

UPCATET Agriculture Chemistry Sample Paper-8

Duration: 25 Minutes

Maximum Marks: 100

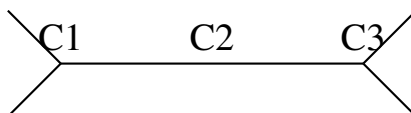
Instructions

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

Q1. A sample of black cotton soil exhibits a high cation exchange capacity (CEC). Which clay mineral group is predominantly responsible for this characteristic structural behavior under varying moisture conditions?

- (A) Kaolinite
- (B) Montmorillonite
- (C) Illite
- (D) Gibbsite

Q2. An organic chemist models a planar hydrocarbon alignment mapping the symmetrical coordinates of a specific alkane molecule to optimize orbital hybridization overlaps. Consider the spatial configuration described below:



If all remaining valencies are satisfied by terminal hydrogen atoms, what is the systematic IUPAC name of the compound whose carbon backbone layout is illustrated?

- (A) Methane
- (B) Ethane



(C) Propane

(D) Butane

Q3. During a laboratory exercise, a student is asked to prepare a standard solution for an acid-base titration. Which of the following conditions represents a primary standard substance that can be weighed directly to calculate exact molar concentration without standardization?

(A) It must be highly hygroscopic to absorb environmental ambient moisture.

(B) It must have a low molecular mass to minimize weighing errors on analytical balances.

(C) It must be available in an exceptionally pure form with high chemical stability over time.

(D) It must react slowly with the analyte to allow manual visual tracking of the color change.

Q4. The quantum numbers of the outermost valence electron of an uncharged atom in its ground state are designated as $n = 3$, $l = 1$, $m = 0$, and $s = +1/2$. To which block and group of the Periodic Table does this element belong?

(A) s-block, Group 2

(B) p-block, Group 14

(C) d-block, Group 6

(D) p-block, Group 13

Q5. A soil testing report indicates a field has an actual soil pH of 4.5. Which chemical amendment must be applied to neutralize the active acidity and lower the toxic availability of aluminum and manganese ions?

(A) Calcium sulfate dihydrate (Gypsum)

(B) Calcium carbonate (Limestone)

(C) Ammonium sulfate

(D) Elemental sulfur dust



- Q6.** Consider the simple orbital polarization vector arrangement representing a covalent interaction between two highly electronegative heteroatoms:



If the electron cloud shifts unsymmetrically along the internuclear axis as indicated by the vector direction, what type of chemical bond is created between Atom A and Atom B?

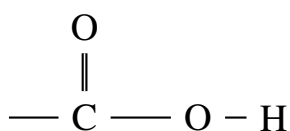
- (A) Pure non-polar covalent bond
 - (B) Coordinate covalent bond only
 - (C) Polar covalent bond
 - (D) Ionic lattice bond
- Q7.** A volumetric analysis requires the complete neutralization of 25.0 mL of a 0.1 M sulfuric acid (H_2SO_4) solution. What exact volume of 0.05 M sodium hydroxide ($NaOH$) solution is needed to reach the stoichiometric equivalence point?
- (A) 12.5 mL
 - (B) 25.0 mL
 - (C) 50.0 mL
 - (D) 100.0 mL
- Q8.** A critical physiological symptom observed in a maize crop includes marginal chlorosis of the older lower leaves, which eventually advances into necrosis and an inverted V-shaped yellowing pattern starting from the leaf tip. Which essential plant nutrient is most likely deficient?
- (A) Phosphorus
 - (B) Potassium
 - (C) Nitrogen
 - (D) Iron



Q9. When an organic acid like acetic acid reacts with an aliphatic alcohol such as ethanol in the presence of a concentrated mineral acid catalyst, a distinct pleasant fruity aroma is produced. What is the organic functional product class of this reaction?

- (A) Ether
- (B) Ester
- (C) Ketone
- (D) Aldehyde

Q10. The structural arrangement of a fundamental chemical functional group found within organic compounds is mapped out below:



Which specific organic acid category contains this terminal linkage as its primary active acidic site?

- (A) Aliphatic Sulfonic Acids
- (B) Carboxylic Acids
- (C) Phenolic Esters
- (D) Fatty Alkoxy Alcohols

Q11. Why is the phosphorus tracking efficiency in neutral to alkaline soils containing high concentrations of calcium ions significantly compromised, leading to induced crop deficiencies?

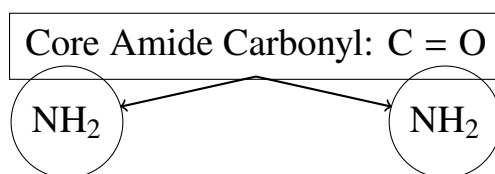
- (A) Volatilization of phosphine gas into the upper atmosphere
- (B) Rapid leaching of highly soluble orthophosphate ions beyond the root zone
- (C) Precipitation of insoluble dicalcium and tricalcium phosphate compounds
- (D) Competitive uptake inhibition by chloride ions present in the rhizosphere

Q12. How many moles of solute particles are present in precisely 500 mL of a 2.0 Normal (2.0 N) solution of a dibasic mineral acid such as H_2SO_4 ?



- (A) 0.5 moles
- (B) 1.0 mole
- (C) 2.0 moles
- (D) 4.0 moles

Q13. An agronomist studies the microscopic structural configuration of a commercial nitrogenous fertilizer particle. The structural composition is represented schematically below:



Which primary synthetic nitrogenous fertilizer formulation matches this exact intramolecular connection?

- (A) Ammonium Nitrate
 - (B) Urea
 - (C) Ammonium Sulfate
 - (D) Calcium Nitrate
- Q14.** Based on the periodic trends across a standard row (Period) from left to right in the Periodic Table, how do atomic radius and electronegativity vary consistently for representative elements?
- (A) Atomic radius increases; Electronegativity increases
 - (B) Atomic radius decreases; Electronegativity decreases
 - (C) Atomic radius decreases; Electronegativity increases
 - (D) Atomic radius increases; Electronegativity decreases
- Q15.** A laboratory synthesis involves the free-radical substitution reaction of methane gas (CH_4) with excess elemental chlorine (Cl_2) under the direct influence of ultraviolet light. What is the ultimate stable chlorinated organic end-product formed when all replaceable hydrogen atoms have reacted?

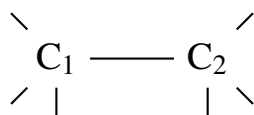


- (A) Chloromethane
- (B) Dichloromethane
- (C) Trichloromethane
- (D) Tetrachloromethane

Q16. Which component of the complex soil potential composition defines the attractive physical force holding water molecules tightly to the solid surfaces of soil particles via adhesion and cohesion processes?

- (A) Osmotic potential
- (B) Gravitational potential
- (C) Matric potential
- (D) Hydrostatic pressure potential

Q17. A chemical structure layout illustrates the tetrahedral hybridization geometries of two carbon centers directly bound together:



If all six open valencies are filled single-bonded to hydrogen atoms exclusively, which specific fuel gas molecule is defined by this saturated system?

- (A) Methane
- (B) Ethane
- (C) Ethene
- (D) Ethyne

Q18. Which specific electronic transition within the hydrogen atom spectrum corresponds to the emission of a photon falling directly into the visible light range, as characterized by the Balmer series?

- (A) Transition from $n = 2$ to $n = 1$
- (B) Transition from $n = 3$ to $n = 2$



(C) Transition from $n = 4$ to $n = 3$

(D) Transition from $n = 1$ to $n = 4$

Q19. A stock aqueous solution contains 40.0 grams of dissolved sodium hydroxide ($NaOH$, Molar Mass = 40.0 g/mol) uniformly distributed in exactly 2.0 Liters of total solution volume. What is the precise molarity (M) of this laboratory reagent?

(A) 0.25 M

(B) 0.50 M

(C) 1.00 M

(D) 2.00 M

Q20. Which essential macronutrient acts as a primary osmotic regulator within plant guard cells, thereby directly controlling stomatal opening and closing mechanisms along with structural stalk strength?

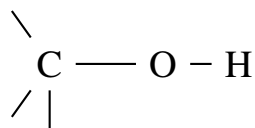
(A) Nitrogen

(B) Phosphorus

(C) Potassium

(D) Calcium

Q21. The structural conformation of a common functional molecule derived from a hydrocarbon source is detailed below:



If the three open back-bonds terminate into a simple methyl radical group via a carbon-carbon bridge, which specific organic product class does this structure represent?

(A) Aliphatic Alcohol

(B) Carboxylic Acid



- (C) Dialkyl Ether
- (D) Alkyl Aldehyde

Q22. How does the physical phenomenon of isomorphic substitution inside the crystalline layered lattices of silicate clay minerals generate a permanent net charge on the clay soil matrix?

- (A) Substitution of a higher-valence cation by a lower-valence cation of similar physical size
- (B) Adsorption of hydrogen ions onto exposed crystal edges during structural weathering
- (C) Loss of hydroxyl groups from the octahedral sheets at low matrix pH levels
- (D) Direct replacement of silicon atoms by aluminum atoms of a significantly larger ionic radius

Q23. Which of the following chemical pairs constitutes a highly effective physiological or chemical buffering system capable of stabilizing pH changes within soil solution environments?

- (A) Sodium chloride and hydrochloric acid
- (B) Carbonic acid and sodium bicarbonate
- (C) Nitric acid and ammonium nitrate
- D. Sodium hydroxide and potassium hydroxide

Q24. What is the correct chemical formula and formal classification of formic acid, which represents the simplest member of the monocarboxylic acid homologous series?

- (A) CH_3COOH , Dicarboxylic acid
- (B) $HCOOH$, Monocarboxylic acid
- (C) $HOOC - COOH$, Tricarboxylic acid
- (D) C_2H_5COOH , Monocarboxylic acid

Q25. Which chemical bond type holds the discrete atomic constituents together in a molecule of methane (CH_4), based on the sharing of valence electron pairs



between the central carbon and terminal hydrogen atoms?

- (A) Electrovalent ionic bond
- (B) Intermolecular hydrogen bond
- (C) Covalent bond
- (D) Metallic coordinate bond



Detailed Solutions**Q1.****Solution**

Concept: The cation exchange capacity (CEC) of soil depends heavily on the type of silicate clay minerals present. Clay minerals vary in their layer structure, expanding properties, and the amount of permanent negative charge generated by isomorphous substitution within their crystalline lattices.

Solution:

- (a) Montmorillonite is a 2:1 expanding type aluminosilicate clay mineral consisting of one octahedral sheet sandwiched between two tetrahedral sheets.
- (b) It undergoes extensive isomorphous substitution, primarily with lower-valence cations replacing higher-valence cations in the crystal layers, resulting in a high net negative charge.
- (c) The weak interlayer bonds allow water molecules and exchangeable cations to enter the internal surfaces readily.
- (d) This expanding nature provides a massive internal and external surface area, giving black cotton soils an exceptionally high cation exchange capacity.
- (e) Conversely, kaolinite is a non-expanding 1:1 clay with low CEC, illite has restricted expansion due to potassium bridges, and gibbsite is an aluminum oxide with minimal exchange capacity.

Final Answer: Montmorillonite

Answer: (B)

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Q2.

Solution

Concept: Saturated open-chain hydrocarbons follow the general molecular formula C_nH_{2n+2} and are classified as alkanes. Identifying their systematic IUPAC name requires determining the length of the continuous unbranched carbon backbone configuration.

Solution:

- The provided structural schematic shows a contiguous, linear chain containing three distinct carbon centers labeled sequentially as C1, C2, and C3.
- The open terminal positions on C1 and C3 represent remaining valencies that are satisfied completely by single bonds to hydrogen atoms.
- A three-carbon saturated alkane network corresponds to $n = 3$, which gives the molecular formula C_3H_8 .
- According to IUPAC nomenclature rules, the prefix for a three-carbon chain is "prop-", and the suffix for a saturated hydrocarbon is "-ane".
- Therefore, the compound illustrated by this specific linear carbon backbone map is propane, whereas methane has one carbon, ethane has two, and butane has four.

Final Answer: Propane

Answer: (C)

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Q3.

Solution

Concept: A primary standard is a highly stable reagent used in volumetric analysis to determine unknown concentrations. It must possess specific chemical properties so that its mass corresponds directly to a precise number of chemical equivalents.

Solution:

- (a) To serve as a reliable primary standard, a substance must be available in an exceptionally pure form, typically exceeding 99.9 percent purity.
- (b) It must exhibit excellent chemical stability, meaning it should not decompose, oxidize, or react with atmospheric gases during storage or weighing operations.
- (c) If a substance is hygroscopic, it will absorb ambient moisture from the air, changing its mass dynamically and introducing severe errors into standard solution calculations.
- (d) A high molecular mass is also preferred rather than a low one because it reduces the relative percentage error during mechanical weighing on analytical balances.
- (e) Fast stoichiometric reactivity is required for clear endpoint determination, making high purity and chemical stability the essential defining characteristics.

Final Answer: It must be available in an exceptionally pure form with high chemical stability over time.

Answer: (C)

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Q4.

Solution

Concept: The position of a representative element in the Periodic Table can be determined using the quantum numbers of its highest-energy valence electron in the ground-state electronic configuration.

Solution:

- (a) The principal quantum number $n = 3$ indicates that the valence electron resides in the third energy shell, which places the element in Period 3.
- (b) The azimuthal quantum number $l = 1$ specifically designates a p-orbital subshell, which classifies the element as a member of the p-block.
- (c) The magnetic quantum number $m = 0$ and spin quantum number $s = +1/2$ signify the presence of an electron filling the p-subshell according to Hund's rule.
- (d) For a ground-state neutral atom, an outer configuration ending in $3p^1$ corresponds to an atomic number of 13, which is aluminum.
- (e) The group number for p-block elements is calculated using the formula: $10 + \text{number of valence electrons}$, which equals Group 13.

Final Answer: p-block, Group 13

Answer: (D)

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Q5.

Solution

Concept: Strongly acidic soils with a pH below 5.0 often contain hazardous concentrations of soluble aluminum and manganese ions. Neutralizing this active acidity requires the application of a basic chemical amendment to raise the soil pH.

Solution:

- (a) Calcium carbonate, commonly known as agricultural limestone, reacts with water in the soil matrix to release hydroxyl ions that neutralize active hydronium ions.
- (b) This neutralization reaction raises the overall soil pH, causing toxic, soluble aluminum and manganese ions to precipitate out as harmless, insoluble hydroxides.
- (c) Calcium sulfate dihydrate, or gypsum, supplies essential calcium and sulfur but does not neutralize soil acidity or alter the native soil pH.
- (d) Ammonium sulfate and elemental sulfur dust are acidifying agents that lower soil pH, which would aggravate toxic metal availability in an already acidic soil.
- (e) Therefore, calcium carbonate is the correct basic amendment needed to reclaim this acidic soil profile safely.

Final Answer: Calcium carbonate (Limestone)

Answer: (B)

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Q6.

Solution

Concept: Chemical bonds are classified based on how valence electrons are shared between adjacent atoms. A difference in electronegativity between two bound atoms causes an uneven distribution of electronic charge density along the bond axis.

Solution:

- (a) The provided schematic illustrates a shared electron pair situated between two heteroatoms, Atom A and Atom B, along their shared internuclear axis.
- (b) The vector arrow indicates that the shared electron cloud shifts unsymmetrically toward Atom B, demonstrating that Atom B has a higher electronegativity.
- (c) This asymmetrical distribution creates a permanent partial negative charge on Atom B and a corresponding partial positive charge on Atom A.
- (d) A covalent bond characterized by an unequal sharing of valence electrons and a permanent dipole moment is defined as a polar covalent bond.
- (e) Non-polar bonds share electrons equally, coordinate bonds involve a single atom donating both electrons, and ionic bonds involve a complete transfer of electrons.

Final Answer: Polar covalent bond

Answer: (C)

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Q7.

Solution

Concept: Volumetric neutralizations follow stoichiometric principles where the total chemical equivalents of acid must equal the total chemical equivalents of base at the reaction equivalence point.

Solution:

- (a) Sulfuric acid is a dibasic mineral acid that releases two moles of hydronium ions per mole of acid, meaning its normality is twice its molarity.
- (b) The total equivalents of acid can be calculated using the normality relation: $N_1 = 2 \times 0.1 \text{ M} = 0.2 \text{ N}$, combined with a volume $V_1 = 25.0 \text{ mL}$.
- (c) Sodium hydroxide is a monoacidic base that releases one mole of hydroxyl ions per mole of base, so its normality matches its molarity: $N_2 = 0.05 \text{ N}$.
- (d) Applying the equivalence formula, $N_1V_1 = N_2V_2$, gives the relationship: $0.2 \text{ N} \times 25.0 \text{ mL} = 0.05 \text{ N} \times V_2$.
- (e) Solving for the required volume yields $V_2 = (0.2 \times 25.0)/0.05 = 5.0/0.05 = 100.0 \text{ mL}$ of sodium hydroxide solution.

Final Answer: 100.0 mL

Answer: (D)

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Q8.

Solution

Concept: Essential plant nutrients show different mobility patterns within the plant vascular system, which dictates whether deficiency symptoms appear first on older lower leaves or younger upper leaves.

Solution:

- (a) Nitrogen is a highly mobile macronutrient within plant tissues. When a deficiency occurs, nitrogen is remobilized from older leaves to support new vegetative growth.
- (b) This remobilization causes chlorosis to develop first on the older, lower leaves of the maize plant.
- (c) The chlorosis progresses in a characteristic inverted V-shaped yellowing pattern that starts at the leaf tip and moves backward along the central midrib.
- (d) Phosphorus deficiency produces dark green or purple leaf discolorations, while potassium deficiency causes chlorosis along the outer margins of the leaf blade.
- (e) Iron is an immobile micronutrient, so its deficiency symptoms appear as interveinal chlorosis exclusively on young, developing upper leaves.

Final Answer: Nitrogen

Answer: (C)

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Q9.

Solution

Concept: The acid-catalyzed condensation reaction between a carboxylic acid and an aliphatic alcohol is a classic organic synthesis known as Fischer esterification.

Solution:

- (a) When acetic acid, a monocarboxylic acid, is combined with ethanol, a primary aliphatic alcohol, a reversible condensation reaction takes place.
- (b) Concentrated sulfuric acid is added as a catalyst to protonate the carbonyl oxygen, increasing the electrophilic character of the carbonyl carbon atom.
- (c) The nucleophilic hydroxyl group of the ethanol molecule attacks this activated carbon center, leading to the elimination of a water molecule.
- (d) This reaction links the acetyl group to the ethoxy group, forming ethyl acetate, which belongs to the ester functional product class.
- (e) Esters are characterized by an internal carbonyl-oxygen linkage and are widely recognized for producing sweet, volatile, fruity aromas.

Final Answer: Ester

Answer: (B)

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Q10.

Solution

Concept: Organic compounds are organized into distinct homologous series based on their functional groups, which dictate their chemical reactivity and systematic classification.

Solution:

- (a) The provided structural layout maps a central carbon atom bound to an oxygen atom by a double bond, forming a reactive carbonyl core group.
- (b) This same central carbon atom is simultaneously bound to a single-bonded hydroxyl group, creating a unified terminal chemical linkage.
- (c) This atomic arrangement forms the acyl-hydroxyl group, which is represented by the condensed chemical formula $-COOH$.
- (d) According to IUPAC nomenclature rules, this terminal functional group defines the carboxylic acid family of organic compounds.
- (e) Aliphatic sulfonic acids contain a sulfur-based group, phenolic esters are modified aromatics, and fatty alkoxy alcohols contain simple ether-linked structural chains.

Final Answer: Carboxylic Acids

Answer: (B)

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Q11.

Solution

Concept: The availability and dynamic fixations of phosphorus in soils depend strongly on soil pH variations and the concentration of competing co-present metallic cations within the rhizosphere solution environment.

Solution:

- (a) In neutral to alkaline soils, free calcium ion levels are high, creating an environment that favors structural interaction with soluble orthophosphate anions.
- (b) Soluble orthophosphate chemical fractions readily react with these dominant calcium ions to initiate sequential chemical precipitation steps.
- (c) The process advances rapidly from highly soluble monocalcium phosphate to progressively less soluble dicalcium phosphate states.
- (d) Eventually, it transforms into highly insoluble tricalcium phosphate minerals, which completely locks the phosphorus into immobile crystalline structures.
- (e) This immobilization process isolates the phosphorus nutrient from the active root extraction zones, causing significant induced crop deficiencies.
- (f) Conversely, options involving phosphine gas generation, rapid physical leaching out of the root boundaries, or chloride anion inhibition do not match standard alkaline soil chemical fixation pathways.

Final Answer: Precipitation of insoluble dicalcium and tricalcium phosphate compounds

Answer: (C)

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Q12.

Solution

Concept: Volumetric solution parameters require distinguishing between analytical normality and molarity concentrations based on the stoichiometric chemical equivalence factors of the specific solute.

Solution:

- (a) Sulfuric acid functions as a classic dibasic mineral acid that yields two moles of active protons per mole of structural compound dissolved.
- (b) The baseline relationship between normality and molarity values is defined by the basic equation where normality equals molarity multiplied by the acidity or basicity equivalence factor.
- (c) Given a 2.0 Normal configuration, dividing by the structural equivalence factor of 2 establishes that the actual molar concentration of the reagent is 1.0 Molar.
- (d) Molarity specifies the precise number of dissolved chemical moles contained within exactly 1.0 Liter of total solution volume.
- (e) Since the required laboratory sample volume is limited to precisely 500 mL, which equals 0.5 Liters, the total absolute moles must scale proportionally.
- (f) Multiplying the 1.0 Molar concentration by 0.5 Liters yields exactly 0.5 moles of pure chemical solute particles present in the final measured sample.

Final Answer: 0.5 moles

Answer: (A)

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Q13.

Solution

Concept: Synthetic nitrogenous fertilizer production utilizes specific industrial chemical pathways to manufacture highly concentrated formulations with structural amide connections.

Solution:

- (a) The structural schematic highlights a central carbonyl group attached symmetrically to two terminal amine functional segments.
- (b) This exact structural pattern defines an organic amide compound known chemically as carbamide, which corresponds directly to commercial urea.
- (c) Industrial synthesis proceeds via the controlled high-pressure reaction of liquid ammonia with carbon dioxide gas to generate this organic molecule.
- (d) Urea contains approximately 46 percent total nitrogen, making it the most concentrated solid nitrogenous crop nutrient option widely available in agricultural markets.
- (e) Other options, such as ammonium nitrate, ammonium sulfate, or calcium nitrate, constitute purely inorganic mineral salts lacking an internal organic carbonyl-amide linkage.
- (f) Therefore, matching the structural diagram against standard fertilizer formulations confirms the identity of the target compound as urea.

Final Answer: Urea

Answer: (B)

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Q14.

Solution

Concept: Periodic properties change systematically across rows and columns of the Periodic Table due to modifications in core nuclear charge and electron shielding behaviors.

Solution:

- (a) Moving systematically from left to right across a single horizontal row or period, the total number of protons in the atomic nucleus increases sequentially.
- (b) This increase in atomic number raises the net effective nuclear charge experienced by valence electrons residing within the same outer energy shell.
- (c) The stronger positive nuclear pull draws the electron cloud tighter toward the nucleus, causing the atomic radius to contract steadily.
- (d) Simultaneously, this enhanced positive nuclear pull increases the inherent ability of the atom to attract shared electron pairs within a chemical bond.
- (e) This specific structural tracking parameter defines electronegativity, which increases consistently across the period as the atomic radius contracts.
- (f) As a result, the dual periodic trend combines a decreasing atomic radius with a steadily increasing electronegativity profile.

Final Answer: Atomic radius decreases; Electronegativity increases

Answer: (C)

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Q15.

Solution

Concept: The light-driven homolytic cleavage of diatomic halogens initiates radical substitution cascades that systematically replace hydrogen atoms on saturated alkane structures.

Solution:

- (a) Photolytic initiation splits molecular chlorine into highly reactive chlorine radicals that attack the localized carbon-hydrogen single bonds of methane.
- (b) The progressive reaction sequence moves through successive substitution intermediate states, beginning with the production of chloromethane.
- (c) If the reaction remains unchecked with excess halogen present, the sequence advances to produce dichloromethane and trichloromethane.
- (d) The substitution cascade continues until all four original replaceable hydrogen positions on the tetrahedral carbon core are fully substituted.
- (e) The ultimate stable chlorinated organic end-product achieved at full structural exhaustion is carbon tetrachloride, known systematically as tetrachloromethane.
- (f) This fully halogenated hydrocarbon lacks any remaining carbon-hydrogen bonds, terminating further radical chain propagation events under standard light exposure conditions.

Final Answer: Tetrachloromethane

Answer: (D)

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Q16.

Solution

Concept: Soil moisture potential incorporates multiple independent physical force components that regulate the retention, migration, and biological availability of water within the soil matrix.

Solution:

- (a) Matric potential represents the collective physical energy status resulting from attractive forces exerted by solid soil particle surfaces.
- (b) It arises directly from adhesion, which binds water molecules to solid surfaces, and cohesion, which holds water molecules together.
- (c) These joint forces create surface tension and capillary actions that hold water within small soil pores against the downward pull of gravity.
- (d) Matric potential always acts as a negative pressure or tension, signifying that work must be expended by plant roots to extract this bound water.
- (e) Osmotic potential depends on dissolved solute concentrations, gravitational potential relies on elevation positions, and hydrostatic potential applies to saturated zones below the water table.
- (f) Thus, matric potential is the specific component that governs the physical binding of water to the solid soil matrix.

Final Answer: Matric potential

Answer: (C)

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Q17.

Solution

Concept: Saturated hydrocarbon nomenclature utilizes specific structural prefixes and suffixes to classify open-chain compounds based on carbon chain length and bond saturation.

Solution:

- (a) The provided structural schematic shows a pair of central carbon atoms linked together by a single covalent bond.
- (b) Each independent carbon center displays three open positions configured to match standard tetrahedral orbital arrangements.
- (c) Fulfilling all six open positions exclusively with hydrogen atoms produces a saturated molecular structure with the formula C_2H_6 .
- (d) This chemical structure features only single covalent bonds, classifying it as a member of the saturated alkane homologous series.
- (e) The systematic prefix for a two-carbon chain is "eth-", and the structural suffix for a completely saturated hydrocarbon series is "-ane".
- (f) Combining these terms identifies the target fuel gas molecule as ethane, whereas ethene contains a double bond and ethyne contains a triple bond.

Final Answer: Ethane

Answer: (B)

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Q18.

Solution

Concept: Electronic transitions within the hydrogen atom emit photons with frequencies that depend on the principal quantum energy levels of the initial and final states.

Solution:

- (a) Spectral emission series are grouped into distinct families based on the lower principal quantum number level (n) where the moving electron lands.
- (b) The Lyman series transitions terminate at the $n = 1$ ground state level, releasing high-energy photons that fall into the ultraviolet spectral band.
- (c) The Balmer series consists of electronic transitions that drop down to the $n = 2$ energy level from higher levels where n is greater than or equal to 3.
- (d) These specific transitions emit photons with energies that correspond to wavelengths within the visible light spectrum.
- (e) A transition shifting from the $n = 3$ shell down to the $n = 2$ shell produces the characteristic red H-alpha spectral line.
- (f) Transitions ending at $n = 3$ or higher levels form the Paschen and Brackett series, which release lower-energy photons in the infrared range.

Final Answer: Transition from $n = 3$ to $n = 2$

Answer: (B)

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Q19.

Solution

Concept: Molarity defines a fundamental concentration parameter that measures the total moles of chemical solute dissolved per Liter of total solution volume.

Solution:

- (a) The calculation requires converting the mass of dissolved sodium hydroxide into an equivalent number of chemical moles.
- (b) Dividing the given mass of 40.0 grams by the standard molar mass of 40.0 g/mol establishes that exactly 1.0 mole of solute is present.
- (c) The total volume of the prepared laboratory reagent is specified as exactly 2.0 Liters.
- (d) The mathematical formula for molarity is stated as the total moles of solute divided by the total volume of solution in Liters.
- (e) Substituting the calculated values into the formula yields 1.0 mole divided by 2.0 Liters, which equals a concentration of 0.50 Molar.
- (f) This confirms that the prepared stock solution contains 0.50 moles of active sodium hydroxide solute per Liter of solution.

Final Answer: 0.50 M

Answer: (B)

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Q20.

Solution

Concept: Essential plant macronutrients regulate specific physiological, biochemical, and cellular processes required to sustain optimal crop development.

Solution:

- (a) Potassium serves as the primary inorganic osmotic regulator within plant tissues and does not integrate into permanent structural organic molecules.
- (b) Stomatal opening is driven by the active transport of potassium ions into the surrounding guard cells.
- (c) This accumulation of potassium creates an osmotic gradient that draws water into the guard cells, increasing turgor pressure and opening the stomatal pore.
- (d) When potassium ions exit the guard cells, water follows out, lowering turgor pressure and causing the stomatal pore to close.
- (e) This ion flux regulates cellular turgidity, water use efficiency, and transpiration rates.
- (f) Other macronutrients, such as nitrogen, phosphorus, and calcium, function primarily as structural components of proteins, nucleic acids, and cell walls rather than as fluid osmotic regulators.

Final Answer: Potassium

Answer: (C)

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Q21.

Solution

Concept: Organic compounds are systematically structurally categorized based on their unique, characteristic functional linkages embedded within their saturated or unsaturated carbon backbones.

Solution:

- (a) The structural schematic illustrates a primary carbon center directly attached to a single-bonded oxygen atom, which is subsequently bound to a terminal hydrogen atom.
- (b) This characteristic linear linkage constitutes a hydroxyl functional segment, which is chemically denoted by the condensed formula -OH .
- (c) The problem states that the remaining three open back-bonds terminate into a simple methyl radical group via a direct carbon-carbon bridging link.
- (d) Attaching a methyl group to this single carbon framework produces a two-carbon organic assembly with the explicit chemical formula $\text{C}_2\text{H}_5\text{OH}$.
- (e) This structural configuration represents ethanol, a prominent member belonging systematically to the aliphatic alcohol homologous class.
- (f) Other functional configurations like carboxylic acids require a carbonyl oxygen, dialkyl ethers contain an internal oxygen bridge, and aldehydes possess a terminal carbonyl group.

Final Answer: Aliphatic Alcohol

Answer: (A)

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Q22.

Solution

Concept: The permanent surface charge of crystalline silicate clay minerals depends primarily on structural alterations occurring during mineral lattice synthesis within the soil profile.

Solution:

- (a) Isomorphic substitution involves the structural replacement of a central ion within tetrahedral or octahedral sheets by a different cation during crystal matrix formation.
- (b) This internal replacement occurs exclusively between ions possessing a similar physical ionic radius, ensuring that the crystalline lattice dimensions remain stable.
- (c) To generate a permanent net negative charge, a cation of higher valence must be systematically substituted by an incoming cation of lower valence.
- (d) A classic example includes the replacement of tetravalent silicon by trivalent aluminum in tetrahedral sheets, or trivalent aluminum by divalent magnesium in octahedral sheets.
- (e) Because the positive electrical charge decreases while the total negative oxygen charges remain constant, a permanent structural deficit is established.
- (f) This permanent net negative electrical charge must then be balanced externally by adsorbing exchangeable plant nutrient cations from the surrounding soil solution.

Final Answer: Substitution of a higher-valence cation by a lower-valence cation of similar physical size

Answer: (A)

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Q23.

Solution

Concept: Chemical and environmental buffering systems require the simultaneous presence of a conjugate acid-base pair capable of neutralizing added hydronium or hydroxyl ions.

Solution:

- (a) An effective chemical buffer must consist of a weak acid paired with its corresponding conjugate base, or a weak base paired with its corresponding conjugate acid.
- (b) Carbonic acid functions as a weak mineral acid that undergoes partial structural dissociation in aqueous environments to establish a dynamic chemical equilibrium.
- (c) Sodium bicarbonate acts as a highly soluble mineral salt that dissociates completely to supply an abundance of conjugate bicarbonate anions.
- (d) When an external acid enters the soil solution, the excess hydronium ions react with the bicarbonate anions to regenerate neutral carbonic acid.
- (e) When a basic substance is introduced, the hydroxyl ions are neutralized by reacting with carbonic acid molecules to form water and bicarbonate.
- (f) Other listed options contain combinations of strong acids, strong bases, or non-conjugate neutral salts that cannot resist active pH modifications.

Final Answer: Carbonic acid and sodium bicarbonate

Answer: (B)

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Q24.

Solution

Concept: Monocarboxylic acids form an organic homologous series defined by the presence of a single acidic carboxyl functional group linked to a hydrogen atom or an alkyl radical.

Solution:

- (a) Formic acid represents the absolute simplest possible structural manifestation of the carboxylic acid family, containing only one single carbon center.
- (b) In this unique molecule, the single carboxyl acid functional group is bound directly to a terminal hydrogen atom rather than an alkyl chain.
- (c) This atomic configuration corresponds to the structural chemical formula HCOOH , containing exactly one active acidic proton site.
- (d) Because the compound contains only one carboxylic acid functional assembly per molecule, it is formally classified as a monocarboxylic acid.
- (e) The formula CH_3COOH represents acetic acid, $\text{HOOC} - \text{COOH}$ represents oxalic acid which is dicarboxylic, and $\text{C}_2\text{H}_5\text{COOH}$ represents propionic acid.
- (f) Thus, evaluating both the single-carbon layout and structural class confirms that formic acid is uniquely represented as a monocarboxylic acid.

Final Answer: HCOOH , Monocarboxylic acid

Answer: (B)

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Q25.

Solution

Concept: Intramolecular forces bind discrete atomic components together within a molecule based on the electronegativity relationships of the participating elements.

Solution:

- (a) Methane consists of a central carbon atom surrounded tetrahedrally by four terminal hydrogen atoms sharing their outer valence shells.
- (b) The electronegativity difference between carbon and hydrogen is relatively small, which prevents the complete physical transfer of electronic mass.
- (c) Instead of forming ions, the central carbon atom shares its four valence electrons equally with four individual hydrogen electrons.
- (d) This mutual orbital sharing creates four distinct single localized electron-pair linkages known chemically as covalent sigma bonds.
- (e) Electrovalent ionic bonds require large electronegativity differences, hydrogen bonds are weak intermolecular forces, and metallic coordinate interactions occur between metal lattices.
- (f) Therefore, the localized sharing of valence electron pairs establishes that the primary binding mechanism inside methane is a covalent bond.

Final Answer: Covalent bond

Answer: (C)

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Answer Key

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

