Rajasthan JET Chemistry Sample Paper-11

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. If 5.85 g of NaCl is dissolved in 500 mL of water, what is the molarity of the resulting solution? (Molar mass of NaCl = 58.5 g mol^{-1})

(A) 0.1 M

(B) 0.2 M

(C) 0.5 M

(D) 1.0 M

Q2. For a first-order reaction, if the initial concentration of the reactant is doubled, the half-life period of the reaction will:

(A) Be doubled

(B) Be halved

(C) Remain unchanged

(D) Become four times

Q3. Black soil in Rajasthan is predominantly found in the Hadoti region. Which clay mineral is dominant in this type of soil?

(A) Kaolinite

(B) Illite

(C) Montmorillonite

(D) Vermiculite

Q4. What is the correct IUPAC name of the compound $CH_3-CH(OH)-CH_2-CHO$?

(A) 3-Hydroxybutanal

(B) 2-Hydroxybutanal

(C) 3-Hydroxybutan-1-ol

(D) 1-Oxobutan-3-ol

Q5. Which of the following sets of quantum numbers represents the outermost electron of a potassium atom ($Z = 19$) in its ground state?

(A) $n = 4, l = 0, m = 0, s = +\frac{1}{2}$

(B) $n = 3, l = 1, m = 0, s = -\frac{1}{2}$

(C) $n = 4, l = 1, m = 0, s = +\frac{1}{2}$

(D) $n = 3, l = 0, m = 0, s = +\frac{1}{2}$

Q6. For the equilibrium reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, what is the relationship between K_p and K_c?

(A) $K_p = K_c$

(B) $K_p = K_c(RT)$

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

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

Q7. Which of the following fertilizers is classified as a complex fertilizer?

(A) Urea

(B) Single Super Phosphate (SSP)

(C) Ammonium Phosphate

(D) Muriate of Potash (MOP)

Q8. Which of the following compounds will give a positive Iodoform test?

(A) Pentan-3-one

(B) Ethanol

(C) Methanol

(D) Benzane

Q9. The pH of an aqueous solution of a strong acid is 3.0. If this solution is diluted 100 times with water, the pH of the resulting solution will be:

(A) 1.0

(B) 5.0

(C) 7.0

(D) 6.0

Q10. Which among the following is a micronutrient required by plants?

(A) Nitrogen

(B) Calcium

(C) Zinc

(D) Magnesium

Q11. When acetaldehyde is heated with Fehling's solution, it gives a red precipitate of:

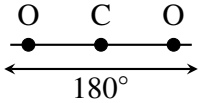
(A) CuO

(B) Cu_2O

(C) $Cu(OH)_2$

(D) Cu

Q12. The species having a linear shape among the following is:



(A) CO_2

(B) SO_2

(C) NO_2^-

(D) O_3

Q13. Gold number is a measure of the:

(A) Protective power of a lyophilic colloid

(B) Coagulating power of an electrolyte

(C) Purity of gold in a colloidal solution

(D) Charge on a colloidal particle

Q14. The fat percentage in the milk of Bhadawari breed of buffalo is approximately:

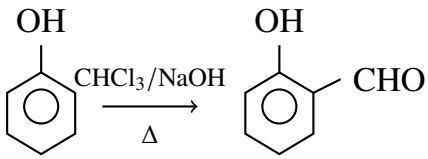
(A) 4.5% to 5.5%

(B) 6.0% to 7.0%

(C) 12% to 14%

(D) 8.0% to 9.5%

Q15. The conversion of phenol to salicylaldehyde by reacting with chloroform and aqueous NaOH is known as:



(A) Kolbe's reaction

(B) Reimer-Tiemann reaction

(C) Rosenmund reduction

(D) Wurtz-Fittig reaction

Q16. In which of the following compounds does nitrogen exhibit its highest oxidation state?

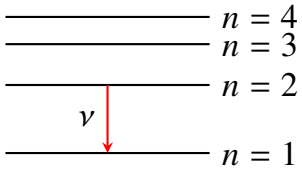
(A) N_2H_4

(B) NH_3

(C) N_2O

(D) HNO_3

Q17. Which of the following transitions in a hydrogen atom emits a photon of the highest frequency?



(A) $n = 2 \rightarrow n = 1$

(B) $n = 4 \rightarrow n = 3$

(C) $n = 3 \rightarrow n = 2$

(D) $n = 5 \rightarrow n = 4$

Q18. Which transition metal ion shows the highest paramagnetic behavior among the following? (Atomic numbers: $Cr = 24, Mn = 25, Fe = 26, Co = 27$)

(A) Cr^{3+}

(B) Mn^{2+}

(C) Fe^{2+}

(D) Co^{2+}

Q19. Alkaline soils can be reclaimed by the application of:

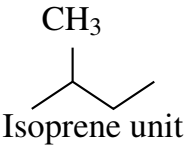
(A) Lime

(B) Gypsum

(C) Urea

(D) Calcium Carbonate

Q20. Natural rubber is a polymer of:



Isoprene unit

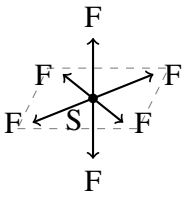
(A) Chloroprene

(B) Isoprene

(C) Styrene

(D) Butadiene

Q21. The hybridization of the central atom in SF_6 molecule is:



(A) sp^3

(B) sp^3d

(C) sp^3d^2

(D) sp^3d^3

Q22. According to Le Chatelier's principle, which of the following conditions will favor the forward reaction in the exothermic synthesis of ammonia: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$?

(A) Increasing the temperature and decreasing the pressure

(B) Decreasing the temperature and increasing the pressure

(C) Increasing both temperature and pressure

(D) Decreasing both temperature and pressure

Q23. Which of the following is a carbohydrate that cannot be further hydrolyzed into simpler units?

(A) Sucrose

(B) Maltose

(C) Fructose

(D) Cellulose

Q24. Biuret test is used for the detection of:

(A) Carbohydrates

(B) Fats

(C) Proteins

(D) Vitamins

Q25. Which element has the highest electron gain enthalpy (with negative sign) in the periodic table?

(A) Fluorine

(B) Chlorine

(C) Oxygen

(D) Nitrogen

Q26. For a reaction A + B $\rightarrow$ Products, doubling the concentration of A increases the rate by 4 times, while doubling the concentration of B has no effect on the rate. The overall order of the reaction is:

(A) 1

(B) 2

(C) 3

(D) 0

Q27. The essential plant nutrient responsible for root development and early maturity in crops is:

(A) Nitrogen

(B) Phosphorus

(C) Potassium

(D) Zinc

Q28. The major organic product obtained in the reaction of bromobenzene with magnesium metal in dry ether followed by treatment with water is:

(A) Phenol

(B) Benzene

(C) Biphenyl

(D) Grignard reagent

Q29. The ionic radii of isoelectronic species F^-, O^{2-}, and Na^+ follow the order:

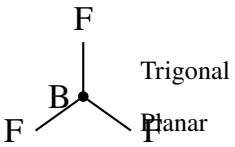
(A) $Na^+ > F^- > O^{2-}$

(B) $O^{2-} > F^- > Na^+$

(C) $F^- > O^{2-} > Na^+$

(D) $O^{2-} > Na^+ > F^-$

Q30. Which of the following behaves as a Lewis acid?



(A) NH_3

(B) H_2O

(C) BF_3

(D) F^-

Q31. Major component of Single Super Phosphate (SSP) fertilizer that supplies sulfur to crops is:

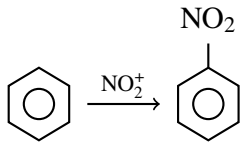
(A) Calcium sulphate

(B) Ammonium sulphate

(C) Elemental sulfur

(D) Potassium sulphate

Q32. Nitration of benzene using a mixture of concentrated HNO_3 and concentrated H_2SO_4 is an example of:



(A) Electrophilic addition reaction

(B) Electrophilic substitution reaction

(C) Nucleophilic substitution reaction

(D) Free radical substitution reaction

Q33. If 22.4 L of $H_2(g)$ at STP reacts completely with 11.2 L of $Cl_2(g)$ at STP, the volume of $HCl(g)$ formed at STP will be:

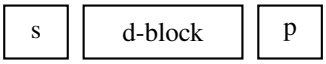
(A) 11.2 L

(B) 22.4 L

(C) 44.8 L

(D) 5.6 L

Q34. Which of the following properties is characteristic of d-block elements?



(A) Variable oxidation states

(B) Formation of colored ions

(C) Catalytic properties

(D) All of the above

Q35. The instrument used for measuring the specific gravity of milk to check its purity is:

(A) Refractometer

(B) Lactometer

(C) Thermometer

(D) Butyrometer

Q36. The acid strength of the given hydrocarbons follows which correct order?

$$HC \equiv \vec{C}H \quad H_2C = \vec{C}H_2 \quad H_3C - CH_3$$
Decreasing acidic character

(A) Ethyne > Ethene > Ethane

(B) Ethane > Ethene > Ethyne

(C) Ethene > Ethyne > Ethane

(D) Ethyne > Ethane > Ethene

Q37. Which of the following is an empirical formula of a compound containing 40% Carbon, 6.7% Hydrogen, and 53.3% Oxygen by weight? (Atomic masses: $C = 12, H = 1, O = 16$)

(A) CHO

(B) CH_2O

(C) CHO_2

(D) C_2H_4O

Q38. Zinc phosphide is commonly used in agricultural fields as a/an:

(A) Herbicide

(B) Fungicide

(C) Rodenticide

(D) Insecticide

Q39. Which of the following options represents a pair of functional isomers?

(A) Ethanol and Dimethyl ether

(B) Propan-1-ol and Propan-2-ol

(C) Pentan-2-one and Pentan-3-one

(D) n-Butane and Isobutane

Q40. The coagulation values of NaCl, $BaCl_2$, and $AlCl_3$ for a negatively charged arsenic sulfide sol follow the order:

$\boxed{Na^+}$ $\boxed{Ba^{2+}}$ $\boxed{Al^{3+}}$

Flocculating power: $Al^{3+} > Ba^{2+} > Na^+$

(A) $NaCl > BaCl_2 > AlCl_3$

(B) $AlCl_3 > BaCl_2 > NaCl$

(C) $BaCl_2 > AlCl_3 > NaCl$

(D) $NaCl = BaCl_2 = AlCl_3$

Detailed Solutions

Q1.

Solution

Concept:

Molarity is defined as the total number of moles of solute dissolved per liter of the given solution. The mathematical formula used for computing this concentration is expressed as:

$$\text{Molarity (M)} = \frac{\text{Number of moles of solute}}{\text{Volume of solution in Liters}}$$

Where the number of moles of a solute can be calculated by dividing the given mass of the substance by its respective molar mass.

Solution:

Step 1: Write down the given values from the problem statement:

Given mass of NaCl = 5.85 g

Molar mass of NaCl = 58.5 g mol^{-1}

Volume of the aqueous solution = 500 mL

Step 2: Compute the total number of moles of NaCl solute using the formula:

$$\text{Moles of NaCl} = \frac{\text{Given mass}}{\text{Molar mass}} = \frac{5.85\ \text{g}}{58.5\ \text{g mol}^{-1}} = 0.1\ \text{mol}$$

Step 3: Convert the total volume of the solution from milliliters (mL) into liters (L):

$$\text{Volume in Liters} = \frac{500\ \text{mL}}{1000\ \text{mL L}^{-1}} = 0.5\ \text{L}$$

Step 4: Substitute the computed number of moles and volume into the primary molarity formula:

$$\text{Molarity} = \frac{0.1\ \text{mol}}{0.5\ \text{L}} = 0.2\ \text{M}$$

Therefore, the molarity of the solution is 0.2 M.

Final Answer: 0.2 M

Answer: (B)

Go Back to Question 1

Q2.

Solution

Concept:

For a first-order chemical reaction, the half-life period ($t_{1/2}$) represents the precise time required for the initial reactant concentration to be reduced to exactly half of its starting value. The core characteristic of a first-order reaction kinetics model is that its half-life depends purely on the rate constant (k) and is entirely independent of the initial amount of reactants present.

Solution:

Step 1: Recall the standard mathematical expression for the half-life period of any typical first-order reaction:

$$t_{1/2} = \frac{\ln(2)}{k} = \frac{0.693}{k}$$

Where k represents the specific rate constant of the reaction.

Step 2: Analyze the components of the formula. Notice that the concentration term $[A]_0$ does not appear anywhere within this derived expression. This indicates that whether the concentration is small or extremely high, the time taken to consume half of it remains a fixed value.

Step 3: Evaluate the effect of changing the initial concentration. The problem states that the initial concentration of the reactant is doubled. Since the expression for $t_{1/2}$ lacks any initial concentration dependency, doubling or changing this parameter will exert zero effect on the time frame.

Step 4: Conclude that the half-life period remains exactly constant. Thus, the half-life period of the reaction will remain completely unchanged.

Final Answer: Remain unchanged

Answer: (C)

Go Back to Question 2

Q3.

Solution

Concept:

Black soils, widely classified as Vertisols, possess highly pronounced swelling and shrinking characteristics due to the high content of a specific expanding lattice type of clay mineral. This type of soil is exceptionally rich in divalent cations like calcium and magnesium, making it highly fertile and ideal for cultivating demanding crops such as cotton.

Solution:

Step 1: Understand the geographical and mineralogical nature of black soils found within the Hadoti region of Rajasthan. These soils are heavily characterized by a fine, clayey texture with advanced moisture retention capacities.

Final Answer: Montmorillonite

Answer: (C)

Go Back to Question 3

Q4.

Solution

Concept:

According to standard IUPAC nomenclature principles for polyfunctional organic compounds, a strict seniority order dictates which functional group acts as the principal group. The principal functional group determines the suffix of the parent chain, while all other remaining functional groups are treated purely as substituents and are indicated using appropriate prefixes.

Solution:

Step 1: Identify the functional groups present in the given chemical structure $CH_3 - CH(OH) - CH_2 - CHO$. The compound possesses a carbonyl group in the form of an aldehyde ($-CHO$) and a hydroxyl group in the form of an alcohol ($-OH$).

Step 2: Determine the priority order between the two functional groups. The aldehyde group ($-CHO$) holds a significantly higher priority status over the alcohol group ($-OH$) according to the standard IUPAC rules. Therefore, the suffix of the molecule will be "-anal".

Step 3: Select and number the longest continuous carbon chain containing the principal functional group. Numbering begins directly at the aldehyde carbon to give it the lowest possible locant:

$$C_4H_3 - C_3H(OH) - C_2H_2 - C_1HO$$

The chain consists of four carbon atoms, which corresponds to the parent alkane name "butane".

Step 4: Identify the position and name of the substituent. The hydroxyl group ($-OH$) is located at the carbon-3 position. When acting as a substituent, its prefix name is designated as "hydroxy".

Step 5: Combine the prefix, parent chain, and principal suffix into a single name. Putting the pieces together gives 3-hydroxybutanal.

Final Answer: 3-Hydroxybutanal

Answer: (A)

Go Back to Question 4

Q5.

Solution

Concept:

The electronic configuration of an atom in its lowest energy state can be accurately systematically determined using the Aufbau principle, Hund's rule, and the Pauli exclusion principle. Quantum numbers (n, l, m, s) describe the complete energetic and spatial distribution behavior of electrons residing within specific subshells of the atomic structure.

Solution:

Step 1: Determine the total atomic number and write out the ground-state electronic configuration for the potassium atom ($Z = 19$):

$$\text{K } (Z = 19) = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$$

Alternatively, this configuration can be compactly expressed relative to the nearest noble gas core as $[\text{Ar}]4s^1$.

Step 2: Identify the outermost valence electron. The last electron added enters the $4s$ orbital, meaning the highest occupied principal energy level corresponds to $n = 4$.

Step 3: Determine the azimuthal quantum number (l) for the target subshell. For any s orbital, the value of l is strictly defined as $l = 0$.

Step 4: Determine the magnetic quantum number (m) based on the value of l. When $l = 0$, the only permissible value for the magnetic orientation is $m = 0$.

Step 5: Assign the spin quantum number (s) for the single electron. Since there is only one lone electron in this $4s$ orbital, it can have an upward spin value of $s = +\frac{1}{2}$ or a downward spin value of $s = -\frac{1}{2}$. Looking at the provided options, the correct set is $n = 4, l = 0, m = 0, s = +\frac{1}{2}$.

Final Answer: $n = 4, l = 0, m = 0, s = +\dfrac{1}{2}$

Answer: (A)

Go Back to Question 5

Q6.

Solution

Concept:

The equilibrium constants K_p (expressed in terms of partial pressures) and K_c (expressed in terms of molar concentrations) for a reversible gas-phase chemical reaction are mathematically interlinked via the ideal gas law relationship. This connection is expressed through the fundamental equation:

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

Where Δn_g signifies the net difference between the stoichiometric coefficients of gaseous products and gaseous reactants.

Solution:

Step 1: Write down the given balanced chemical equation representing the gas-phase dissociation equilibrium:

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

Step 2: Identify and sum the stoichiometric coefficients for the gaseous components on both sides:
Total moles of gaseous products = 1 (from PCl_3) + 1 (from Cl_2) = 2
Total moles of gaseous reactants = 1 (from PCl_5) Step 3: Calculate the change in the total number of gaseous moles (Δn_g):

$$\Delta n_g = (\text{Moles of gaseous products}) - (\text{Moles of gaseous reactants})$$

$$\Delta n_g = 2 - 1 = 1$$

Step 4: Substitute the value of $\Delta n_g = 1$ back into the original relational equation:

$$K_p = K_c(RT)^1 = K_c(RT)$$

Thus, the relationship is $K_p = K_c(RT)$.

Final Answer: $K_p = K_c(RT)$

Answer: (B)

Go Back to Question 6

Q7.

Solution

Concept:

Chemical fertilizers are rigorously categorized into straight, complex, or mixed types based on the number of primary plant macronutrients (Nitrogen, Phosphorus, Potassium) they supply. Straight fertilizers provide only one primary nutrient, whereas complex fertilizers contain a chemical combination of two or more primary nutrients manufactured within a single uniform granule.

Solution:

Step 1: Evaluate the composition of each fertilizer provided in the options to determine their primary nutrients:

Urea (NH_2CONH_2) contains only Nitrogen ($\sim 46\%$), so it is a straight fertilizer.

Single Super Phosphate (SSP) provides only Phosphorus ($\sim 16\%$ P_2O_5) along with calcium and sulfur, classifying it as a straight fertilizer.

Muriate of Potash (KCl) delivers only Potassium ($\sim 60\%$ K_2O), making it a straight fertilizer.

Ammonium Phosphate provides both Nitrogen (N) and Phosphorus (P) chemically bound together.

Step 2: Match the definition of complex fertilizers with the options. Since Ammonium Phosphate provides two essential primary nutrients, it is classified as a complex fertilizer.

Final Answer: Ammonium Phosphate

Answer: (C)

Go Back to Question 7

Q8.

Solution

Concept:

The iodoform test serves as a highly specific diagnostic tool used in organic chemistry to identify molecules containing a methyl ketone structural unit ($CH_3 - C = O$) or compounds that can be readily oxidized under the reaction conditions to form a methyl ketone structure, such as specific secondary alcohols or ethanol.

Solution:

Step 1: Examine the structural formula of all the chemical compounds given in the choices:
Pentan-3-one is $CH_3 - CH_2 - CO - CH_2 - CH_3$. It does not contain a terminal $CH_3 - CO-$ group.
Ethanol is $CH_3 - CH_2 - OH$. Upon treatment with iodine and sodium hydroxide, it undergoes initial oxidation to form acetaldehyde ($CH_3 - CHO$), which contains the necessary $CH_3 - CO-$ linkage.
Methanol is $CH_3 - OH$. It oxidizes to formaldehyde (HCHO), which lacks the required methyl group adjacent to the carbonyl carbon.
Benzene is an aromatic hydrocarbon entirely lacking any carbonyl or alcohol functionalities.

Step 2: Identify which compound meets the structural criteria. Ethanol is the only option capable of forming the required methyl carbonyl intermediate, allowing it to yield a bright yellow precipitate of iodoform (CHI_3).

Final Answer: Ethanol

Answer: (B)

Go Back to Question 8

Q9.

Solution

Concept:

The pH of an aqueous solution is a mathematical measure of its molar hydrogen ion (H^+) concentration, expressed via the negative logarithm to the base 10:

$$\text{pH} = -\log_{10}[\text{H}^+]$$

When an acidic solution is diluted with pure water, the total volume increases, leading to a corresponding decrease in the molar concentration of the hydrogen ions, which systematically elevates the pH value.

Solution:

Step 1: Determine the initial concentration of hydrogen ions (H^+) using the given starting pH value:

$$\text{pH}_{\text{initial}} = 3.0 \implies -\log_{10}[\text{H}^+]_{\text{initial}} = 3.0 \implies [\text{H}^+]_{\text{initial}} = 10^{-3}\ \text{M}$$

Step 2: Account for the dilution effect. The problem states that the acidic solution is diluted 100 times. Therefore, the new hydrogen ion concentration will be exactly one-hundredth of the original value:

$$[\text{H}^+]_{\text{final}} = \frac{[\text{H}^+]_{\text{initial}}}{100} = \frac{10^{-3}\ \text{M}}{10^2} = 10^{-5}\ \text{M}$$

Step 3: Calculate the new pH value of the diluted solution using the definition log formula:

$$\text{pH}_{\text{final}} = -\log_{10}[\text{H}^+]_{\text{final}} = -\log_{10}(10^{-5}) = 5.0$$

Thus, the final pH of the resulting solution shifts to 5.0.

Final Answer: 5.0

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept:

Essential plant nutrients are broadly categorized into macro-elements and micro-elements based on the relative quantities required for healthy plant growth. Macronutrients are needed in large amounts, whereas micronutrients (or trace elements) are vital for biochemical processes but are required in minute quantities.

Solution:

Step 1: Classify the nutrients listed in the options based on standard agronomic requirements:
Nitrogen (N), Calcium (Ca), and Magnesium (Mg) are classified as macronutrients.
Zinc (Zn), along with iron, boron, manganese, copper, molybdenum, and chlorine, is required in tiny quantities, placing it in the micronutrient category.

Step 2: Conclude that Zinc is the correct micronutrient among the choices.

Final Answer: Zinc

Answer: (C)

Go Back to Question 10

Q11.

Solution

Concept:

Fehling's solution is an alkaline mixture containing copper(II) ions complexed with tartrate ligands. It acts as a mild oxidizing agent that selectively oxidizes aliphatic aldehydes into their corresponding carboxylate anions, while the copper(II) complex is simultaneously reduced to an insoluble copper(I) species.

Solution:

Step 1: Write out the balanced chemical pathway for the reduction reaction of acetaldehyde with Fehling's reagent:

$$CH_3CHO + 2Cu^{2+} + 5OH^- \rightarrow CH_3COO^- + Cu_2O \downarrow + 3H_2O$$

Step 2: Identify the chemical composition of the red precipitate that separates from the solution. The copper changes its oxidation state from +2 in the soluble complex down to +1 in the insoluble cuprous oxide oxide.

Step 3: Match this product with the choices. The resulting red precipitate consists of cuprous oxide, which has the chemical formula Cu_2O.

Final Answer: Cu_2O

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept:

The three-dimensional geometric shape of a molecular species can be predicted using Valence Shell Electron Pair Repulsion (VSEPR) theory. The geometry depends directly on the total steric number of the central atom, which is calculated as the sum of the surrounding sigma bonds and the remaining non-bonding lone pairs of electrons.

Solution:

Step 1: Calculate the steric parameters for each molecule listed in the choices:

For CO_2: Carbon has 4 valence electrons, forms 2 double bonds (σ-bonds), and retains 0 lone pairs. Steric number = 2, leading to an sp hybridization state and a perfectly linear molecular geometry (180° bond angle).

For SO_2: Sulfur has 6 valence electrons, forms 2 double bonds (σ-bonds), and has 1 lone pair. Steric number = 3, leading to an sp^2 hybridization state and a bent/V-shaped geometry.

For NO_2^-: Nitrogen forms 2 σ-bonds and retains 1 lone pair, resulting in an sp^2 hybridized bent structure.

For O_3: The central oxygen atom forms bonds and holds a lone pair, creating an sp^2 hybridized angular shape.

Step 2: Identify the linear species. Carbon dioxide (CO_2) is the only molecule that possesses a strictly linear geometry.

Final Answer: CO_2

Answer: (A)

Go Back to Question 12

Q13.

Solution

Concept:

Lyophobic colloidal sols are thermodynamically unstable and easily undergo coagulation upon the addition of small amounts of electrolytes. Lyophilic colloids can be added to protect these lyophobic sols from coagulating. The protective efficiency of these lyophilic substances is quantitatively expressed using the Gold Number, as defined by Richard Zsigmondy.

Solution:

Step 1: Define the Gold Number. It is the minimum mass in milligrams of a protective lyophilic colloid required to completely prevent the coagulation of 10 mL of a standard red gold sol when 1 mL of a 10% sodium chloride solution is introduced.

Step 2: Relate the magnitude of the gold number to protective performance. A smaller gold number indicates that a very small amount of the colloid is sufficient to offer protection, meaning it possesses a much higher protective capability.

Step 3: Conclude that the gold number serves as a direct quantitative measure of the protective power of a lyophilic colloid.

Final Answer: Protective power of a lyophilic colloid

Answer: (A)

Go Back to Question 13

Q14.

Solution

Concept:

The composition of milk varies considerably among different breeds of livestock. The Bhadawari buffalo breed, native to the Agra district of Uttar Pradesh and widespread across neighboring parts of Rajasthan, is globally renowned for producing milk with an exceptionally high fat content compared to other standard breeds.

Solution:

Step 1: Review factual dairy science data concerning the milk composition of different Indian buffalo breeds. While typical buffalo milk contains an average of 6% to 8% fat, the Bhadawari breed exhibits distinct genetic traits that concentrate lipids in its milk.

Step 2: Identify the specific fat range for this breed. Under standard management conditions, the fat percentage in the milk of a Bhadawari buffalo ranges from 8.0% to 13%, with an average baseline operating near 8.0% to 9.5%, frequently climbing higher during late lactation phases. Thus, option D is the most accurate representation.

Final Answer: 8.0% to 9.5%

Answer: (D)

Go Back to Question 14

Q15.

Solution

Concept:

The Reimer-Tiemann reaction is a classic organic named transformation that achieves the direct formylation of phenolic rings. When phenol is treated with chloroform ($CHCl_3$) in the presence of an aqueous alkali hydroxide like NaOH, a highly reactive dichlorocarbene intermediate (: CCl_2) is generated in situ to attack the electron-rich aromatic ring.

Solution:

Step 1: Analyze the chemical conversion described in the prompt: Phenol is transformed into salicylaldehyde (2-hydroxybenzaldehyde) via reaction with $CHCl_3$ and base.

Step 2: Examine the named reactions listed in the options to find a match:
Kolbe's reaction involves the carboxylation of phenol using carbon dioxide (CO_2) and NaOH to yield salicylic acid.
Reimer-Tiemann reaction introduces a formyl group ($-CHO$) specifically at the ortho position of the phenol ring using chloroform.
Rosenmund reduction involves transforming an acyl chloride into an aldehyde using hydrogen gas over a poisoned palladium catalyst.
Wurtz-Fittig reaction couples an aryl halide with an alkyl halide in the presence of sodium metal.

Step 3: Conclude that the described pathway is the Reimer-Tiemann reaction.

Final Answer: Reimer-Tiemann reaction

Answer: (B)

Go Back to Question 15

Q16.

Solution

Concept:

The oxidation state or oxidation number of an element in a chemical species represents the formal charge that an atom would carry if all bonding electron pairs were assigned entirely to the more electronegative element. This can be calculated using standard oxidation number rules, where hydrogen is typically assigned +1 and oxygen is assigned −2.

Solution:

Step 1: Calculate the oxidation state of Nitrogen (N) in each given compound:

For Hydrazine (N_2H_4): Let the oxidation state of nitrogen be x.

$$2(x) + 4(+1) = 0 \implies 2x = -4 \implies x = -2$$

For Ammonia (NH_3): Let the oxidation state of nitrogen be x.

$$x + 3(+1) = 0 \implies x = -3$$

For Nitrous oxide (N_2O): Let the oxidation state of nitrogen be x.

$$2(x) + 1(-2) = 0 \implies 2x = +2 \implies x = +1$$

For Nitric acid (HNO_3): Let the oxidation state of nitrogen be x.

$$(+1) + x + 3(-2) = 0 \implies 1 + x - 6 = 0 \implies x = +5$$

Step 2: Compare the calculated values: $-3, -2, +1$, and $+5$. The highest value among these is $+5$, which occurs in nitric acid.

Final Answer: HNO_3

Answer: (D)

Go Back to Question 16

Q17.

Solution

Concept:

According to the Bohr model of the hydrogen atom, electronic transitions between different principal energy levels result in the emission or absorption of electromagnetic radiation. The frequency (ν) of the emitted photon is directly proportional to the magnitude of the energy difference (ΔE) between the two quantum states involved:

$$\Delta E = h\nu = R_H \cdot c \left(\frac{1}{n^2_{\text{final}}} - \frac{1}{n^2_{\text{initial}}} \right)$$

Solution:

Step 1: Understand the spacing of energy levels in a hydrogen atom. The energy gaps between consecutive levels decrease rapidly as the principal quantum number (n) increases. The largest single energy gap exists between the ground state ($n = 1$) and the first excited state ($n = 2$).

Step 2: Evaluate the energy difference for each transition option:

For $n = 2 \rightarrow n = 1$: $\Delta E = 13.6 \left(1 - \frac{1}{4}\right) = 13.6 \times 0.75 = 10.2$ eV

For $n = 3 \rightarrow n = 2$: $\Delta E = 13.6 \left(\frac{1}{4} - \frac{1}{9}\right) = 13.6 \times 0.139 = 1.89$ eV

For $n = 4 \rightarrow n = 3$: $\Delta E = 13.6 \left(\frac{1}{9} - \frac{1}{16}\right) = 13.6 \times 0.048 = 0.66$ eV

For $n = 5 \rightarrow n = 4$: $\Delta E = 13.6 \left(\frac{1}{16} - \frac{1}{25}\right) = 13.6 \times 0.022 = 0.31$ eV

Step 3: Relate the energy difference to frequency. Since $\Delta E = h\nu$, the transition with the largest energy change will emit a photon with the highest frequency. The $n = 2 \rightarrow n = 1$ transition produces the largest energy drop (10.2 eV), yielding the highest frequency.

Final Answer: $n = 2 \rightarrow n = 1$

Answer: (A)

Go Back to Question 17

Q18.

Solution

Concept:

Paramagnetic behavior is exhibited by chemical species that contain one or more unpaired electrons. The magnitude of an ion's paramagnetic character is directly proportional to the total number of unpaired electrons (n) present within its valence subshell, which can be quantitatively calculated using the spin-only magnetic moment formula:

$$\mu = \sqrt{n(n+2)} \text{ Bohr Magnetons (B.M.)}$$

Solution:

Step 1: Write down the neutral atomic numbers and outer electronic configurations for each transition metal:

Cr ($Z = 24$) = $[\text{Ar}]3d^5 4s^1$

Mn ($Z = 25$) = $[\text{Ar}]3d^5 4s^2$

Fe ($Z = 26$) = $[\text{Ar}]3d^6 4s^2$

Co ($Z = 27$) = $[\text{Ar}]3d^7 4s^2$

Step 2: Determine the electronic configuration and count the number of unpaired electrons (n) for each ion by removing valence electrons:

For Cr^{3+}: Remove 3 electrons $\implies$ $[\text{Ar}]3d^3$. The five d-orbitals hold 3 unpaired electrons, so $n = 3$.

For Mn^{2+}: Remove 2 electrons $\implies$ $[\text{Ar}]3d^5$. The five d-orbitals each hold 1 electron, yielding 5 unpaired electrons, so $n = 5$.

For Fe^{2+}: Remove 2 electrons $\implies$ $[\text{Ar}]3d^6$. One orbital is paired and four contain single electrons, yielding 4 unpaired electrons, so $n = 4$.

For Co^{2+}: Remove 2 electrons $\implies$ $[\text{Ar}]3d^7$. Two orbitals are paired and three contain single electrons, yielding 3 unpaired electrons, so $n = 3$.

Step 3: Compare the number of unpaired electrons. The Mn^{2+} ion contains the highest number of unpaired electrons ($n = 5$), giving it the strongest paramagnetic behavior among the choices.

Final Answer: Mn^{2+}

Answer: (B)

Go Back to Question 18

Q19.

Solution

Concept:

Alkaline or alkali soils are characterized by high concentrations of exchangeable sodium ions (Na^+) and elevated pH values, which impair soil structure and restrict plant growth. Reclaiming these soils requires replacing the exchangeable sodium ions on the soil clay complex with divalent calcium ions (Ca^{2+}), followed by leaching out the resulting soluble sodium salts.

Solution:

Step 1: Understand the chemical action of the soil amendments listed in the choices:
Lime ($CaCO_3$ or CaO) is basic in nature and is used to raise the pH of acidic soils.
Gypsum ($CaSO_4 \cdot 2H_2O$) provides a direct source of soluble divalent calcium ions (Ca^{2+}) without raising the soil pH further.

Step 2: Analyze the reaction that occurs when gypsum is added to alkaline soil. The calcium ions displace sodium ions from the clay exchange sites:

$$\text{Clay} - Na_2 + CaSO_4 \rightarrow \text{Clay} - Ca + Na_2SO_4$$

The displaced sodium forms highly soluble sodium sulfate (Na_2SO_4), which can then be easily leached down out of the root zone via irrigation water. This effectively reduces soil alkalinity.

Final Answer: Gypsum

Answer: (B)

Go Back to Question 19

Q20.

Solution

Concept:

Natural rubber is a naturally occurring elastomer extracted from the latex sap of specific tropical trees. From a macromolecular standpoint, it is a high-molecular-weight addition polymer made from repeating conjugated diene monomer units arranged in a sterically regular configuration.

Solution:

Step 1: Identify the chemical monomer that constitutes natural rubber. Natural rubber consists of repeating units of 2-methylbuta-1,3-diene, which is commonly known by its industrial name, isoprene.

Step 2: Note the stereochemical arrangement of the polymer. Natural rubber is specifically the cis-polyisoprene form, where all the repeating $-CH_2-$ chain segments lie on the same side of the carbon-carbon double bonds. This cis-geometry gives the polymer chains high flexibility and elasticity.

Final Answer: Isoprene

Answer: (B)

Go Back to Question 20

Q21.

Solution

Concept:

The hybridization state of a central atom in a given molecule can be determined by calculating its steric number (H). The formula for calculating this value is:

$$H = \frac{1}{2}[V + M - C + A]$$

Where V is the number of valence electrons on the central atom, M is the number of monovalent atoms bonded to it, C represents any positive charge, and A represents any negative charge.

Solution:

Step 1: Identify the central atom and its parameters in the sulfur hexafluoride (SF_6) molecule:

Central atom = Sulfur (S, Group 16) $\implies V = 6$ valence electrons.

Surrounding atoms = Six monovalent Fluorine atoms (F) $\implies M = 6$.

Net ionic charge = 0 $\implies C = 0, A = 0$.

Step 2: Calculate the steric number (H) using the values:

$$H = \frac{1}{2}[6 + 6 - 0 + 0] = \frac{12}{2} = 6$$

Step 3: Correlate the steric number with the corresponding hybridization state:

A steric number of 6 corresponds to an sp^3d^2 hybridization state, which produces an octahedral molecular geometry.

Final Answer: sp^3d^2

Answer: (C)

Go Back to Question 21

Q22.

Solution

Concept:

Le Chatelier's principle states that if a dynamic chemical system at equilibrium is subjected to a change in temperature, pressure, or component concentrations, the system will shift its equilibrium position in a direction that counteracts and minimizes the effect of that applied disturbance.

Solution:

Step 1: Write down the provided chemical equilibrium equation for the industrial synthesis of ammonia:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + \text{Heat} \quad (\Delta H < 0)$$

Step 2: Evaluate the effect of temperature changes. Since this forward reaction is exothermic (ΔH is negative), it releases heat. According to Le Chatelier's principle, lowering the system temperature will cause the equilibrium to shift in the direction that generates heat, thereby favoring the forward reaction.

Step 3: Evaluate the effect of pressure changes. Count the total number of gaseous moles on both sides:
Reactant side = 1 + 3 = 4 moles
Product side = 2 moles
Increasing the total external pressure forces the system to shift toward the side with fewer gas moles to reduce pressure. In this case, higher pressure drives the reaction toward the product side (2 moles).

Step 4: Combine the optimal conditions. The forward production of ammonia is maximized by maintaining a lower temperature and a higher pressure. This matches choice B.

Final Answer: Decreasing the temperature and increasing the pressure

Answer: (B)

Go Back to Question 22

Q23.

Solution

Concept:

Carbohydrates are polyhydroxy aldehydes or ketones that are classified into monosaccharides, oligosaccharides, or polysaccharides based on their behavior toward acid-catalyzed hydrolysis. Monosaccharides are the simplest carbohydrate units and cannot be broken down into smaller sugar molecules.

Solution:

Step 1: Examine the chemical classification of each carbohydrate listed in the choices:
Sucrose ($C_{12}H_{22}O_{11}$) is a disaccharide that hydrolyzes into one glucose unit and one fructose unit.
Maltose ($C_{12}H_{22}O_{11}$) is a disaccharide that hydrolyzes to yield two glucose units.
Fructose ($C_6H_{12}O_6$) is a polyhydroxy ketone monosaccharide. Because it is already a single monomeric sugar unit, it cannot undergo further hydrolysis into simpler sugars.
Cellulose is a complex polysaccharide that breaks down into numerous glucose molecules upon complete hydrolysis.

Step 2: Identify the non-hydrolyzable option. Fructose matches the definition of a monosaccharide.

Final Answer: Fructose

Answer: (C)

Go Back to Question 23

Q24.

Solution

Concept:

The Biuret test is a colorimetric chemical assay used to detect the presence of peptide bonds within a sample. When a substance containing two or more peptide bonds reacts with copper(II) ions (Cu^{2+}) in an alkaline solution, coordination complexes form between the copper ions and the nitrogen atoms of the peptide linkages, producing a characteristic color change.

Solution:

Step 1: Understand the reaction mechanism of the Biuret test. The reagent consists of a basic solution of sodium hydroxide (NaOH) and a tiny amount of copper(II) sulfate ($CuSO_4$).

Step 2: Identify the target functional group. This test requires at least two peptide bonds ($-CO-NH-$) to form the colored coordination complex. When these links are present, the solution changes from its original light blue color to a distinct violet or purple color.

Step 3: Relate this to the options. Proteins are long polypeptide chains composed of amino acids linked together by numerous peptide bonds, meaning they readily give a positive Biuret test response.

Final Answer: Proteins

Answer: (C)

Go Back to Question 24

Q25.

Solution

Concept:

Electron gain enthalpy ($\Delta_{eg}H$) represents the enthalpy change that occurs when an electron is added to a neutral gaseous atom to form a negative ion. Generally, electron gain enthalpy becomes more negative across a period from left to right and less negative moving down a group. However, anomalies can occur in the second and third periods due to differences in atom size and electron density.

Solution:

Step 1: Analyze the periodic trend for Halogens (Group 17), which possess the most negative electron gain enthalpies because they require only a single electron to achieve a stable noble gas configuration.

Step 2: Compare Fluorine (F) and Chlorine (Cl). Although fluorine is located above chlorine in Group 17, its $2p$ subshell is exceptionally small. Adding an electron to this compact subshell creates significant electron-electron repulsion, which diminishes the energy released.

Step 3: Analyze chlorine's structure. Chlorine has a larger $3p$ subshell with more space, allowing it to accept an incoming electron with minimal inter-electronic repulsion. As a result, chlorine releases more energy ($\Delta_{eg}H = -349$ kJ mol^{-1}) than fluorine ($\Delta_{eg}H = -328$ kJ mol^{-1}), giving it the highest negative electron gain enthalpy in the entire periodic table.

Final Answer: Chlorine

Answer: (B)

Go Back to Question 25

Q26.

Solution

Concept:

The rate law for a chemical reaction expresses the relationship between the reaction rate and the molar concentrations of its reactants, with each concentration raised to a power known as the partial order. The mathematical formulation is written as:

$$\text{Rate} = k[\text{A}]^x[\text{B}]^y$$

Where x and y represent the partial reaction orders with respect to reactants A and B, respectively, and the sum $(x + y)$ defines the overall reaction order.

Solution:

Step 1: Determine the partial order with respect to reactant A (x). The problem states that doubling the concentration of A causes the reaction rate to increase by a factor of 4:

$$2^x = 4 \implies 2^x = 2^2 \implies x = 2$$

This means the reaction is second-order with respect to reactant A.

Step 2: Determine the partial order with respect to reactant B (y). The problem states that doubling the concentration of B has no effect on the reaction rate, meaning the rate is independent of B:

$$2^y = 1 \implies 2^y = 2^0 \implies y = 0$$

This means the reaction is zeroth-order with respect to reactant B.

Step 3: Calculate the overall order of the reaction by summing the partial orders:

$$\text{Overall Order} = x + y = 2 + 0 = 2$$

Thus, the overall order of the reaction is 2.

Final Answer: 2

Answer: (B)

Go Back to Question 26

Q27.

Solution

Concept:

Each essential primary macronutrient (N, P, K) plays a specific, distinct role in plant physiological and biochemical development. Nitrogen primarily promotes vegetative growth and leaf development, while potassium regulates stomatal activity and stress resistance. Phosphorus is essential for cellular energy conservation and structural development within the plant.

Solution:

Step 1: Identify the primary functions of Phosphorus (P) in crop plants. It is a vital constituent of adenosine triphosphate (ATP), nucleic acids, and phospholipids.

Step 2: Relate these biochemical roles to visible plant development. Because it drives energy transfer processes, phosphorus is vital for cellular division, rapid root elongation, strong structural root development, early flower initiation, and accelerated crop maturity. This makes phosphorus the key element responsible for root development and early maturity.

Final Answer: Phosphorus

Answer: (B)

Go Back to Question 27

Q28.

Solution

Concept:

Aryl halides react with magnesium metal in an anhydrous ethereal solvent to form organomagnesium halides, commonly known as Grignard reagents. These compounds contain highly nucleophilic and basic carbon centers that react rapidly with protic sources (such as water or alcohols) via an acid-base proton transfer to yield the corresponding hydrocarbon.

Solution:

Step 1: Formulate the first step of the reaction sequence. Treating bromobenzene (C_6H_5Br) with magnesium (Mg) turnings in dry ether inserts the metal into the carbon-halogen bond, yielding phenylmagnesium bromide:

$$C_6H_5Br + Mg \xrightarrow{\text{dry ether}} C_6H_5MgBr$$

Step 2: Formulate the second step of the sequence. Phenylmagnesium bromide acts as a strong base due to the highly polarized carbon-metal bond ($C_6H_5^{\delta-} - MgBr^{\delta+}$). Introducing water ($H_2O$) causes an immediate, highly exothermic protonation reaction:

$$C_6H_5MgBr + H - OH \rightarrow C_6H_6 + Mg(OH)Br$$

Step 3: Identify the final organic product. The protonation of the phenyl ring produces benzene (C_6H_6).

Final Answer: Benzene

Answer: (B)

Go Back to Question 28

Q29.

Solution

Concept:

Isoelectronic chemical 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 (Z_{eff}), which depends on the number of protons in the nucleus. A higher nuclear charge exerts a stronger attractive force on the electron cloud, pulling it closer and decreasing the ionic radius.

Solution:

Step 1: Determine the total number of electrons for each provided species to verify they are isoelectronic:

O^{2-} (Atomic number = 8) $\implies$ 8 + 2 = 10 electrons

F^- (Atomic number = 9) $\implies$ 9 + 1 = 10 electrons

Na^+ (Atomic number = 11) $\implies$ 11 − 1 = 10 electrons

All three species possess exactly 10 electrons.

Step 2: Count the number of protons (nuclear charge, Z) in each nucleus:

$O^{2-} \implies Z = 8$ protons

$F^- \implies Z = 9$ protons

$Na^+ \implies Z = 11$ protons

Step 3: Evaluate the relationship between nuclear charge and ionic radius. The sodium ion (Na^+) has the highest nuclear charge (11 protons) pulling on the 10 electrons, making it the smallest ion. Conversely, the oxide ion (O^{2-}) has the lowest nuclear charge (8 protons), resulting in weaker electron attraction and the largest ionic radius.

Step 4: Arrange the ions in order of decreasing size based on these nuclear charge differences:

$$O^{2-} > F^- > Na^+$$

Final Answer: $O^{2-} > F^- > Na^+$

Answer: (B)

Go Back to Question 29

Q30.

Solution

Concept:

According to the Lewis acid-base definition, a Lewis acid is a chemical species capable of accepting an electron pair from a donor molecule to form a covalent bond. These species typically feature central atoms that are electron-deficient, meaning they have incomplete valence octets or available vacant orbitals.

Solution:

Step 1: Analyze the electronic structure of each option to check for electron deficiencies or lone pairs:

Ammonia (NH_3) has a central nitrogen atom with 3 bonding pairs and 1 non-bonding lone pair, allowing it to act as a Lewis base.

Water (H_2O) features an oxygen atom carrying 2 non-bonding lone pairs, allowing it to act as a Lewis base.

Boron trifluoride (BF_3) features a central boron atom bonded to 3 fluorine atoms. This leaves the boron atom with only 6 electrons in its outer valence shell, creating an incomplete octet and an empty, accessible $2p$ orbital.

The fluoride ion (F^-) carries a full negative charge and complete lone pairs, making it an electron pair donor (Lewis base).

Step 2: Identify the electron acceptor. Because the central boron atom in BF_3 is electron-deficient, it can readily accept an electron pair into its vacant orbital, classifying it as a strong Lewis acid.

Final Answer: BF_3

Answer: (C)

Go Back to Question 30

Q31.

Solution

Concept:

Single Super Phosphate (SSP) is a popular, cost-effective phosphatic mineral fertilizer manufactured by reacting insoluble rock phosphate mineral powder with concentrated sulfuric acid (H_2SO_4). This chemical treatment converts the insoluble phosphate into a water-soluble form while generating a significant chemical byproduct within the final granules.

Solution:

Step 1: Examine the chemical equation for the industrial manufacture of Single Super Phosphate fertilizer:

$$Ca_3(PO_4)_2 + 2H_2SO_4 + 4H_2O \rightarrow Ca(H_2PO_4)_2 + 2(CaSO_4 \cdot 2H_2O)$$

Step 2: Identify the components of the resulting mixture. The fertilizer product is a blend of water-soluble monocalcium phosphate, $Ca(H_2PO_4)_2$, which supplies phosphorus, and calcium sulfate (gypsum), $CaSO_4 \cdot 2H_2O$.

Step 3: Determine which component supplies sulfur. The calcium sulfate byproduct accounts for nearly half of the mass of the bulk material, supplying crops with essential secondary nutrients, particularly sulfur ($\sim 11\% - 12\%$ S).

Final Answer: Calcium sulphate

Answer: (A)

Go Back to Question 31

Q32.

Solution

Concept:

Benzene is an electron-rich, planar, conjugated aromatic ring system stabilized by a high resonance energy. Because the delocalized π-electron cloud is susceptible to attack by electron-deficient species, benzene primarily undergoes substitution reactions rather than addition reactions. This preserves the highly stable aromatic core of the ring system.

Solution:

Step 1: Analyze the role of the acids in the nitrating mixture. Concentrated sulfuric acid (H_2SO_4) protonates concentrated nitric acid (HNO_3), leading to the loss of a water molecule and the generation of the highly reactive nitronium electrophile (NO_2^+):

$$HNO_3 + 2H_2SO_4 \rightleftharpoons NO_2^+ + H_3O^+ + 2HSO_4^-$$

Step 2: Determine the reaction mechanism. The electron-rich π-system of the benzene ring attacks the incoming nitronium electrophile (NO_2^+), forming a resonance-stabilized arenium ion intermediate (sigma complex).

Step 3: Identify the final step of the mechanism. A base (HSO_4^-) removes a proton from the sp3-hybridized carbon of the intermediate, restoring the aromaticity of the ring and yielding nitrobenzene. Because an electrophile replaces a hydrogen atom on the aromatic ring, the reaction is classified as an electrophilic substitution reaction.

Final Answer: Electrophilic substitution reaction

Answer: (B)

Go Back to Question 32

Q33.

Solution

Concept:

Stoichiometric calculations for gas-phase chemical reactions can be directly solved using Avogadro's law, which states that equal volumes of gases at the same temperature and pressure contain an equal number of moles. This allows gaseous volume ratios to be treated identically to stoichiometric mole ratios under constant conditions.

Solution:

Step 1: Write down the balanced chemical equation for the synthesis reaction:

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

According to the stoichiometry of the reaction, exactly 1 volume of hydrogen gas reacts completely with 1 volume of chlorine gas to yield 2 volumes of hydrogen chloride gas.

Step 2: Identify the given quantities and determine the limiting reactant:
Volume of H_2 = 22.4 L at STP
Volume of Cl_2 = 11.2 L at STP
Since 11.2 L of Cl_2 requires only 11.2 L of H_2 for complete reaction, chlorine gas (Cl_2) is completely consumed first, making it the limiting reactant. Hydrogen gas (H_2) is present in excess.

Step 3: Calculate the volume of HCl gas produced based on the volume of the limiting reactant:

$$\text{Volume of HCl} = 2 \times (\text{Volume of limiting reactant } Cl_2)$$

$$\text{Volume of HCl} = 2 \times 11.2 \text{ L} = 22.4 \text{ L at STP}$$

Thus, the volume of HCl gas formed at STP is 22.4 L.

Final Answer: 22.4 L

Answer: (B)

Go Back to Question 33

Q34.

Solution

Concept:

The d-block transition elements occupy positions in the periodic table between the highly electropositive s-block and the electronegative p-block elements. Their characteristic physical and chemical properties stem from the progressive filling of their inner $(n-1)d$ subshells, where the valence ns and inner $(n-1)d$ orbitals have very similar energy levels.

Solution:

Step 1: Evaluate each chemical property listed in the choices to see if it characterizes transition metals:

Variable oxidation states: Because the energy gap between the $(n-1)d$ and ns orbitals is minimal, electrons from both shells can participate in chemical bonding, allowing these elements to exhibit multiple oxidation states.

Formation of colored ions: The presence of partially filled d-orbitals allows valence electrons to undergo transitions between different d-orbital energy levels upon absorbing visible light ($d-d$ transition), imparting distinct colors to their ions and complexes.

Catalytic properties: Transition metals and their complexes serve as effective catalysts due to their ability to adopt variable oxidation states and form stable reaction intermediates.

Step 2: Conclude that all the listed properties are defining characteristics of d-block elements.

Final Answer: All of the above

Answer: (D)

Go Back to Question 34

Q35.

Solution

Concept:

The physical density or specific gravity of milk is a reliable indicator used in dairy quality control to detect adulteration, such as the unauthorized addition of water or the removal of valuable fat components. Specific gravity measurements are typically performed using specialized hydrometers calibrated for specific fluid types.

Solution:

Step 1: Review the function of each instrument listed in the options:

A refractometer measures the refractive index of a solution to estimate total dissolved solids or sugar content.

A lactometer is a specialized, calibrated hydrometer designed specifically to measure the specific gravity of milk. Pure milk generally exhibits a specific gravity reading ranging between 1.028 and 1.032 g cm^{-3} at standard temperature. If water is added, the specific gravity drops toward 1.000, which is readily detected by the instrument.

A thermometer measures temperature changes.

A butyrometer is used in the Gerber method to measure the total fat percentage in a milk sample.

Step 2: Identify the correct instrument for measuring specific gravity. The lactometer is the tool used for this purpose.

Final Answer: Lactometer

Answer: (B)

Go Back to Question 35

Q36.

Solution

Concept:

The relative acidity of hydrocarbons depends primarily on the hybridization state of the carbon atom bonded to the hydrogen. A higher percentage of s-character in a hybrid orbital positions the bonding electrons closer to the carbon nucleus, increasing its effective electronegativity. This stabilizes the resulting conjugate base carbanion, making the parent hydrocarbon more acidic.

Solution:

Step 1: Determine the hybridization state and s-character percentage for each hydrocarbon:
Ethyne ($HC \equiv CH$): The carbon atoms are sp hybridized, which corresponds to 50% s-character.
Ethene ($H_2C = CH_2$): The carbon atoms are sp^2 hybridized, which corresponds to 33.33% s-character.
Ethane ($H_3C - CH_3$): The carbon atoms are sp^3 hybridized, which corresponds to 25% s-character.

Step 2: Relate the hybridization and s-character to electronegativity and acidity. The sp hybridized carbon in ethyne is highly electronegative due to its 50% s-character, allowing it to strongly attract the C – H bonding pair and readily release a proton (H^+). The sp^3 hybridized carbons in ethane hold electrons less tightly, making it the least acidic.

Step 3: Arrange the hydrocarbons in order of decreasing acid strength:

$$\text{Ethyne} > \text{Ethene} > \text{Ethane}$$

Final Answer: Ethyne > Ethene > Ethane

Answer: (A)

Go Back to Question 36

Q37.

Solution

Concept:

The empirical formula represents the simplest whole-number ratio of the various atoms present within a chemical compound. It can be systematically calculated by converting the mass percentages of each constituent element into relative molar amounts, followed by dividing each molar value by the smallest value in the set.

Solution:

Step 1: List the given mass percentages for each element:

Carbon (C) = 40.0% Hydrogen (H) = 6.7% Oxygen (O) = 53.3% Step 2: Calculate the relative number of moles for each element by dividing its mass percentage by its atomic mass:

$$\text{Moles of C} = \frac{40.0}{12} = 3.33 \text{ moles}$$

$$\text{Moles of H} = \frac{6.7}{1} = 6.70 \text{ moles}$$

$$\text{Moles of O} = \frac{53.3}{16} = 3.33 \text{ moles}$$

Step 3: Determine the simplest atomic ratio by dividing each molar amount by the smallest calculated value (3.33):

$$\text{Ratio for C} = \frac{3.33}{3.33} = 1$$

$$\text{Ratio for H} = \frac{6.70}{3.33} \approx 2$$

$$\text{Ratio for O} = \frac{3.33}{3.33} = 1$$

Step 4: Express these whole-number ratios as an empirical formula, which yields CH_2O.

Final Answer: CH_2O

Answer: (B)

Go Back to Question 37

Q38.

Solution

Concept:

Agrochemicals are synthetic chemical compounds used in farming to protect crops from damage caused by various pests, weeds, or pathogens. These agents are strictly classified based on their target pest organisms, such as insects, fungi, weeds, or destructive rodents.

Solution:

Step 1: Identify the chemical nature and application of zinc phosphide (Zn_3P_2). It is an inorganic compound that acts as a fast-acting, highly toxic ingestion poison.

Step 2: Understand its mechanism of action. When consumed by a pest, the compound reacts with hydrochloric acid in the stomach to release toxic phosphine gas (PH_3), which enters the bloodstream and causes systemic organ failure. This highly toxic pathway makes it effective for controlling rodent populations, such as rats and mice, in agricultural fields and storage facilities. Therefore, it is classified as a rodenticide.

Final Answer: Rodenticide

Answer: (C)

Go Back to Question 38

Q39.

Solution

Concept:

Functional isomers are structural isomers that possess the exact same molecular formula but contain different functional groups. This structural divergence imparts entirely distinct physical and chemical properties to the isomeric compounds.

Solution:

Step 1: Analyze the structural relationships for each pair listed in the options:

Ethanol (CH_3CH_2OH) and Dimethyl ether (CH_3OCH_3) both share the same molecular formula, C_2H_6O. However, ethanol contains an alcohol functional group ($-OH$), while dimethyl ether contains an ether linkage ($-O-$). Since they share a molecular formula but have different functional groups, they are functional isomers.

Propan-1-ol and Propan-2-ol both contain an alcohol group but at different carbon positions, making them positional isomers.

Pentan-2-one and Pentan-3-one are positional isomers because they vary only in the position of the carbonyl group along the carbon chain.

n-Butane and Isobutane differ in the branching pattern of their carbon skeletons, making them chain isomers.

Step 2: Conclude that the pair consisting of ethanol and dimethyl ether represents functional isomers.

Final Answer: Ethanol and Dimethyl ether

Answer: (A)

Go Back to Question 39

Q40.

Solution

Concept:

According to the Hardy-Schulze rule, the coagulation or flocculation of a lyophobic colloidal sol is driven by ions carrying a charge opposite to that of the colloidal particles. The coagulating power of an ion increases rapidly with its valence. Conversely, the coagulation value (the minimum concentration required to cause precipitation) is inversely proportional to the ion's coagulating power.

Solution:

Step 1: Identify the electrical charge characteristics of the given colloidal sol. An arsenic sulfide sol (As_2S_3) is a classic example of a negatively charged lyophobic sol.

Step 2: Identify the active coagulating cations provided by each electrolyte option and note their respective valences:
From NaCl, the active cation is Na^+ (monovalent, +1).
From $BaCl_2$, the active cation is Ba^{2+} (divalent, +2).
From $AlCl_3$, the active cation is Al^{3+} (trivalent, +3).

Step 3: Apply the Hardy-Schulze rule to determine the order of coagulating power based on cation charge:

$$\text{Coagulating Power: } Al^{3+} > Ba^{2+} > Na^+$$

Step 4: Relate coagulating power to coagulation values. Since the coagulation value is inversely proportional to coagulating power, the ion with the highest power (Al^{3+}) requires the lowest concentration to induce coagulation, while the weakest ion (Na^+) requires the highest concentration. Therefore, the coagulation values follow the order:

$$NaCl > BaCl_2 > AlCl_3$$

Final Answer: $NaCl > BaCl_2 > AlCl_3$

Answer: (A)

Go Back to Question 40

Answer Key

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