2 gas occupies a volume of 2.24 Liters at STP.

Final Answer: $\boxed{\text{2.24 Liters}}$

Answer: (C)

Go Back to Question 11

Q12.

Solution

Concept: The transition elements in the D-block possess valence electrons in both their outermost $4s$ subshell and the underlying $(n-1)d$ subshell. The maximum oxidation state shown by a transition metal is often determined by the total number of available un-paired $3d$ electrons plus the two $4s$ electrons.

Solution: Step 1: Examine Manganese (Mn), whose atomic number is 25. Its ground-state electron configuration is:

$$\text{Mn} = [\text{Ar}]3d^5 4s^2$$

Step 2: Manganese has 5 electrons in its $3d$ orbitals and 2 electrons in its $4s$ orbital, all of which can participate in chemical bonding due to their close energy levels.

Step 3: When all 7 valence electrons are lost or shared (as in permanganate ions, MnO_4^-), Manganese attains its highest oxidation state of +7.

Step 4: Compare this with Chromium ($[\text{Ar}]3d^5 4s^1$, max +6) and Iron ($[\text{Ar}]3d^6 4s^2$, max +6 under extreme conditions). Thus, Manganese stands out as the $3d$ metal that reaches +7.

Final Answer: $\boxed{\text{Manganese (Mn)}}$

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

Go Back to Question 12

Q13.

Solution

Concept: IUPAC nomenclature rules require: (1) Finding the longest continuous carbon chain to serve as the parent alkane. (2) Numbering the principal chain from the end that gives the substituent groups the lowest possible locants. (3) Listing substituents alphabetically with their positions.

Solution: Step 1: Expand the condensed structural formula to locate the longest chain:

$$CH_3 - CH(CH_3) - CH(CH_3) - CH_2 - CH_3$$

Step 2: Count the continuous carbon chains. The longest unbranched path contains 5 carbon atoms. Therefore, the root word for the parent alkane is pentane.
Step 3: Number the chain to minimize locant values. Numbering from the left end gives substituents at positions 2 and 3. Numbering from the right gives positions 3 and 4. We choose the lower set: $(2, 3)$.
Step 4: Identify the substituents at positions 2 and 3. Both are methyl ($-CH_3$) groups. Combining them gives "2,3-dimethyl".
Step 5: Assemble the complete name: 2,3-Dimethylpentane.

Final Answer: $\boxed{\text{2,3-Dimethylpentane}}$

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

Go Back to Question 13

Q14.

Solution

Concept: Plants require micronutrients in trace amounts to serve as cofactors or structural components in critical enzymes. Each microelement regulates specific metabolic processes. For example, nitrogen assimilation and urea conversion rely heavily on nickel-dependent enzymatic pathways.

Solution: Step 1: Identify the specific enzyme mentioned: Urease. Urease catalyzes the hydrolysis of urea into ammonia and carbon dioxide:

$$CO(NH_2)_2 + H_2O \rightarrow 2NH_3 + CO_2$$

Step 2: Recall the biochemical cofactor requirements. Urease was the first enzyme crystallized, and it contains Nickel (Ni^{2+}) ions at its active catalytic site.
Step 3: Without adequate nickel levels, plants cannot utilize nitrogen from urea effectively, causing toxic urea accumulation in leaf tips. Zinc is a cofactor for carbonic anhydrase, and copper is found in plastocyanin, which rules them out.

Final Answer: $\boxed{\text{Nickel (Ni)}}$

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

Go Back to Question 14

Q15.

Solution

Concept: Isoelectronic species are atoms or ions that possess the exact same number of electrons. For these species, the size or ionic radius is determined by the effective nuclear charge (number of protons). A higher nuclear charge exerts a stronger electrostatic pull on the electron cloud, shrinking the ion.

Solution: Step 1: Count the total electrons in each ion to confirm they are isoelectronic:

$$N^{3-} = 7 + 3 = 10e^-, \quad O^{2-} = 8 + 2 = 10e^-, \quad F^- = 9 + 1 = 10e^-, \quad Na^+ = 11 - 1 = 10e^-$$

Step 2: Determine the nuclear charge (number of protons, Z) for each nucleus:

$$Z(Na^+) = 11, \quad Z(F^-) = 9, \quad Z(O^{2-}) = 8, \quad Z(N^{3-}) = 7$$

Step 3: Relate the nuclear charge to ionic radius. Size is inversely proportional to Z because more protons pull the same 10 electrons closer to the nucleus.
Step 4: Arrange by nuclear charge. Sodium ($Z = 11$) is the smallest, while Nitrogen ($Z = 7$) experiences the weakest pull and is the largest.
Step 5: The correct increasing order of ionic radii is: $Na^+ < F^- < O^{2-} < N^{3-}$.

Final Answer: $\boxed{Na^+ < F^- < O^{2-} < N^{3-}}$

Answer: (A)

Go Back to Question 15

Q16.

Solution

Concept: Polymers are classified by their synthesis mechanism (addition vs condensation) and their intermolecular forces, which determine their physical properties (elastomers, fibers, thermoplastics, thermosets). Condensation polymerization involves eliminating small molecules like water, while fibers feature strong hydrogen bonding.

Solution: Step 1: Analyze the monomer components of Nylon-6,6. It is synthesized from hexamethylenediamine and adipic acid.
Step 2: Examine the reaction mechanism. The amine ($-NH_2$) and carboxylic acid ($-COOH$) groups react to form amide linkages ($-NH-CO-$) while splitting off water molecules (H_2O). This classification defines it as a condensation polymer.
Step 3: Evaluate its mechanical properties. Nylon-6,6 contains highly polar amide linkages that form extensive intermolecular hydrogen bonds between parallel chains.
Step 4: These strong interactions provide high tensile strength, stiffness, and structural resistance to stretching. Consequently, Nylon-6,6 is classified as a fiber.

Final Answer: $\boxed{\text{Condensation polymer, Fiber}}$

Answer: (B)

Go Back to Question 16

Q17.

Solution

Concept: Single Superphosphate (SSP) is a popular phosphatic fertilizer used in agriculture. It is produced by reacting rock phosphate mineral with sulfuric acid. The standard nutrient value of fertilizers is strictly regulated by fertilizer control orders to ensure consistent quality for farmers.

Solution: Step 1: Recall the standard industrial grade specifications for Single Superphosphate (SSP).
Step 2: Commercial SSP contains monocalcium phosphate [$Ca(H_2PO_4)_2$], which provides plant-available phosphorus, along with a significant amount of gypsum ($CaSO_4$).
Step 3: The standard content of water-soluble phosphorus in standard SSP is exactly 16% available P_2O_5.
Step 4: For comparison, Triple Superphosphate (TSP) offers around 46% P_2O_5. Therefore, the value for a standard bag of SSP is 16%.

Final Answer: $\boxed{16\%}$

Answer: (C)

Go Back to Question 17

Q18.

Solution

Concept: The position of an element in the modern periodic table is directly linked to its ground-state electronic configuration. The highest principal quantum number (n) determines its period, and the configuration of the valence shell determines its group.

Solution: Step 1: Examine the given electron configuration:

$$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$$

Step 2: Identify the highest principal quantum number (n) present. The highest shell with electrons is $n = 4$ (seen in $4s^1$). This means the element belongs to Period 4.
Step 3: Determine the block type. The last electron enters a $3d$ orbital, which classifies it as a D-block transition element.
Step 4: Calculate the group number for a D-block element. The group number equals the sum of the electrons in the $(n-1)d$ subshell and the ns subshell:

$$\text{Group Number} = \text{Electrons in } 3d + \text{Electrons in } 4s = 5 + 1 = 6$$

Step 5: Conclude that the element is Chromium (Cr, $Z = 24$), which resides in Group 6 and Period 4.

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

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

Go Back to Question 18

Q19.

Solution

Concept: Water hardness is caused by dissolved polyvalent metallic cations, primarily calcium (Ca^{2+}) and magnesium (Mg^{2+}). Hardness is divided into two types: temporary hardness (carbonate hardness), which can be removed by boiling, and permanent hardness (non-carbonate hardness), which cannot.

Solution: Step 1: Understand the chemical cause of temporary hardness. It is due to the presence of dissolved bicarbonate salts of calcium and magnesium, namely $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$.
Step 2: When water with temporary hardness is boiled, soluble bicarbonates decompose into insoluble carbonates, which precipitate out out of the solution:

$$Mg(HCO_3)_2 \xrightarrow{\Delta} Mg(OH)_2 \downarrow +2CO_2 \uparrow$$

Step 3: Contrast this with permanent hardness, which is caused by sulfate and chloride salts ($CaSO_4$, $MgCl_2$). These salts do not decompose upon boiling. Therefore, Magnesium Bicarbonate is the compound responsible for temporary hardness.

Final Answer: $\boxed{\text{Magnesium Bicarbonate } (Mg(HCO_3)_2)}$

Answer: (C)

Go Back to Question 19

Q20.

Solution

Concept: The oxidation number changes in a redox reaction reveal which species undergoes oxidation or reduction. The overall change for a single atom is calculated by finding its oxidation state in both the reactant molecule and the product ion.

Solution: Step 1: Determine the initial oxidation state of Manganese in the permanganate reactant ion (MnO_4^-). Let it be x.

$$x + 4(-2) = -1 \implies x - 8 = -1 \implies x = +7$$

Step 2: Determine the final oxidation state of Manganese in the product state. It exists as a simple monatomic ion, Mn^{2+}. The oxidation state of a monatomic ion equals its charge, which is +2.
Step 3: Calculate the total change in the oxidation number for a single Manganese atom:

$$\text{Change} = \text{Final State} - \text{Initial State} = (+2) - (+7) = -5$$

Step 4: Interpret the negative result. The oxidation number decreases by 5 units, meaning each manganese atom gains 5 electrons during this reduction step.

Final Answer: $\boxed{\text{Decreases by 5}}$

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

Go Back to Question 20

Q21.

Solution

Concept: Colloidal dispersions are classified as lyophilic (liquid-loving) or lyophobic (liquid-hating) based on the level of interaction between the dispersed phase and the dispersion medium. This chemical affinity directly determines how easily they coagulate.

Solution: Step 1: Analyze lyophobic sols. They have little to no interaction with the solvent and rely entirely on surface electrical charges to stay suspended. Neutralizing this charge causes rapid coagulation.
Step 2: Analyze lyophilic sols. The particles have a high thermodynamic affinity for the dispersion medium. When mixed, they form a strong layer of solvent molecules around each colloidal particle.
Step 3: Identify the stabilizing factors. Lyophilic particles are stabilized by both their surface charge and this extensive solvation (hydration) layer. This solvent sheath acts as a physical barrier that prevents the particles from clustering together, even if electrolytes neutralize their surface charge.

Final Answer: Extensive solvation (hydration) of the colloidal particles

Answer: (C)

Go Back to Question 21

Q22.

Solution

Concept: Humus is a complex, chemically heterogeneous mixture of organic substances created by soil microbial decomposition. It can be separated into three main structural fractions—humic acid, fulvic acid, and humin—based on their solubility in acidic and alkaline solutions.

Solution: Step 1: Analyze Humin. This organic fraction is completely insoluble in both dilute aqueous bases and mineral acids.
Step 2: Analyze Humic Acid. This fraction dissolves readily in alkaline solutions (NaOH or KOH) but precipitates as a dark brown solid when the solution is acidified to a pH below 2.
Step 3: Analyze Fulvic Acid. This fraction remains completely soluble under both strongly alkaline conditions and highly acidic conditions. It has a lower molecular weight and a higher content of hydrophilic functional groups ($-COOH$ and $-OH$) compared to humic acid. Therefore, it stays dissolved across the entire pH range.

Final Answer: Fulvic acid

Answer: (B)

Go Back to Question 22

Q23.

Solution

Concept: The Cannizzaro reaction is a base-catalyzed disproportionation (redox) reaction of aldehydes that lack an α-hydrogen atom. In a strongly alkaline environment, one molecule of the aldehyde is oxidized to a carboxylic acid salt, while another molecule is reduced to its corresponding alcohol.

Solution: Step 1: Examine the structure of the reactant, Benzaldehyde (C_6H_5CHO). The carbonyl group is attached to a benzene ring carbon that has no hydrogen atoms, meaning it lacks an α-hydrogen.
Step 2: Since there are no α-hydrogens, it cannot form an enolate ion or undergo an aldol condensation when treated with a concentrated base (NaOH).
Step 3: Instead, a nucleophilic hydroxide ion attacks the carbonyl carbon of one benzaldehyde molecule. This initiates a hydride transfer to a second benzaldehyde molecule.
Step 4: This self-redox process converts one benzaldehyde molecule into benzyl alcohol (reduction) and another into a sodium benzoate salt (oxidation):

$$2C_6H_5CHO + NaOH \rightarrow C_6H_5CH_2OH + C_6H_5COONa$$

Step 5: This reaction is called the Cannizzaro reaction.

Final Answer: $\boxed{\text{Cannizzaro Reaction}}$

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

Go Back to Question 23

Q24.

Solution

Concept: The geometry and hybridization of a covalent molecule can be predicted using the Valence Shell Electron Pair Repulsion (VSEPR) theory and by calculating the steric number of the central atom.

Solution: Step 1: Determine the total number of valence electrons for the central phosphorus atom (P, Group 15). It has 5 valence electrons.
Step 2: Count the single bonds formed. Phosphorus bonds with 5 chlorine atoms, sharing one electron with each. This uses all 5 valence electrons, leaving zero lone pairs on the central atom.
Step 3: Calculate the steric number:

$$\text{Steric Number} = \text{Bond Pairs} + \text{Lone Pairs} = 5 + 0 = 5$$

Step 4: A steric number of 5 corresponds to sp^3d hybridization for the phosphorus atom.
Step 5: According to VSEPR theory, 5 bonding pairs arrange themselves to minimize repulsion by adopting a trigonal bipyramidal spatial geometry. Three chlorine atoms lie in an equatorial plane at 120° angles, while two occupy linear axial positions perpendicular to this plane.

Final Answer: $\boxed{\text{Trigonal bipyramidal, } sp^3d}$

Answer: (B)

Go Back to Question 24

Q25.

Solution

Concept: Soil pH measures the hydrogen ion concentration in the soil solution, defining whether it is acidic, neutral, or alkaline. Arid and semi-arid regions, like western Rajasthan, often accumulate soluble salts and exchangeable sodium due to low rainfall and high evaporation, leading to high alkalinity.

Solution: Step 1: Understand the climatic factors of western Rajasthan. Low rainfall prevents the leaching of basic cations (Ca^{2+}, Mg^{2+}, Na^+), causing them to accumulate in the upper soil layers.
Step 2: High concentration of exchangeable sodium ions on clay particles leads to the formation of sodium carbonate (Na_2CO_3), which hydrolyzes to release hydroxide (OH^-) ions into solution.
Step 3: This hydrolysis drives the soil pH well into the alkaline range, typically between 8.5 and 10.0. These conditions restrict nutrient availability and damage soil structure. Values below 7.0 represent acidic conditions, which are rare in these arid zones.

Final Answer: $\boxed{8.5 - 10.0}$

Answer: (D)

Go Back to Question 25

Q26.

Solution

Concept: The rate of a chemical reaction is sensitive to temperature changes. Svante Arrhenius proposed a mathematical relationship that models how temperature affects the rate constant k by factoring in the activation energy (E_a) required for a reaction to proceed.

Solution: Step 1: Identify the variables. The problem describes how the reaction rate constant changes from k_1 to k_2 when the temperature is raised from T_1 to T_2.
Step 2: Recall the Arrhenius equation in its exponential form:

$$k = Ae^{-\frac{E_a}{RT}}$$

Step 3: Examine the integrated, two-temperature form of this equation:

$$\log_{10}\left(\frac{k_2}{k_1}\right) = \frac{E_a}{2.303R}\left(\frac{T_2 - T_1}{T_1 T_2}\right)$$

Step 4: This equation calculates the activation energy based on how the rate constant changes with temperature. It confirms that the temperature dependence of k is described by the Arrhenius Equation. The Kirchhoff equation governs enthalpy changes, and the Van 't Hoff equation describes equilibrium shifts.

Final Answer: $\boxed{\text{Arrhenius Equation}}$

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

Go Back to Question 26

Q27.

Solution

Concept: Carbohydrates are classified into monosaccharides, oligosaccharides, and polysaccharides based on their degree of polymerization. Animals and plants store excess glucose in different polymeric forms to maintain osmotic stability within cells.

Solution: Step 1: Evaluate the options. Starch is the primary storage polysaccharide in plants, composed of amylose and amylopectin. Cellulose serves as a structural component in plant cell walls.

Step 2: Identify the animal storage form. Animals store glucose as glycogen, primarily in liver and muscle tissues.

Step 3: Examine the structural architecture of glycogen. It is a highly branched polymer of α-D-glucose units, joined by $\alpha(1 \rightarrow 4)$ glycosidic bonds along the main chains and $\alpha(1 \rightarrow 6)$ glycosidic bonds at branching points.

Step 4: Its highly branched structure allows enzymes to rapidly break it down into glucose when blood sugar levels drop. Therefore, glycogen is the animal carbohydrate reserve.

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

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

Go Back to Question 27

Q28.

Solution

Solution

Concept: Dehydrohalogenation of alkyl halides using a strong, hot base like alcoholic potassium hydroxide (KOH) proceeds via an E2 elimination mechanism. When multiple elimination products are possible, the major alkene product is determined by Zaitsev's rule, which states that the more substituted and thermodynamically stable alkene will predominate.

Solution: Step 1: Write down the structural formula for secondary butyl chloride:

$$CH_3 - CH_2 - CH(Cl) - CH_3$$

Step 2: Identify the β-carbons adjacent to the chlorine-bearing α-carbon. There are two distinct β-carbons: the terminal C_1 methyl group and the internal C_3 methylene group.
Step 3: Base attack can remove a proton from either site. Removing a proton from C_1 yields But-1-ene (a monosubstituted alkene). Removing a proton from C_3 yields But-2-ene (a disubstituted alkene).
Step 4: According to Zaitsev's rule, the internal, more highly substituted disubstituted alkene is more stable and forms the major product.
Step 5: Determine the stereochemical preference. But-2-ene exists as cis and trans isomers. The trans-But-2-ene isomer has less steric hindrance between the methyl groups, making it more stable than cis-But-2-ene. Thus, trans-But-2-ene is the preferred major product.

Final Answer: $\boxed{\text{trans-But-2-ene}}$

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

Go Back to Question 28

Q29.

Solution

Concept: Arnon and Stout established the criteria for plant nutrient essentiality, which lists 17 elements required by all higher plants. However, certain other elements are classified as "beneficial elements". While not universally essential, they significantly promote growth, yield, or stress resistance in specific crop species.

Solution: Step 1: Recall the 17 essential plant nutrients: C, H, O, N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, B, Mo, Cl, and Ni. Iron, copper, and magnesium are included in this core list.
Step 2: Identify non-classic beneficial nutrients, which include elements like Silicon (Si), Sodium (Na), Cobalt (Co), and Selenium (Se).
Step 3: Consider the agronomic requirements of wetland rice (*Oryza sativa*). Rice absorbs large amounts of Silicon (Si).
Step 4: Silicon deposits within the epidermal cell layers of rice leaves and stems. This forms a mechanical barrier that improves stalk rigidity, prevents lodging, and protects the plant against fungal infections and insect pests. Thus, Silicon is a classic beneficial element for rice.

Final Answer: $\boxed{\text{Silicon (Si)}}$

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

Go Back to Question 29

Q30.

Solution

Concept: The magnetic behavior of transition metal ions depends on the number of unpaired electrons in their D-orbitals. The spin-only magnetic moment (μ) can be calculated using the formula: $\mu = \sqrt{n(n+2)}$ Bohr Magnetons (BM), where n represents the total number of unpaired electrons.

Solution: Step 1: Write down the atomic number and electron configuration of neutral elemental Iron (Fe, $Z = 26$):

$$\mathrm{Fe} = [\mathrm{Ar}]3d^6 4s^2$$

Step 2: Determine the configuration of the divalent iron ion (Fe^{2+}). Forming the +2 cation requires removing the two outermost valence electrons from the $4s$ orbital first:

$$\mathrm{Fe}^{2+} = [\mathrm{Ar}]3d^6 4s^0$$

Step 3: Map the 6 electrons into the five degenerate $3d$ orbitals according to Hund's rule of maximum multiplicity:

Orbitals: [↑↓] [↑] [↑] [↑] [↑]

Step 4: Count the number of unpaired electrons (n). There is 1 paired orbital and 4 unpaired orbitals, so $n = 4$.
Step 5: Substitute $n = 4$ into the spin-only magnetic moment equation:

$$\mu = \sqrt{4(4+2)} = \sqrt{4 \times 6} = \sqrt{24} \approx 4.90 \text{ BM}$$

The calculated spin-only magnetic moment for the ion is 4.90 BM.

Final Answer: $\boxed{4.90 \text{ BM}}$

Answer: (B)

Go Back to Question 30

Q31.

Solution

Concept: Chemical pesticides are classified into distinct groups based on their core organic structural framework and active functional groups. The major families used in crop protection include organochlorines, organophosphates, carbamates, and synthetic pyrethroids.

Solution: Step 1: Examine the chemical name and structure of Malathion. Its systematic name is diethyl [(dimethoxyphosphinothioyl)thio]butanedioate.
Step 2: Identify key functional groups in its structure. Malathion contains a central phosphorus atom bonded to sulfur and oxygen atoms, forming a characteristic thiophosphate ester linkage.
Step 3: This phosphorus-centered bonding framework classifies it as an organophosphate pesticide.
Step 4: Organophosphate compounds act as acetylcholinesterase inhibitors in nervous systems. Other options like Lindane belong to organochlorines, and Carbaryl is a carbamate, making option B correct.

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

Answer: (B)

Go Back to Question 31

Q32.

Solution

Concept: Kjeldahl's method is a classic analytical procedure used to quantify the nitrogen content in organic substances, soils, and fertilizers. The method consists of three consecutive chemical steps: digestion, distillation, and titration.

Solution: Step 1: Digestion stage. The soil sample is heated with concentrated sulfuric acid (H_2SO_4) in the presence of a catalyst, converting organic nitrogen into soluble ammonium sulfate [$(NH_4)_2SO_4$].
Step 2: Distillation stage. The digested solution is treated with an excess of a strong base (NaOH) to liberate volatile ammonia gas (NH_3):

$$(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2NH_3 \uparrow +2H_2O$$

Step 3: Absorption stage. The evolved ammonia gas is distilled and funneled into a receiving flask filled with a known excess of a standard acid solution, typically standard Sulfuric Acid (H_2SO_4) or Boric acid.
Step 4: In standard classical back-titration setups, a known excess of standard Sulfuric Acid is used to trap the ammonia, and the unreacted acid is then titrated against a standard base.

Final Answer: $\boxed{\text{Sulfuric Acid } (H_2SO_4)}$

Answer: (B)

Go Back to Question 32

Q33.

Solution

Concept: When an organic molecule contains more than one functional group, it is classified as a polyfunctional compound. IUPAC rules establish a strict priority order for functional groups to determine which one serves as the principal suffix. All other groups are treated as substituents and listed as prefixes.

Solution: Step 1: Review the standard IUPAC hierarchical priority list for common organic functional groups.
Step 2: Carboxylic acids ($-COOH$) hold the highest priority among all common functional carbon networks. This places $-COOH$ at the top of the sequence.
Step 3: Compare aldehydes ($-CHO$) and hydroxyl groups ($-OH$). Carbonyl groups in aldehydes outrank hydroxyl groups, so $-CHO$ comes before $-OH$.
Step 4: Compare hydroxyl groups ($-OH$) and amine groups ($-NH_2$). Alcohols have higher priority than amines.
Step 5: Assembling these rankings gives the correct decreasing priority order:

$$-COOH > -CHO > -OH > -NH_2$$

This matches the sequence presented in option A.

Final Answer: $\boxed{-COOH > -CHO > -OH > -NH_2}$

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

Go Back to Question 33

Q34.

Solution

Concept: Molecular Orbital Theory (MOT) explains the bonding and stability of diatomic molecules by distributing valence electrons into bonding and antibonding molecular orbitals. A molecule is stable only if its calculated bond order is greater than zero.

Solution: Step 1: Write down the definition for calculating bond order:

$$\text{Bond Order} = \frac{N_b - N_a}{2}$$

where N_b is the number of bonding electrons and N_a is the number of antibonding electrons.
Step 2: Analyze the Beryllium dimer (Be_2). The atomic number of Beryllium is 4, so a Be_2 molecule contains a total of $4 + 4 = 8$ electrons.
Step 3: Fill the molecular orbitals with these 8 electrons in order of increasing energy:

$$\sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}$$

Step 4: Count the bonding (N_b) and antibonding (N_a) electrons from the configuration:

$$N_b = 2\ (\text{from } \sigma_{1s}) + 2\ (\text{from } \sigma_{2s}) = 4$$

$$N_a = 2\ (\text{from } \sigma_{1s}^*) + 2\ (\text{from } \sigma_{2s}^*) = 4$$

Step 5: Calculate the final bond order value:

$$\text{Bond Order} = \frac{4 - 4}{2} = 0$$

Since the bond order is zero, there is no net energetic stabilization, meaning the Be_2 molecule is unstable and does not exist.

Final Answer: $\boxed{Be_2}$

Answer: (B)

Go Back to Question 34

Q35.

Solution

Concept: Synthesizing alkyl fluorides via direct fluorination is often difficult to control due to the highly violent nature of fluorine gas. Instead, they are typically prepared using a halogen exchange reaction, where an existing alkyl chloride or bromide is heated with an inorganic metallic fluoride.

Solution: Step 1: Analyze the reaction conditions described. The process involves heating an alkyl halide (like CH_3Cl) with a metallic fluoride reagent such as silver fluoride (AgF), antimony trifluoride (SbF_3), or cobalt fluoride (CoF_2).

Step 2: Examine the chemical transformation. The metallic fluoride exchanges its fluoride ion for the halide ion bound to the alkyl group:

$$R-Cl + AgF \xrightarrow{\Delta} R-F + AgCl\downarrow$$

Step 3: Identify the name of this organic reaction. This specific halogen exchange method to form alkyl fluorides is called the Swarts reaction.

Step 4: Differentiate from other options. The Finkelstein reaction uses sodium iodide (NaI) in acetone to synthesize alkyl iodides, and the Wurtz reaction couples alkyl halides using sodium metal. Thus, the Swarts reaction is the correct answer.

Final Answer: $\boxed{\text{Swarts Reaction}}$

Answer: (B)

Go Back to Question 35

Q36.

Solution

Concept: Nitrogenous fertilizers can alter soil pH over time depending on the chemical nature of the compounds and how soil microorganisms transform them. When ammonium ions are oxidized during nitrification, they release hydrogen ions (H^+), which increases soil acidity.

Solution: Step 1: Understand the biochemical process of nitrification. Soil bacteria convert ammonium (NH_4^+) into nitrate (NO_3^-) via the following reaction:

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

Step 2: Compare the potential acidity generated by different fertilizers. Ammonium Sulfate [$(NH_4)_2SO_4$] contains nitrogen entirely in the ammonium form, and its sulfate ion remains behind, compounding the acidic effect.
Step 3: Its physiological residual acidity equivalent is high, requiring approximately 110 kg of calcium carbonate ($CaCO_3$) to neutralize the acidity produced by 100 kg of the fertilizer.
Step 4: Urea produces less residual acidity because its hydrolysis yields carbonate ions that partially buffer the system. Calcium Ammonium Nitrate (CAN) is chemically neutral, making Ammonium Sulfate the most acidifying choice.

Final Answer: $\boxed{\text{Ammonium Sulfate}}$

Answer: (B)

Go Back to Question 36

Q37.

Solution

Concept: The equilibrium constants K_p (expressed in terms of partial pressures) and K_c (expressed in terms of molar concentrations) for an ideal gas mixture are related by the ideal gas law equation. The mathematical relationship between them depends on the net change in the number of gaseous moles (Δn_g) during the reaction.

Solution: Step 1: Write down the general formula relating the two equilibrium constants:

$$K_p = K_c(RT)^{\Delta n_g}$$

where R is the ideal gas constant, T is the absolute temperature in Kelvin, and Δn_g is the total moles of gaseous products minus the total moles of gaseous reactants.
Step 2: Refer to the provided chemical equation for the industrial synthesis of ammonia:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Step 3: Count the gaseous moles on both sides to calculate Δn_g:

$$\text{Moles of gas in products} = 2 \text{ (from } 2NH_3)$$

$$\text{Moles of gas in reactants} = 1 \text{ (from } N_2) + 3 \text{ (from } 3H_2) = 4$$

$$\Delta n_g = 2 - 4 = -2$$

Step 4: Substitute $\Delta n_g = -2$ back into the foundational equation:

$$K_p = K_c(RT)^{-2}$$

This matches the mathematical relationship shown in option C.

Final Answer: $\boxed{K_p = K_c(RT)^{-2}}$

Answer: (C)

Go Back to Question 37

Q38.

Solution

Concept: The thermodynamic properties of an ideal gas depend heavily on temperature. Internal energy (U) and enthalpy (H) are state functions that are solely determined by the absolute temperature of an ideal gas sample, meaning they are independent of volume or pressure changes.

Solution: Step 1: Analyze the specific thermodynamic conditions stated in the problem: the expansion process is explicitly defined as isothermal.
Step 2: By definition, an isothermal process is one that occurs at a constant temperature, meaning $\Delta T = 0$.
Step 3: Express the change in internal energy (ΔU) for an ideal gas mathematically:

$$\Delta U = nC_v\Delta T$$

Because the temperature is constant ($\Delta T = 0$), the change in internal energy is exactly zero ($\Delta U = 0$).
Step 4: Express the change in enthalpy (ΔH) for an ideal gas mathematically:

$$\Delta H = nC_p\Delta T$$

Similarly, because $\Delta T = 0$, the change in enthalpy is also exactly zero ($\Delta H = 0$).
Step 5: Conclude that for any isothermal expansion or compression of an ideal gas, both thermodynamic changes are zero, which corresponds to option B.

Final Answer: $\boxed{\Delta U = 0, \Delta H = 0}$

Answer: (B)

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Q39.

Solution

Concept: Natural resins and biopolymers are complex structural materials produced by living organisms. Lac is a prominent natural commercial resin secreted by the tiny lac insect *Kerria lacca*. Its chemical makeup consists of a complex mixture of interlinked organic monomer units.

Solution: Step 1: Understand the origin of Lac. It is a natural resinous secretion gathered from host trees colonized by lac insects.
Step 2: Analyze its chemical composition. Lac is not a simple hydrocarbon polymer like natural rubber (which is made of isoprene units), nor is it a carbohydrate or a protein.
Step 3: Chemical analysis shows that lac is a natural polyester network composed primarily of hydroxy fatty acids and sesquiterpene acids.
Step 4: The major monomer constituents include aleuritic acid (a hydroxy fatty acid) and shellolic acid (a sesquiterpene acid). These monomers form cross-linked ester chains that give the resin its thermoplastic properties. Thus, option C is correct.

Final Answer: $\boxed{\text{Hydroxy fatty acids and sesquiterpene acids}}$

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

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Q40.

Solution

Concept: Agricultural soils are composed of various rock-forming minerals that break down over time. These soil minerals are classified into primary minerals, which are inherited from parent rocks, and secondary minerals, which form through chemical weathering processes.

Solution: Step 1: Identify the mineral in question: Quartz. Quartz is one of the most abundant primary minerals found in the Earth's crust.
Step 2: Consider its resistance to weathering. Quartz is highly resistant to chemical and physical breakdown, so it accumulates in large quantities as rocks weather, dominating the sand fraction of most agricultural soils.
Step 3: Recall the basic chemical formula of quartz. It consists of a continuous framework of silicon-oxygen tetrahedra (SiO_4), giving it an overall chemical formula of Silicon Dioxide (SiO_2).
Step 4: Evaluate the other choices. Calcium carbonate is calcite, aluminum oxide is corundum, and potassium feldspar is orthoclase. Therefore, the core chemical composition of quartz is silicon dioxide.

Final Answer: $\boxed{\text{Silicon Dioxide } (SiO_2)}$

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

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Answer Key

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