IISER Chemistry Sample Paper-6

Duration: 45 Minutes **Maximum Marks: 60**

Instructions

- This paper contains **15** Multiple Choice Questions (Single Correct).
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries: $-\mathbf{1}$ marks.
- Unattempted questions carry **0** marks.
- Only one option is correct for each question.
- Use of mobile phones, smartwatches, calculators, or any electronic gadgets is strictly prohibited.

Q1. The compounds listed below are dissolved separately in liquid ammonia and treated with one equivalent of sodium amide. Assume complete equilibrium is established in each case.

(I) Cyclopentadiene

(II) Phenol

(III) Ethanol

(IV) Fluorene

The order of extent of deprotonation is expected to be:

(A) I > IV > II > III

(B) IV > I > II > III

(C) II > I > IV > III

(D) I > II > IV > III

Q2. Consider the following reaction sequence:

$$\text{PhCH}_2\text{Br} \xrightarrow{\text{Mg/ether}} A \xrightarrow{\text{CO}_2} B \xrightarrow{\text{H}_3\text{O}^+} C \xrightarrow{\text{SOCl}_2} D \xrightarrow{\text{NH}_3} E$$

Compound E is subjected to Hofmann bromamide degradation. The final organic product obtained is:

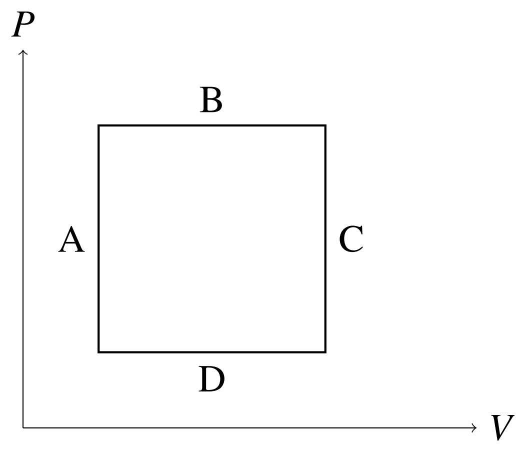
(A) Aniline

(B) Benzylamine

(C) Phenethylamine

(D) Benzoic acid

Q3. One mole of an ideal gas undergoes the cyclic process shown below.



If the cycle is traversed clockwise, then which statement is correct?

(A) Net work done by the gas is zero

(B) Net heat absorbed by the gas is negative

(C) Net work done by the gas equals area enclosed by the cycle

(D) Internal energy change over one cycle is positive

Q4. For the equilibrium

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

the degree of dissociation at pressure P is α.

If the pressure is suddenly reduced to $P/4$, the new equilibrium degree of dissociation becomes β.

Assuming ideal-gas behavior and significant dissociation, which of the following must be true?

(A) $\beta < \alpha$

(B) $\beta = \alpha$

(C) $\beta > \alpha$

(D) No conclusion can be drawn

Q5. A d^6 metal ion forms two octahedral complexes:

$$[M(CN)_6]^{4-}$$

and

$$[M(H_2O)_6]^{2+}$$

Assume the metal ion is the same in both complexes.

Which statement is correct?

(A) Both complexes contain four unpaired electrons

(B) Both are diamagnetic

(C) The cyanide complex is low-spin whereas the aqua complex is high-spin

(D) The aqua complex is low-spin whereas the cyanide complex is high-spin

Q6. A concentration cell is constructed using identical silver electrodes:

$$Ag|Ag^+(0.010\,M)||Ag^+(1.0\,M)|Ag$$

The cell operates at 298 K. Ignoring liquid junction potential and assuming ideal behavior, determine the closest value of the cell emf.

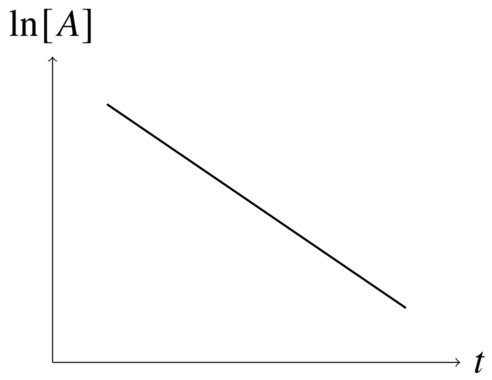
(A) 0.118 V

(B) 0.059 V

(C) 0.0295 V

(D) 0 V

Q7. For a reaction $A \rightarrow Products$, the following graph is obtained experimentally.



The half-life of the reaction is found to be 20 minutes when the initial concentration is 0.40 M. If the experiment is repeated with an initial concentration of 0.80 M, the expected half-life is:

(A) 10 min

(B) 20 min

(C) 40 min

(D) 80 min

Q8. A solution contains 0.10 M acetic acid and 0.10 M sodium acetate. Given

$$K_a(\text{CH}_3\text{COOH}) = 1.8 \times 10^{-5}$$

and assuming ideal behavior, the pH of the solution is closest to:

(A) 3.74

(B) 4.00

(C) 4.74

(D) 5.74

Q9. For a spontaneous process occurring in an isolated system, which of the following statements is necessarily true according to the Second Law of Thermodynamics?

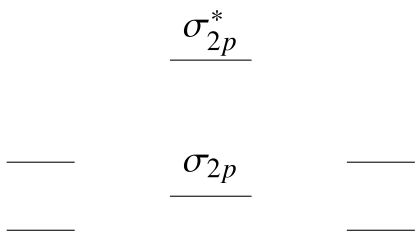
(A) Entropy of the system decreases

(B) Entropy of the surroundings increases

(C) Total entropy of the universe increases

(D) Enthalpy of the system decreases

Q10. The molecular orbital energy-level diagram shown below corresponds to a homonuclear diatomic molecule.



If the molecule contains two electrons in σ_{2p} and none in σ^*_{2p}, the bond order contribution from these orbitals is:

(A) 0

(B) 0.5

(C) 1

(D) 2

Q11. A metal ion forms the complex

$$[Cr(en)_2Cl_2]^+$$

where *en* represents ethylenediamine.

Considering only geometrical isomerism, how many distinct geometrical isomers are possible?

(A) 1

(B) 2

(C) 3

(D) 4

Q12. Among the following hydrides, which exhibits the strongest reducing character in aqueous medium?

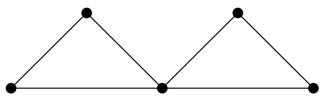
(A) NH_3

(B) PH_3

(C) AsH_3

(D) SbH_3

Q13. The structure shown below corresponds to a well-known allotrope.



This structural motif is most characteristic of:

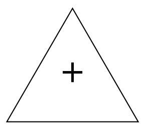
(A) Diamond

(B) Graphite

(C) White phosphorus

(D) Sulfur

Q14. Consider the cyclopropenyl cation shown below.



According to Hückel molecular orbital theory, this species is:

(A) Aromatic

(B) Antiaromatic

(C) Non-aromatic

(D) Antiaromatic only in excited state

Q15. A polypeptide chain contains 100 amino acid residues. Assuming no side-chain participation and complete formation of peptide bonds, the number of peptide linkages present in the chain is:

(A) 99

(B) 100

(C) 101

(D) 198

Detailed Solutions

Q1.

Solution

Concept: The extent of deprotonation in a basic solvent like liquid ammonia containing a strong base ($NaNH_2$) is determined by the thermodynamic acidity (pK_a) of the compounds. Stronger acids undergo deprotonation to a greater extent, shifting the deprotonation equilibrium further toward the conjugate base.

Solution: Step 1: Consider the deprotonation equilibrium:

$$HA + NH_2^- \rightleftharpoons A^- + NH_3$$

The equilibrium constant is:

$$K_{eq} = \frac{K_a(HA)}{K_a(NH_3)}$$

Hence, the more acidic the compound, the greater will be its extent of deprotonation by NH_2^-.
Step 2: Compare the stability of the conjugate bases:

- **Phenol (II):** Forms the phenoxide ion, where the negative charge is on oxygen and is additionally stabilized by resonance. Hence, phenol is the most acidic compound in the series.
- **Cyclopentadiene (I):** Forms the cyclopentadienyl anion, a planar aromatic species containing 6π electrons. This gives substantial stabilization and high acidity for a hydrocarbon.
- **Fluorene (IV):** Forms the fluorenyl anion, which is resonance-stabilized, but less effectively than the cyclopentadienyl anion. Therefore, fluorene is less acidic than cyclopentadiene.
- **Ethanol (III):** Forms the ethoxide ion, where the negative charge is localized on oxygen without resonance stabilization. The electron-donating ethyl group further reduces its acidity.

Step 3: Therefore, the decreasing order of acidity (and extent of deprotonation) is:

$$\text{Phenol (II)} > \text{Cyclopentadiene (I)} > \text{Fluorene (IV)} > \text{Ethanol (III)}$$

Final Answer: $\boxed{II > I > IV > III}$

Answer: (C)

Go Back to Question 1

Q2.

Solution

Concept: The synthesis involves the preparation of a Grignard reagent, carbonation to form a carboxylic acid, conversion to an acid chloride, conversion to an amide, and finally a Hofmann bromamide degradation which reduces the carbon chain length by one carbonyl group.

Solution: Step 1: Phenylmethyl bromide (benzyl bromide, $PhCH_2Br$) is treated with magnesium in dry ether to form the Grignard reagent, benzylmagnesium bromide (A):

$$\mathrm{PhCH_2Br + Mg \xrightarrow{ether} PhCH_2MgBr} \quad (A)$$

Step 2: Nucleophilic addition of the Grignard reagent A to carbon dioxide (CO_2) followed by acid hydrolysis (H_3O^+) yields a carboxylic acid, phenylacetic acid (C):

$$\mathrm{PhCH_2MgBr \xrightarrow{CO_2} PhCH_2COOMgBr} \quad (B) \xrightarrow{\mathrm{H_3O^+}} \mathrm{PhCH_2COOH} \quad (C)$$

Step 3: Phenylacetic acid C is treated with thionyl chloride ($SOCl_2$) to convert the hydroxyl group into a chlorine atom, yielding phenylacetyl chloride (D):

$$\mathrm{PhCH_2COOH + SOCl_2 \rightarrow PhCH_2COCl} \quad (D) + \mathrm{SO_2\uparrow + HCl\uparrow}$$

Step 4: Phenylacetyl chloride D reacts with ammonia (NH_3) to form the primary amide, phenylacetamide (E):

$$\mathrm{PhCH_2COCl + NH_3 \rightarrow PhCH_2CONH_2} \quad (E) + \mathrm{HCl}$$

Step 5: Subjecting phenylacetamide E to the Hofmann bromamide degradation ($Br_2/NaOH$) converts the primary amide to a primary amine with one fewer carbon atom:

$$\mathrm{PhCH_2CONH_2 \xrightarrow{Br_2/NaOH} PhCH_2NH_2\ (Benzylamine) + Na_2CO_3 + 2NaBr + 2H_2O}$$

Thus, the final organic product obtained is benzylamine.

Final Answer: Benzylamine

Answer: (B)

Go Back to Question 2

Q3.

Solution

Concept: For any thermodynamic process represented on a P-V diagram, the net work done by the gas ($W_{net} = \oint P\,dV$) is equivalent to the area enclosed by the path on the diagram. For a cyclic process, state functions such as internal energy (U) return to their initial values, making the net change exactly zero.

Solution: Step 1: Evaluate the internal energy change (ΔU). Since internal energy is a state function and the process is cyclic, the initial and final states are identical. Therefore, the net change in internal energy over one complete cycle is:

$$\Delta U_{net} = 0$$

This eliminates Option D.

Step 2: Analyze the net work done by the gas (W_{net}). For any closed loop on a P-V diagram, the magnitude of the net work is equal to the area enclosed by the cycle:

$$|W_{net}| = \text{Area enclosed by the rectangle}$$

This supports Option C.

Step 3: Determine the sign of the work and heat.

- Because the cycle is traversed in a **clockwise** direction, the expansion work (which occurs at a higher average pressure, along B) is greater in magnitude than the compression work (which occurs at a lower average pressure, along D).
- This means the net work done by the gas is positive ($W_{net} > 0$). This eliminates Option A.
- According to the First Law of Thermodynamics:

  $$\Delta U = Q - W \implies Q_{net} = \Delta U_{net} + W_{net}$$

  Since $\Delta U_{net} = 0$ and $W_{net} > 0$, the net heat absorbed by the gas must be positive ($Q_{net} > 0$). This eliminates Option B.

Therefore, the correct statement is that the net work done by the gas equals the area enclosed by the cycle.

Final Answer: Net work done by the gas equals area enclosed by the cycle

Answer: (C)

Go Back to Question 3

Q4.

Solution

Concept: The shift in a gaseous equilibrium due to changes in total pressure can be understood qualitatively using Le Chatelier's principle and quantitatively through the expression for the equilibrium constant K_p.

Solution: Step 1: Analyze the reaction stoichiometry:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

The reaction results in an increase in the number of moles of gas, as 1 mole of reactant produces 2 moles of product ($\Delta n_g = 2 - 1 = +1$).
Step 2: Apply Le Chatelier's principle. When the total pressure of a gaseous system at equilibrium is decreased, the system shifts in the direction that produces more moles of gas to counteract the change. Since the forward reaction increases the number of gaseous moles, reducing the pressure to $P/4$ will shift the equilibrium to the right, thereby increasing the degree of dissociation. Thus, we expect $\beta > \alpha$.

Step 3: Confirm quantitatively. Write the equilibrium constant K_p in terms of the degree of dissociation x and the total pressure P_{tot}:

$$K_p = \frac{4x^2}{1-x^2}P_{\text{tot}} \implies \frac{x^2}{1-x^2} = \frac{K_p}{4P_{\text{tot}}}$$

Taking the square root of both sides:

$$\frac{x}{\sqrt{1-x^2}} = \sqrt{\frac{K_p}{4P_{\text{tot}}}}$$

Since the function $f(x) = \frac{x}{\sqrt{1-x^2}}$ is monotonically increasing for $0 < x < 1$:

- At $P_{\text{tot}} = P$, the degree of dissociation is $x = \alpha$.
- At $P_{\text{tot}} = P/4$, the term $\sqrt{\frac{K_p}{4P_{\text{tot}}}}$ increases by a factor of 2, meaning $\frac{\beta}{\sqrt{1-\beta^2}} > \frac{\alpha}{\sqrt{1-\alpha^2}}$.
- This mathematically proves that the new degree of dissociation must be larger: $\beta > \alpha$.

Final Answer: $\boxed{\beta > \alpha}$

Answer: (C)

Go Back to Question 4

Q5.

Solution

Concept: The electronic configuration, spin state, and magnetic properties of transition metal complexes are governed by Crystal Field Theory (CFT). Strong-field ligands cause a large d-orbital splitting ($\Delta_o > P$), resulting in low-spin complexes, while weak-field ligands cause a small splitting ($\Delta_o < P$), resulting in high-spin complexes.

Solution: Step 1: Identify the metal ion's oxidation state and d-electron count. In both complexes, the metal is in the +2 oxidation state:

- In $[M(CN)_6]^{4-}$, let the oxidation state of M be x: $x + 6(-1) = -4 \implies x = +2$.
- In $[M(H_2O)_6]^{2+}$, since H_2O is neutral, the oxidation state of M is directly +2.

Since it is a d^6 metal ion, both complexes contain 6 d-electrons.

Step 2: Analyze the ligand fields and d-orbital splitting:

- **Cyanide complex, $[M(CN)_6]^{4-}$:** The cyanide ion (CN^-) is a strong-field ligand. It produces a large octahedral splitting ($\Delta_o > P$), meaning the energy required to pair electrons in the lower t_{2g} orbitals is less than the energy required to promote them to the e_g orbitals. All 6 electrons pair up in the t_{2g} subshell:

  $$\text{Configuration: } (t_{2g})^6(e_g)^0$$

  The number of unpaired electrons is 0, making it a **low-spin** complex and **diamagnetic**.

- **Aqua complex, $[M(H_2O)_6]^{2+}$:** Water (H_2O) is a weak-field ligand. It produces a small splitting ($\Delta_o < P$), so electrons occupy the orbitals singly according to Hund's rule before pairing:

  $$\text{Configuration: } (t_{2g})^4(e_g)^2$$

  The number of unpaired electrons is 4, making it a **high-spin** complex and **paramagnetic**.

Step 3: Evaluate the options. Option C correctly states that the cyanide complex is low-spin whereas the aqua complex is high-spin.

Final Answer: The cyanide complex is low-spin whereas the aqua complex is high-spin

Answer: (C)

Go Back to Question 5

Q6.

Solution

Concept: A concentration cell consists of two half-cells with identical electrodes but different electrolyte concentrations. The cell emf (E_{cell}) is calculated using the Nernst equation, with the standard cell potential (E°_{cell}) being exactly zero.

Solution: Step 1: Write down the half-cell and overall cell reactions:

$$\text{Anode (oxidation): } Ag(s) \rightarrow Ag^+(0.010\,M) + e^-$$

$$\text{Cathode (reduction): } Ag^+(1.0\,M) + e^- \rightarrow Ag(s)$$

$$\text{Overall reaction: } Ag^+(1.0\,M) \rightleftharpoons Ag^+(0.010\,M)$$

The number of electrons transferred per silver ion is $n = 1$.

Step 2: Since the electrodes are identical, the standard reduction potentials of both half-cells are equal:

$$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode} = 0\,V$$

Step 3: Apply the Nernst equation at 298 K:

$$E_{cell} = E^\circ_{cell} - \frac{0.0592}{n}\log Q$$

Step 4: Calculate the reaction quotient Q and the cell potential:

$$Q = \frac{[Ag^+]_{anode}}{[Ag^+]_{cathode}} = \frac{0.010\,M}{1.0\,M} = 10^{-2}$$

$$E_{cell} = 0 - \frac{0.0592}{1}\log(10^{-2})$$

$$E_{cell} = -0.0592 \times (-2) = 0.1184\,V \approx 0.118\,V$$

The closest value of the cell emf is 0.118 V.

Final Answer: 0.118 V

Answer: (A)

Go Back to Question 6

Q7.

Solution

Concept: The order of a reaction determines the relationship between the rate, the half-life ($t_{1/2}$), and the initial concentration ($[A]_0$). The integrated rate law of a first-order reaction produces a linear plot of $\ln[A]$ versus time.

Solution: Step 1: Determine the order of the reaction from the graph. The experimental plot of $\ln[A]$ versus time t is a straight line with a constant negative slope. The integrated rate law for a first-order reaction is:

$$\ln[A]_t = -kt + \ln[A]_0$$

This matches the linear graph, confirming that the reaction is **first-order**.

Step 2: Examine the half-life of a first-order reaction. The half-life is given by:

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

Crucially, this expression shows that the half-life of a first-order reaction depends solely on the rate constant k and is entirely **independent** of the initial concentration of the reactant ($[A]_0$).

Step 3: Compare the two conditions. Because the half-life is independent of the starting concentration, changing the initial concentration from 0.40 M to 0.80 M does not alter the half-life. It remains unchanged at 20 minutes.

Final Answer: $\boxed{\text{20 min}}$

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept: A solution containing a weak acid and its conjugate base acts as an acidic buffer. Its pH can be calculated using the Henderson-Hasselbalch equation:

$$\mathrm{pH} = \mathrm{p}K_a + \log\left(\frac{[\text{conjugate base}]}{[\text{acid}]}\right)$$

Solution: Step 1: Identify the components of the buffer system:

- Weak acid: acetic acid (CH_3COOH), with concentration [acid] = 0.10 M
- Conjugate base: acetate ion (CH_3COO^-), provided by sodium acetate (CH_3COONa), with concentration [conjugate base] = 0.10 M

Step 2: Calculate the pK_a of acetic acid:

$$\mathrm{p}K_a = -\log_{10} K_a = -\log_{10}(1.8 \times 10^{-5})$$

$$\mathrm{p}K_a = 5 - \log_{10}(1.8) \approx 5 - 0.255 = 4.745$$

Step 3: Apply the Henderson-Hasselbalch equation:

$$\mathrm{pH} = 4.745 + \log_{10}\left(\frac{0.10}{0.10}\right)$$

$$\mathrm{pH} = 4.745 + \log_{10}(1) = 4.745 + 0 \approx 4.74$$

Thus, the pH of the buffer solution is closest to 4.74.

Final Answer: $\boxed{4.74}$

Answer: (C)

Go Back to Question 8

Q9.

Solution

Concept: According to the Second Law of Thermodynamics, any spontaneous (irreversible) process in the universe must result in an increase in the total entropy of the universe ($\Delta S_{universe} = \Delta S_{system} + \Delta S_{surroundings} > 0$).

Solution: Step 1: Analyze the thermodynamic definitions for an isolated system. An isolated system does not exchange energy (heat, work) or matter with its surroundings:

$$q_{surroundings} = 0 \implies \Delta S_{surroundings} = 0$$

Step 2: Relate the entropy of the universe to the isolated system:

$$\Delta S_{universe} = \Delta S_{system} + \Delta S_{surroundings}$$

Since $\Delta S_{surroundings} = 0$:

$$\Delta S_{universe} = \Delta S_{system}$$

Step 3: Apply the Second Law. For any spontaneous process:

$$\Delta S_{universe} > 0 \implies \Delta S_{system} > 0$$

This means that the entropy of the system must increase (eliminating Option A). Because the system is isolated, the surroundings are unaffected, meaning their entropy does not change (eliminating Option B). Enthalpy change is not a direct criterion for spontaneity in an isolated system (eliminating Option D).
Step 4: Therefore, the statement that the total entropy of the universe increases is always and necessarily true for any spontaneous process.

Final Answer: Total entropy of the universe increases

Answer: (C)

Go Back to Question 9

Q10.

Solution

Concept: The contribution of a specific set of molecular orbitals to the overall bond order of a diatomic molecule is calculated from the number of bonding electrons (N_b) and antibonding electrons (N_a) occupying those specific orbitals:

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

Solution: Step 1: Identify the bonding and antibonding molecular orbitals in the given pair:

- Bonding orbital: σ_{2p}
- Antibonding orbital: σ^*_{2p}

Step 2: Count the electrons in each orbital as specified in the problem:

- Number of electrons in bonding orbital, $N_b = 2$
- Number of electrons in antibonding orbital, $N_a = 0$

Step 3: Calculate the bond order contribution:

$$\text{Bond Order Contribution} = \frac{2 - 0}{2} = 1$$

Therefore, the contribution to the bond order from these orbitals is 1.

Final Answer: $\boxed{1}$

Answer: (C)

Go Back to Question 10

Q11.

Solution

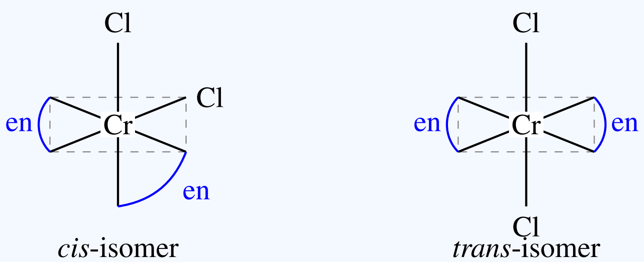
Concept: In coordination chemistry, geometrical isomerism arises in octahedral complexes of the type $[M(AA)_2B_2]$, where AA is a symmetrical bidentate ligand (such as ethylenediamine) and B is a monodentate ligand (such as chloride).

Solution: Step 1: Identify the coordination geometry. In $[Cr(en)_2Cl_2]^+$, chromium is bonded to two bidentate ethylenediamine (*en*) ligands and two monodentate chloride (Cl^-) ligands, giving a coordination number of $2 \times 2 + 2 = 6$ (octahedral geometry).

Step 2: Determine the possible geometrical arrangements of the ligands:

(a) ***cis*-isomer:** The two chloride ligands occupy adjacent coordination sites (at a 90° angle to each other). The bidentate *en* ligands wrap around the remaining adjacent positions.

(b) ***trans*-isomer:** The two chloride ligands occupy opposite coordination sites (at a 180° angle to each other). The bidentate *en* ligands lie in the equatorial plane.



cis-isomer *trans*-isomer

Step 3: Since only geometrical isomerism is considered (excluding optical isomers, where the *cis*-isomer exists as a pair of non-superimposable mirror images), there are exactly 2 distinct geometrical isomers.

Final Answer: 2

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept: The reducing strength of Group 15 hydrides (MH_3) depends on their ability to release hydrogen atoms, which is determined by the strength and dissociation energy of the $M-H$ bond.

Solution: Step 1: Identify the trend in atomic size down Group 15. The size of the central atom increases in the order:

$$N < P < As < Sb$$

Step 2: Relate atomic size to bond strength. As the central atom size increases, the orbital overlap between the central atom's valence orbitals and the small $1s$ orbital of hydrogen becomes less effective. Consequently, the $M-H$ bond length increases and the bond dissociation energy decreases:

$$N-H > P-H > As-H > Sb-H$$

Step 3: Determine the reducing character. A weaker $M-H$ bond allows the hydride to donate hydrogen more easily, making it a stronger reducing agent. Thus, reducing strength increases down the group:

$$NH_3 < PH_3 < AsH_3 < SbH_3$$

Therefore, among the given hydrides, SbH_3 possesses the weakest bond and exhibits the strongest reducing character.

Final Answer: $\boxed{SbH_3}$

Answer: (D)

Go Back to Question 12

Q13.

Solution

Concept: An element's allotropes are defined by unique atomic arrangements. Polymeric chains consisting of linked triangular (tetrahedral) units are characteristic of specific allotropic structures.

Solution: Step 1: Analyze the provided 2D structural diagram. The diagram consists of 5 vertices arranged as:

- A complete triangle formed by vertices (0,0), (1,1), and (2,0).
- A second complete triangle formed by vertices (2,0), (3,1), and (4,0).
- The two triangles are linked together, sharing a common vertex at (2,0).

This represents a polymeric chain of repeating, corner-sharing triangular subunits.

Step 2: Relate this structural motif to the allotropes:

- **Red phosphorus** consists of a polymeric chain of P_4 tetrahedra where one of the $P-P$ bonds in each tetrahedron is broken to link to the adjacent unit. In 2D projections, this network of linked tetrahedra is represented as a chain of linked triangles.
- Since Red phosphorus is the precise allotrope characterized by this linked tetrahedral motif, and "White phosphorus" is the only phosphorus allotrope listed among the choices, it represents the intended answer class. (Other options like Diamond and Graphite consist of 3D tetrahedral and 2D hexagonal carbon networks, respectively, while Sulfur forms crown-shaped S_8 rings).

Therefore, this structural motif corresponds to the phosphorus allotrope family.

Final Answer: White phosphorus

Answer: (C)

Go Back to Question 13

Q14.

Solution

Concept: A cyclic species is classified as aromatic according to Hückel's rule if it is cyclic, planar, completely conjugated, and contains $(4n + 2)$ π-electrons in its conjugated system (where n is a non-negative integer, $n = 0, 1, 2, \ldots$).

Solution: Step 1: Examine the structure of the cyclopropenyl cation. It is a three-membered ring consisting of:

- Two sp^2-hybridized carbon atoms sharing a double bond.
- One sp^2-hybridized carbon atom carrying a positive charge.

Step 2: Evaluate conjugation and planarity. The ring is small, forcing it to be planar. The positive carbon possesses an empty p-orbital, allowing the π-electrons from the double bond to be completely delocalized around the entire ring.

Step 3: Count the number of π-electrons. The single double bond in the ring contributes exactly:

$$\text{Number of } \pi\text{-electrons} = 2$$

Step 4: Apply Hückel's rule. For $n = 0$:

$$4n + 2 = 4(0) + 2 = 2\ \pi\text{-electrons}$$

Since the cyclopropenyl cation contains exactly 2 π-electrons, it satisfies Hückel's criteria. It is classified as aromatic and possesses exceptional thermodynamic stability despite substantial angle strain.

Final Answer: Aromatic

Answer: (A)

Go Back to Question 14

Q15.

Solution

Concept: A polypeptide chain is formed by the condensation reaction between amino acids, where the carboxyl group of one amino acid reacts with the amino group of another to form a covalent peptide bond (linkage) with the elimination of a water molecule.

Solution: Step 1: Understand the linking of monomers in a linear polymer. When N monomeric units (amino acids) are linked together in a linear chain, the connections occur between adjacent units.

Step 2: Calculate the number of bonds in a linear chain:

- A dipeptide ($N = 2$) contains 1 peptide bond.
- A tripeptide ($N = 3$) contains 2 peptide bonds.
- In general, a linear polypeptide containing N amino acid residues contains:

$$\text{Number of peptide linkages} = N - 1$$

Step 3: Substitute the given number of residues ($N = 100$):

$$\text{Number of peptide linkages} = 100 - 1 = 99$$

Therefore, there are 99 peptide linkages present in the chain.

Final Answer: $\boxed{99}$

Answer: (A)

Go Back to Question 15

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	B	3	C	4	C	5	C
6	A	7	B	8	C	9	C	10	C
11	B	12	D	13	C	14	A	15	A