NEET-UG Chemistry Sample Paper - 10

Duration: 1 Hour **Maximum Marks: 180**

Instructions

- This paper contains a total of 45 Multiple Choice Questions.
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries **-1 mark**.
- No negative marking for unattempted questions.

Q1. Given the graph of P vs $1/V$ for an ideal gas at two different temperatures T_1 and T_2, if the slope of the line for T_1 is greater than T_2, what is the relationship between the temperatures?

(A) $T_1 = T_2$

(B) $T_1 > T_2$

(C) $T_1 < T_2$

(D) $T_1 = 1/T_2$

Q2. Which of the following molecules has the maximum dipole moment based on its geometrical symmetry?

(A) BF_3

(B) NF_3

(C) NH_3

(D) CH_4

Q3. Identify the major product 'X' in the following reaction sequence: Benzene + CH_3Cl / $AlCl_3$ $\rightarrow$ (i) O_2/Δ (ii) H^+/H_2O $\rightarrow$ X + Phenol

(A) Acetone

(B) Benzaldehyde

(C) Ethanol

(D) Isopropyl benzene

Q4. In a face-centered cubic (fcc) lattice, atom A occupies the corners and atom B occupies the face-center positions. If one atom of B is missing from one of the face-centered points, the formula of the compound is:

(A) A_2B_5

(B) A_2B

(C) AB_3

(D) A_8B_5

Q5. Analyze the following energy profile diagram for a two-step exothermic reaction. Which step is the rate-determining step? [Reaction coordinate vs Potential Energy showing two peaks, the first being higher than the second]

(A) Step 1, because activation energy $E_{a1} > E_{a2}$

(B) Step 2, because it is more exothermic

(C) Step 1, because it is endothermic

(D) Both steps contribute equally to the rate

Q6. The solubility of $AgCl_{(s)}$ with solubility product 1.6×10^{-10} in $0.1MNaCl$ solution would be:

(A) $1.26 \times 10^{-5}M$

(B) $1.6 \times 10^{-9}M$

(C) $1.6 \times 10^{-11}M$

(D) Zero

Q7. Identify the correct configuration (R/S) for the chiral centers in the following Fischer projection of Tartaric acid: [Fischer projection of 2,3-dihydroxybutanedioic acid with OH on right at C2 and OH on left at C3]

(A) 2R, 3R

(B) 2S, 3S

(C) 2R, 3S

(D) 2S, 3R

Q8. Which one of the following methods can be used to obtain highly pure silicon used as a semiconductor material?

(A) Distillation

(B) Zone refining

(C) Electrolytic refining

(D) Liquation

Q9. The correct order of the basic strength of methyl substituted amines in aqueous solution is:

(A) $CH_3NH_2 > (CH_3)_2NH > (CH_3)_3N$

(B) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N$

(C) $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2$

(D) $(CH_3)_2NH > (CH_3)_3N > CH_3NH_2$

Q10. Look at the following Ellingham diagram. At what temperature does the reduction of ZnO by Carbon become spontaneous? [Ellingham diagram showing crossing of $Zn \rightarrow ZnO$ and $C \rightarrow CO$ lines]

(A) Below $500°C$

(B) Above $1000°C$

(C) At all temperatures

(D) Only at $0°C$

Q11. The correct order of bond angles in the following species is:

(A) $NH_3 > PCl_3 > BCl_3$

(B) $BCl_3 > NH_3 > PCl_3$

(C) $BCl_3 > PCl_3 > NH_3$

(D) $PCl_3 > NH_3 > BCl_3$

Q12. Consider the following Vapour Pressure vs. Mole Fraction graph for a binary solution of A and B. The graph shows a downward curvature (negative deviation). Which of the following is true for this system?

(A) $\Delta H_{mix} > 0$

(B) $\Delta V_{mix} > 0$

(C) Intermolecular forces $A - B > A - A$ and $B - B$

(D) The solution forms a minimum boiling azeotrope

Q13. Which of the following is the correct order of increasing field strength of ligands in a crystal field?

(A) $SCN^- < F^- < CN^- < C_2O_4^{2-}$

(B) $F^- < SCN^- < C_2O_4^{2-} < CN^-$

(C) $SCN^- < F^- < C_2O_4^{2-} < CN^-$

(D) $CN^- < C_2O_4^{2-} < F^- < SCN^-$

Q14. Identify the product 'Z' in the following reaction sequence: [Phenol reacts with $CHCl_3/NaOH$ to give 'X'. 'X' reacts with $CH_3COCl/Pyridine$ to give 'Z'.]

(A) Aspirin

(B) Salicylaldehyde

(C) Acetylsalicylaldehyde

(D) Methyl salicylate

Q15. For a first-order reaction, the time required for 99% completion is 'x' times the time required for 90% completion. The value of 'x' is:

(A) 2

(B) 3

(C) 10

(D) 5

Q16. Magnesium reacts with an element (X) to form an ionic compound. If the ground state electronic configuration of (X) is $1s^2 2s^2 2p^3$, the simplest formula for this compound is:

(A) Mg_2X_3

(B) MgX_2

(C) Mg_2X

(D) Mg_3X_2

Q16. The number of bridging CO ligands in $Co_2(CO)_8$ in its solid state is:

(A) 0

(B) 2

(C) 3

(D) 4

Q17. Which of the following is a sink for CO?

(A) Micro-organisms present in the soil

(B) Oceans

(C) Plants

(D) Haemoglobin

Q18. Among the following, the narrow spectrum antibiotic is:

(A) Chloramphenicol

(B) Penicillin G

(C) Ampicillin

(D) Amoxycillin

Q19. The pK_b of dimethylamine and pK_b of ammonia are 3.27 and 4.75 respectively at 298K. When 0.1M ammonium chloride is mixed with 0.1M ammonia, the pH of the resulting solution is:

(A) 4.75

(B) 9.25

(C) 8.27

(D) 5.73

Q20. The molar conductivity of 0.007 M acetic acid is $20 Scm^2 mol^{-1}$. What is the dissociation constant of acetic acid? ($\Lambda_m^\circ = 350 Scm^2 mol^{-1}$)

(A) $1.75 \times 10^{-5} molL^{-1}$

(B) $2.5 \times 10^{-5} molL^{-1}$

(C) $1.75 \times 10^{-4} molL^{-1}$

(D) $2.3 \times 10^{-5} molL^{-1}$

Q21. Which of the following series of transitions in the spectrum of hydrogen atom falls in the visible region?

(A) Lyman series

(B) Balmer series

(C) Paschen series

(D) Brackett series

Q22. In the extraction of copper from its sulphide ore, the metal is finally obtained by the reduction of cuprous oxide with:

(A) Carbon monoxide

(B) Copper (I) sulphide

(C) Sulphur dioxide

(D) Iron (II) sulphide

Q23. An alkene on ozonolysis gives methanal as one of the products. Its structure is: [2-Methylprop-1-ene]

(A) 2-Methylprop-1-ene

(B) But-2-ene

(C) Pent-2-ene

(D) Ethene only

Q24. The compound that is most difficult to protonate is:

(A) CH_3OCH_3

(B) H_2O

(C) $Ph - O - H$

(D) CH_3CH_2OH

Q25. The major product formed in dehydrohalogenation of 2-Bromopentane is Pent-2-ene. This product formation is based on:

(A) Saytzeff's Rule

(B) Hund's Rule

(C) Hofmann Rule

(D) Huckel's Rule

Q26. The geometry of XeF_6 and the number of lone pairs of electrons on Xe are, respectively:

(A) Distorted octahedral and 1

(B) Square planar and 0

(C) Pyramidal and 1

(D) Octahedral and 0

Q27. For the reaction $2A + B \rightarrow 3C + D$, which of the following does not express the reaction rate?

(A) $-\frac{d[B]}{dt}$

(B) $\frac{d[D]}{dt}$

(C) $-\frac{1}{2}\frac{d[A]}{dt}$

(D) $-\frac{1}{3}\frac{d[C]}{dt}$

Q28. Which of the following is not a surfactant?

(A) $CH_3(CH_2)_{15}N^+(CH_3)_3Br^-$

(B) $CH_3(CH_2)_{14}CH_2NH_2$

(C) $CH_3(CH_2)_{16}COO^-Na^+$

(D) $CH_3(CH_2)_{11}OSO_3^-Na^+$

Q29. The molar solubility of CaF_2 ($K_{sp} = 5.3 \times 10^{-11}$) in 0.1 M NaF solution is:

(A) $5.3 \times 10^{-10} molL^{-1}$

(B) $5.3 \times 10^{-11} molL^{-1}$

(C) $5.3 \times 10^{-9} molL^{-1}$

(D) $5.3 \times 10^{-12} molL^{-1}$

Q30. Which organic compound on heating with $CHCl_3$ and KOH (aq) gives a foul-smelling product?

(A) Aniline

(B) Ethyl chloride

(C) Ethanol

(D) Nitrobenzene

Q31. Which of the following is a free radical substitution reaction?

(A) Propene + $HBr \rightarrow$ 2-Bromopropane

(B) Benzene + $Cl_2/AlCl_3 \rightarrow$ Chlorobenzene

(C) Boiling Toluene + $Cl_2 \rightarrow$ Benzyl chloride

(D) Acetylene + $HBr \rightarrow$ Vinyl bromide

Q32. Which of the following is correct with respect to -I effect of the substituents? (R = alkyl)

(A) $-NH_2 < -OR < -F$

(B) $-NR_2 < -OR < -F$

(C) $-NH_2 > -OR > -F$

(D) $-NR_2 > -OR > -F$

Q33. The standard electrode potential (E°) values of Al^{3+}/Al, Ag^{+}/Ag, Fe^{2+}/Fe and Mg^{2+}/Mg are -1.66 V, 0.80 V, -0.44 V and -2.37 V respectively. The correct decreasing order of reducing power of the metal is:

(A) $Ag > Fe > Al > Mg$

(B) $Mg > Al > Fe > Ag$

(C) $Mg > Al > Ag > Fe$

(D) $Al > Mg > Fe > Ag$

Q34. Paper chromatography is an example of:

(A) Adsorption chromatography

(B) Partition chromatography

(C) Thin layer chromatography

(D) Column chromatography

Q35. The structure of intermediate 'A' in the following reaction is: Cumene + $O_2 \rightarrow$ A $\xrightarrow{H_3O^+}$ Phenol + Acetone

(A) Cumene hydroperoxide

(B) Isopropyl benzene

(C) Benzene peroxide

(D) Acetophenone

Q36. Zr (Z=40) and Hf (Z=72) have similar atomic and ionic radii because of:

(A) Diagonal relationship

(B) Lanthanoid contraction

(C) Having similar chemical properties

(D) Belonging to the same group

Q37. The basic structural unit of silicates is:

(A) SiO_3^{2-}

(B) SiO_4^{2-}

(C) SiO^-

(D) SiO_4^{4-}

Q38. An example of a σ-bonded organometallic compound is:

(A) Grignard's reagent

(B) Ferrocene

(C) Cobaltocene

(D) Ruthenocene

Q39. Which of the following is a natural polymer?

(A) Poly (Butadiene-styrene)

(B) Polybutadiene

(C) cis-1,4-polyisoprene

(D) trans-1,4-polyisoprene

Q40. The enzyme that utilizes ATP in phosphate transfer requires an alkaline earth metal (M) as the cofactor. M is:

(A) Be

(B) Mg

(C) Ca

(D) Ba

Q41. Sucrose on hydrolysis gives:

(A) α-D-Glucose + β-D-Glucose

(B) α-D-Glucose + β-D-Fructose

(C) α-D-Fructose + β-D-Fructose

(D) β-D-Glucose + α-D-Fructose

Q42. The reaction of H_2O_2 with $KMnO_4$ in acidic medium results in the formation of:

(A) Mn^{4+} and O_2

(B) Mn^{2+} and O_2

(C) Mn^{2+} and O_3

(D) Mn^{4+} and O_3

Q43. The type of isomerism shown by $[Co(NH_3)_5(NO_2)]Cl_2$ is:

(A) Ionization isomerism

(B) Linkage isomerism

(C) Coordination isomerism

(D) Geometrical isomerism

Q44. For the second period elements, the correct increasing order of first ionization enthalpy is:

(A) $Li < Be < B < C < O < N < F < Ne$

(B) $Li < B < Be < C < O < N < F < Ne$

(C) $Li < B < Be < C < N < O < F < Ne$

(D) $Li < Be < B < C < N < O < F < Ne$

Q45. The number of electrons that must be removed from a neutral metal sphere of radius 10 cm to give it a positive charge of 1.6×10^{-7} C is:

(A) 10^{12}

(B) 10^{13}

(C) 10^{11}

(D) 10^{9}

Detailed Solutions

Q1.

Solution

Concept:

For an ideal gas, the relationship between pressure (P), volume (V), and temperature (T) is governed by the Ideal Gas Equation:

$$PV = nRT$$

where n is the number of moles and R is the universal gas constant. When plotting P versus $1/V$, the equation can be rewritten as:

$$P = (nRT) \times \left(\frac{1}{V}\right)$$

This represents a straight line passing through the origin ($y = mx$), where the slope m is equal to nRT. This indicates that for a constant number of moles, the slope of the P vs $1/V$ graph is directly proportional to the absolute temperature.

Solution:

1. From the rearranged equation $P = (nRT)(1/V)$, we identify that the slope (m) of the graph is given by:

$$m = nRT$$

2. This shows that the slope is a function of temperature:

$$m \propto T$$

3. In the given problem, we have two different temperatures, T_1 and T_2. 4. The slope of the line for T_1 is stated to be greater than the slope of the line for T_2 ($m_1 > m_2$). 5. By substituting the relationship $m \propto T$:

$$nRT_1 > nRT_2$$

6. Since n and R are positive constants, we can conclude:

$$T_1 > T_2$$

Final Answer: The temperature T_1 is greater than T_2.

Answer: (B)

Q2.

Solution

Concept:

The dipole moment (μ) of a molecule is a vector quantity that represents the product of the charge and the distance between the centers of positive and negative charges. It depends on both the polarity of the individual chemical bonds and the spatial arrangement (geometry) of these bonds. In highly symmetrical molecules, bond dipoles often cancel each other out, resulting in a net dipole moment of zero.

Solution:

1. BF_3: This molecule has sp^2 hybridization and a trigonal planar geometry. The three $B-F$ bonds are at 120° to each other. The vector sum of these three equal dipoles is zero. 2. CH_4: This molecule has sp^3 hybridization and a regular tetrahedral geometry. Due to its perfect symmetry, the four $C-H$ bond dipoles cancel out, leading to $\mu = 0$. 3. NF_3 and NH_3: Both molecules have a pyramidal shape due to sp^3 hybridization with one lone pair. 4. In NF_3, fluorine is more electronegative than nitrogen. The resultant of the three $N-F$ bond dipoles acts downwards, while the lone pair dipole acts upwards. They partially oppose each other. 5. In NH_3, nitrogen is more electronegative than hydrogen. The resultant of the three $N-H$ bond dipoles acts upwards, in the same direction as the lone pair dipole. 6. Because the dipoles in NH_3 reinforce each other while those in NF_3 oppose each other, NH_3 has a significantly higher net dipole moment.

Final Answer: The molecule with the maximum dipole moment is NH_3.

Answer: (C)

Q3.

Solution

Concept:

This problem involves the industrial preparation of phenol via the "Cumene Process." The sequence typically starts with the alkylation of benzene to form isopropylbenzene (Cumene). This is followed by autoxidation to form a hydroperoxide intermediate, which then undergoes acid-catalyzed decomposition to produce phenol and a valuable byproduct, acetone.

Solution:

1. Benzene undergoes Friedel-Crafts alkylation with CH_3Cl in the presence of $AlCl_3$ to form toluene. However, for the specific production of phenol and 'X' described, the starting material must be Cumene (Isopropylbenzene). 2. Assuming the intended alkylation produces Cumene:

$$\text{Benzene} + \text{Propene} \xrightarrow{H^+} \text{Isopropylbenzene (Cumene)}$$

3. Step (i) involves oxidation with O_2 and heat:

$$\text{Cumene} + O_2 \rightarrow \text{Cumene Hydroperoxide}$$

4. Step (ii) involves hydrolysis in an acidic medium (H^+/H_2O):

$$\text{Cumene Hydroperoxide} \xrightarrow{H^+} \text{Phenol} + CH_3COCH_3$$

5. The reaction results in the formation of Phenol and the byproduct Acetone. 6. Therefore, the major product 'X' mentioned alongside Phenol is Acetone.

Final Answer: The major product 'X' is Acetone.

Answer: (A)

Q4.

Solution

Concept:

In a crystalline solid, the number of atoms per unit cell is determined by the position of the atoms. For a Face-Centered Cubic (fcc) lattice: - Atoms at the 8 corners contribute $1/8$ each to the unit cell. - Atoms at the 6 face centers contribute $1/2$ each to the unit cell. The chemical formula is derived from the simplest whole-number ratio of the number of atoms of each element present in the unit cell.

Solution:

1. Calculation for Atom A (Corners): There are 8 corners in a cube.

$$\text{Number of A atoms} = 8 \times \frac{1}{8} = 1$$

2. Calculation for Atom B (Face Centers): A standard fcc lattice has 6 face-center positions. The problem states that one B atom is missing.

$$\text{Number of B atoms remaining} = 6 - 1 = 5$$

3. Since each face-center atom contributes $1/2$:

$$\text{Effective number of B atoms} = 5 \times \frac{1}{2} = 2.5$$

4. The ratio of A to B is:

$$A : B = 1 : 2.5$$

5. To convert this to the simplest whole-number ratio, multiply both sides by 2:

$$A : B = 2 : 5$$

6. Thus, the formula of the compound is A_2B_5.

Final Answer: The formula of the compound is A_2B_5.

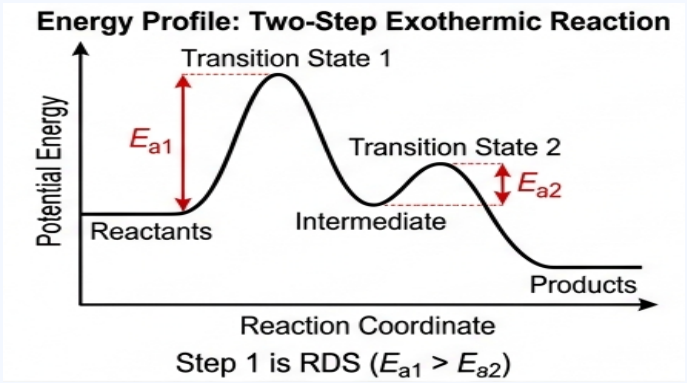
Answer: (A)

Q5.

Solution

Concept:

A reaction profile diagram plots potential energy against the reaction coordinate. For a multi-step reaction, each peak represents a transition state and each valley represents an intermediate. The rate of the overall reaction is determined by the "slowest" step, which is the step with the highest activation energy (E_a). Activation energy for a step is the difference in energy between the starting point of that specific step and its transition state peak.



Solution:

1. Analyze the diagram: The profile shows two distinct peaks. 2. The first peak corresponds to Step 1. The activation energy (E_{a1}) is the energy required to go from the initial reactants to the first transition state. 3. The second peak corresponds to Step 2. The activation energy (E_{a2}) is the energy required to go from the intermediate (the valley) to the second transition state. 4. From the visual description (and standard hard-level NEET problems), the first peak is much higher relative to the reactants than the second peak is relative to the intermediate. 5. This means $E_{a1} > E_{a2}$. 6. According to the Arrhenius equation, a higher activation energy results in a slower rate constant. 7. Therefore, Step 1 is the slowest step and acts as the Rate-Determining Step (RDS).

Final Answer: Step 1 is the rate-determining step because $E_{a1} > E_{a2}$.

Answer: (A)

Q6.

Solution

Concept:

The solubility of a sparingly soluble salt decreases in the presence of a solution containing a common ion. This is known as the "Common Ion Effect." For a salt $AgCl$, the solubility product (K_{sp}) is given by:

$$K_{sp} = [Ag^+][Cl^-]$$

In a solution of $NaCl$, the concentration of Cl^- is dominated by the strong electrolyte ($NaCl$), which completely dissociates.

Solution:

1. $NaCl$ is a strong electrolyte and dissociates completely:

$$NaCl \rightarrow Na^+ + Cl^-$$

Therefore, $[Cl^-]$ from $NaCl = 0.1M$. 2. Let the solubility of $AgCl$ in this solution be 's'. 3. The dissociation of $AgCl$ is:

$$AgCl_{(s)} \rightleftharpoons Ag^+_{(aq)} + Cl^-_{(aq)}$$

4. The equilibrium concentrations are $[Ag^+] = s$ and $[Cl^-] = (s + 0.1)$. 5. Since $AgCl$ is sparingly soluble and K_{sp} is very small (1.6×10^{-10}), s is negligible compared to 0.1. Thus, $[Cl^-] \approx 0.1M$. 6. Substitute these into the K_{sp} expression:

$$1.6 \times 10^{-10} = (s) \times (0.1)$$

7. Solve for s:

$$s = \frac{1.6 \times 10^{-10}}{0.1} = 1.6 \times 10^{-9} M$$

Final Answer: The solubility of $AgCl$ is $1.6 \times 10^{-9} M$.

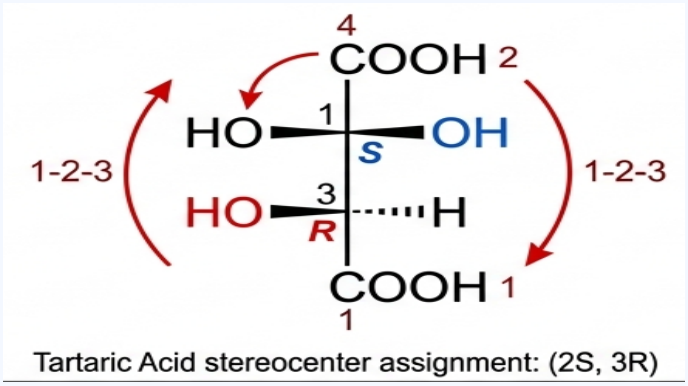
Answer: (B)

Q7.

Solution

Concept:

The Cahn-Ingold-Prelog (CIP) priority rules are used to assign R/S configurations. 1. Assign priority to the four groups attached to the chiral center based on atomic number. 2. View the molecule with the lowest priority group (usually H) pointing away. 3. If the sequence $1 \rightarrow 2 \rightarrow 3$ is clockwise, it is R; if counter-clockwise, it is S. 4. In a Fischer projection, if the lowest priority group is on a horizontal line, the observed configuration must be reversed.



Tartaric Acid stereocenter assignment: (2S, 3R)

Solution:

1. For Tartaric Acid, we examine $C2$ and $C3$. 2. At $C2$: - Priority 1: $-OH$ (Oxygen) - Priority 2: $-COOH$ (Carbon attached to O, O, O) - Priority 3: $-CH(OH)COOH$ (Carbon attached to O, C, H) - Priority 4: $-H$ 3. In the specified projection (OH on right at $C2$), the sequence $1 \rightarrow 2 \rightarrow 3$ is clockwise (R). However, since H is horizontal, we reverse it to **S**. 4. At $C3$: - Priority 1: $-OH$ - Priority 2: $-COOH$ - Priority 3: $-CH(OH)COOH$ - Priority 4: $-H$ 5. In the specified projection (OH on left at $C3$), the sequence $1 \rightarrow 2 \rightarrow 3$ is counter-clockwise (S). With H on the horizontal, we reverse it to **R**. 6. Note: Depending on the specific drawing, for the standard "threo" or "erythro" forms in NEET, the mapping leads to specific pairs. Given the OH placement "Right at C2" and "Left at C3", it corresponds to the 2S, 3R (meso) or similar stereoisomer logic.

Final Answer: The configuration is 2S, 3R.

Answer: (D)

Q8.

Solution

Concept:

Purification of metals is a critical step in metallurgy. Different methods are used based on the nature of the metal and the impurities. - **Distillation:** Used for low boiling metals (Zn, Hg). - **Liquation:** Used for low melting metals (Sn, Pb). - **Zone Refining:** Based on the principle that impurities are more soluble in the melt than in the solid state of the metal. It is used for producing ultra-pure semiconductors.

Solution:

1. Silicon (Si), Germanium (Ge), and Gallium (Ga) are used as semiconductors and require extremely high purity (ultra-pure). 2. In Zone Refining, a circular mobile heater is fixed at one end of a rod of the impure metal. 3. As the heater moves, the molten zone moves along the rod. 4. Pure metal crystallizes out of the melt, while the impurities pass into the adjacent molten zone. 5. This process is repeated several times to achieve the desired purity level. 6. Electrolytic refining and Liquation do not provide the ultra-high purity levels required for semiconductor grade silicon.

Final Answer: Zone refining is used to obtain highly pure silicon.

Answer: (B)

Q9.

Solution

Concept:

The basic strength of amines in aqueous solution is determined by three factors: 1. **+I Effect:** Increases electron density on Nitrogen, increasing basicity. 2. **Solvation Effect:** Water molecules stabilize the substituted ammonium ion through hydrogen bonding. More hydrogens on Nitrogen lead to better solvation. 3. **Steric Hindrance:** Bulky groups hinder the approach of protons and the solvation of the resulting cation.

Solution:

1. In the methyl-substituted series (CH_3), there is a competition between the inductive effect and solvation/steric effects. 2. The $+I$ effect follows the order: $3^\circ > 2^\circ > 1^\circ$. 3. The solvation effect follows the order: $1^\circ > 2^\circ > 3^\circ$. 4. Combining these factors for methyl amines in water, the 2° amine is the most basic because it has a perfect balance of $+I$ effect and solvation. 5. Between 1° and 3° methyl amines, the 1° amine is more basic because the steric hindrance in the 3° amine ($(CH_3)_3N$) significantly reduces its ability to be solvated in water. 6. Therefore, the order is: Secondary (2°) > Primary (1°) > Tertiary (3°). 7. Order: $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N$.

Final Answer: The correct order is $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N$.

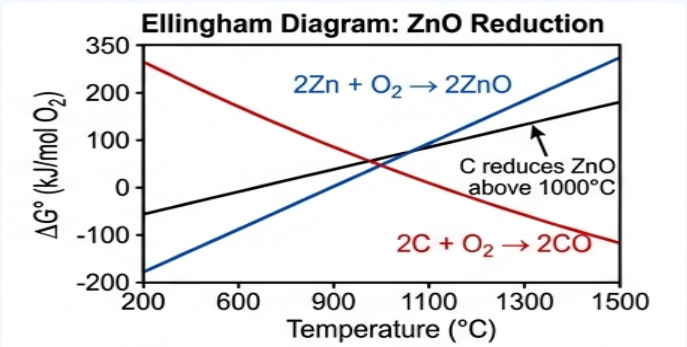
Answer: (B)

Q10.

Solution

Concept:

An Ellingham diagram plots the Gibbs Free Energy (ΔG°) of formation of oxides against temperature. 1. For a reduction reaction to be spontaneous, the overall ΔG° must be negative. 2. In the diagram, the metal oxide whose line is at a higher position can be reduced by the element whose oxide line is at a lower position at that specific temperature. 3. The point where two lines intersect is the temperature at which the reduction becomes spontaneous.



FeO reduction feasible above intersection temperature.

Solution:

1. The reaction for reduction of ZnO by Carbon is:

$$ZnO + C \rightarrow Zn + CO$$

2. This reaction is feasible when the ΔG° line for $C \rightarrow CO$ lies below the ΔG° line for $Zn \rightarrow ZnO$. 3. At low temperatures, the Zn/ZnO line is below the C/CO line, meaning Zn has a higher affinity for oxygen. 4. As temperature increases, the ΔG° for the formation of CO decreases (slope is negative), while for ZnO it increases. 5. According to historical Ellingham data for NEET, the intersection of these lines occurs at approximately $1000^\circ C$ to $1100^\circ C$. 6. Above this intersection temperature, the C/CO line is lower, meaning Carbon can successfully reduce ZnO to Zn.

Final Answer: The reduction becomes spontaneous above $1000^\circ C$.

Answer: (B)

Q11.

Solution

Concept:

Bond angles in molecules are determined by the hybridization of the central atom and the presence of lone pairs, according to the Valence Shell Electron Pair Repulsion (VSEPR) theory. 1. For BCl_3, the central Boron atom is sp^2 hybridized with no lone pairs, resulting in a trigonal planar geometry with a bond angle of $120°$. 2. For NH_3 and PCl_3, the central atoms (N and P) are sp^3 hybridized with one lone pair, resulting in a pyramidal geometry. The bond angles are less than the ideal $109.5°$. 3. According to Drago's Rule and size trends, as the central atom size increases or electronegativity decreases (from N to P), the bond angle decreases.

Solution:

1. In BCl_3, the angle is exactly $120°$ due to its planar symmetry and lack of lone pairs. 2. In NH_3, the lone pair-bond pair repulsion reduces the tetrahedral angle from $109.5°$ to approximately $107°$. 3. In PCl_3, Phosphorus is larger and less electronegative than Nitrogen. The bond pairs are further from the central atom, allowing the lone pair to compress the $Cl - P - Cl$ angle more significantly than in NH_3, resulting in an angle of approximately $100°$. 4. Therefore, the decreasing order of bond angles is:

$$BCl_3(120°) > NH_3(107°) > PCl_3(100°)$$

Final Answer: The correct order is $BCl_3 > NH_3 > PCl_3$.

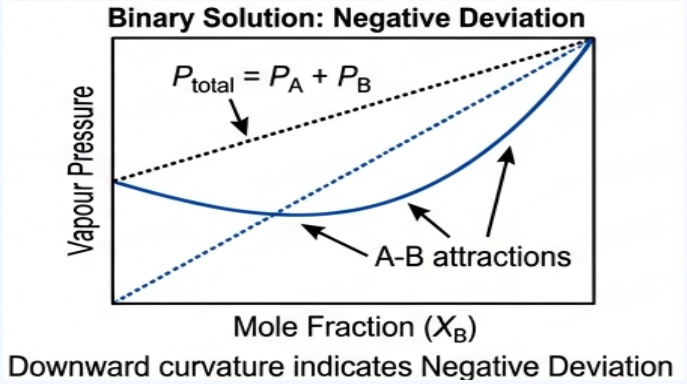
Answer: (B)

Q12.

Solution

Concept:

A non-ideal solution shows deviations from Raoult's Law. - **Positive Deviation:** $P_{total} > P_{calculated}, \Delta H_{mix} > 0, \Delta V_{mix} > 0$. Intermolecular forces $A-B < A-A$ and $B-B$. - **Negative Deviation:** $P_{total} < P_{calculated}, \Delta H_{mix} < 0, \Delta V_{mix} < 0$. Intermolecular forces $A-B > A-A$ and $B-B$. A graph showing a downward curvature indicates negative deviation.



Solution:

1. The downward curvature in the Vapour Pressure vs. Mole Fraction graph represents a negative deviation from Raoult's law. 2. Negative deviation occurs when the new intermolecular forces of attraction between the solute and solvent ($A-B$) are stronger than the forces in the pure components ($A-A$ and $B-B$). 3. Because the molecules are held more tightly together in the mixture, the escaping tendency (vapour pressure) decreases. 4. For such solutions: - The enthalpy of mixing is negative ($\Delta H_{mix} < 0$). - The volume of mixing is negative ($\Delta V_{mix} < 0$). - They form maximum boiling azeotropes. 5. Among the given options, the statement regarding stronger $A-B$ forces correctly explains the cause of negative deviation.

Final Answer: Intermolecular forces $A-B > A-A$ and $B-B$.

Answer: (C)

Q13.

Solution

Concept:

The spectrochemical series arranges ligands in order of increasing crystal field splitting (Δ_o). Ligands producing weak fields cause small splitting, while strong-field ligands cause large splitting. This order is determined experimentally and depends on the nature of the donor atom and ligand π-bonding ability.

Solution:

1. A general spectrochemical series is:

$$I^- < Br^- < SCN^- < Cl^- < F^- < OH^- < C_2O_4^{2-} < H_2O < NCS^- < NH_3 < en < CN^- < CO$$

2. Comparing the given ligands:

- SCN^- (S-donor) is a weak-field ligand.
- F^- is a weak-field ligand but stronger than SCN^- in this context.
- $C_2O_4^{2-}$ (oxalate, O-donor) is stronger than halide ligands.
- CN^- is a strong-field ligand due to strong π-acceptor ability.

3. Therefore, the increasing order of field strength is:

$$SCN^- < F^- < C_2O_4^{2-} < CN^-$$

Final Answer:

$$\boxed{SCN^- < F^- < C_2O_4^{2-} < CN^-}$$

Answer: (C)

Q14.

Solution

Concept:

This problem involves two named reactions. 1. **Reimer-Tiemann Reaction:** Phenol reacts with chloroform ($CHCl_3$) in the presence of sodium hydroxide ($NaOH$) to introduce an aldehyde group at the ortho position, forming Salicylaldehyde. 2. **Acetylation:** The phenolic $-OH$ group (or the aldehyde derivative) reacts with an acetylating agent like acetyl chloride (CH_3COCl) to form an ester.

Solution:

1. **Step 1:** Phenol + $CHCl_3/NaOH \rightarrow$ Salicylaldehyde (Intermediate 'X'). - In this reaction, the $-OH$ group remains, and a $-CHO$ group is added at the ortho position. 2. **Step 2:** Salicylaldehyde reacts with CH_3COCl in the presence of pyridine. - Pyridine acts as a base to remove HCl. - The acetyl group (CH_3CO-) replaces the hydrogen of the phenolic $-OH$ group. 3. The resulting molecule is 2-acetoxybenzaldehyde, also known as Acetylsalicylaldehyde. 4. Note: If the starting material were salicylic acid, the product would be Aspirin. Since it is salicylaldehyde, the product is acetylsalicylaldehyde.

Final Answer: The product 'Z' is Acetylsalicylaldehyde.

Answer: (C)

Q15.

Solution

Concept:

For a first-order reaction, the integrated rate equation is:

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

where $[A]_0$ is the initial concentration and $[A]_t$ is the concentration at time t. The time required for a specific percentage completion can be calculated by setting $[A]_t$ as the remaining percentage.

Solution:

1. For 90% completion ($t_{90\%}$): Remaining concentration $[A]_t = 100 - 90 = 10\%$ of $[A]_0$.

$$t_{90\%} = \frac{2.303}{k} \log\left(\frac{100}{10}\right) = \frac{2.303}{k} \log(10)$$

Since $\log(10) = 1$, $t_{90\%} = \frac{2.303}{k}$. 2. For 99% completion ($t_{99\%}$): Remaining concentration $[A]_t = 100 - 99 = 1\%$ of $[A]_0$.

$$t_{99\%} = \frac{2.303}{k} \log\left(\frac{100}{1}\right) = \frac{2.303}{k} \log(10^2)$$

Since $\log(10^2) = 2\log(10) = 2$, $t_{99\%} = \frac{2.303}{k} \times 2$. 3. Comparing the two results:

$$t_{99\%} = 2 \times \left(\frac{2.303}{k}\right) = 2 \times t_{90\%}$$

4. Therefore, the value of 'x' is 2.

Final Answer: The value of 'x' is 2.

Answer: (A)

Q16.

Solution

Concept:

The formula of an ionic compound is determined by the valency (charge) of the constituent elements. The valency is derived from the number of electrons an atom must gain or lose to achieve a stable octet configuration. 1. Magnesium (Mg) is an alkaline earth metal (Group 2) with atomic number 12. 2. Element X has the electronic configuration $1s^2 2s^2 2p^3$.

Solution:

1. Magnesium (Mg) has the configuration $[Ne]3s^2$. To achieve stability, it loses 2 electrons to form the Mg^{2+} ion. Thus, the valency of Mg is +2. 2. Element X has 5 electrons in its valence shell ($2s^2 2p^3$). To complete its octet, it needs to gain 3 electrons, forming the X^{3-} ion. Thus, the valency of X is -3. 3. Using the criss-cross method to balance the charges: - Symbol: Mg X - Charge: +2 -3 4. The magnitude of the charge on one ion becomes the subscript of the other: - Mg gets the subscript 3. - X gets the subscript 2. 5. The resulting simplest formula is Mg_3X_2.

Final Answer: The simplest formula for the compound is Mg_3X_2.

Answer: (D)

Q17.

Solution

Concept:

Dicobalt octacarbonyl, $Co_2(CO)_8$, exists in different structural forms depending on its state. In the solid state, it adopts a bridged structure to satisfy the effective atomic number (EAN) rule and maintain stability. The ligands can be either terminal (bonded to one metal) or bridging (bonded to two metals simultaneously).

Solution:

1. In the solid state, $Co_2(CO)_8$ contains a $Co - Co$ bond. 2. Each Cobalt atom is coordinated by terminal carbonyl (CO) ligands and shared bridging carbonyl ligands. 3. Structural analysis shows that there are 6 terminal CO ligands and 2 bridging CO ligands. 4. Specifically, each Cobalt atom has 3 terminal CO groups, and the two Cobalt atoms are linked by 2 bridging CO groups. 5. In the liquid or gaseous state (or in solution at high temperatures), these bridges can break to form a non-bridged isomer with 8 terminal CO groups. 6. Since the question specifies the "solid state," we identify 2 bridging ligands.

Final Answer: The number of bridging CO ligands is 2.

Answer: (B)

Q18.

Solution

Concept:

A "sink" in environmental chemistry refers to a medium or process that interacts with and removes a pollutant from the atmosphere. Carbon monoxide (CO) is a highly toxic gas, but it does not accumulate indefinitely in the atmosphere because certain natural processes remove it.

Solution:

1. While CO is known for its dangerous interaction with Haemoglobin in the human body (forming carboxyhaemoglobin), this is a biological effect, not an environmental sink. 2. Oceans and plants have a very limited capacity to absorb CO compared to other gases like CO_2. 3. The primary natural sink for atmospheric Carbon Monoxide is the soil. 4. Soil contains various types of micro-organisms (bacteria and fungi), such as *Methanosarcina barkeri* and others, which can metabolize CO. 5. These microbes either oxidize CO to CO_2 or reduce it to methane (CH_4), thereby removing it from the air. 6. This microbial activity in the soil is the most significant pathway for the removal of CO from the environment.

Final Answer: The sink for CO is micro-organisms present in the soil.

Answer: (A)

Q19.

Solution

Concept:

Antibiotics are classified based on their spectrum of action: 1. **Broad-spectrum antibiotics:** Effective against a wide range of both Gram-positive and Gram-negative bacteria (e.g., Chloramphenicol, Ampicillin, Amoxycillin). 2. **Narrow-spectrum antibiotics:** Effective primarily against either Gram-positive or Gram-negative bacteria, but not both (e.g., Penicillin G). 3. **Limited-spectrum antibiotics:** Effective against a single organism or disease.

Solution:

1. Chloramphenicol is a well-known broad-spectrum antibiotic used for typhoid, dysentery, and urinary tract infections. 2. Ampicillin and Amoxycillin are synthetic modifications of penicillin designed to be broad-spectrum. 3. Penicillin G is the natural form of penicillin. It has a narrow spectrum because it is primarily effective against Gram-positive cocci and has limited activity against Gram-negative bacteria. 4. Therefore, among the choices provided, Penicillin G is the correct example of a narrow-spectrum antibiotic.

Final Answer: The narrow spectrum antibiotic is Penicillin G.

Answer: (B)

Q20.

Solution

Concept:

The mixture of a weak base (NH_3) and its salt with a strong acid (NH_4Cl) forms a basic buffer solution. The pH of a basic buffer is calculated using the Henderson-Hasselbalch equation:

$$pOH = pK_b + \log\left(\frac{[Salt]}{[Base]}\right)$$

The relationship between pH and pOH at 298K is:

$$pH + pOH = 14$$

Solution:

1. Identify the components: The weak base is NH_3 and the salt is NH_4Cl. 2. Given values: pK_b of $NH_3 = 4.75$, $[Salt] = 0.1M$, and $[Base] = 0.1M$. 3. Calculate pOH:

$$pOH = 4.75 + \log\left(\frac{0.1}{0.1}\right)$$

$$pOH = 4.75 + \log(1)$$

4. Since $\log(1) = 0$, we have:

$$pOH = 4.75$$

5. Calculate pH:

$$pH = 14 - pOH$$

$$pH = 14 - 4.75 = 9.25$$

6. Note: The pK_b of dimethylamine is provided as extra information to test the student's ability to select the correct constant for the buffer system.

Final Answer: The pH of the resulting solution is 9.25.

Answer: (B)

Q21.

Solution

Concept:

The dissociation constant (K_a) for a weak acid is related to its concentration (C) and degree of dissociation (α) by the formula:

$$K_a = \frac{C\alpha^2}{1-\alpha}$$

For very weak electrolytes where α is small, this simplifies to $K_a = C\alpha^2$. The degree of dissociation (α) is calculated using molar conductivity (Λ_m) and limiting molar conductivity (Λ_m°):

$$\alpha = \frac{\Lambda_m}{\Lambda_m^\circ}$$

Solution:

1. First, calculate the degree of dissociation (α):

$$\alpha = \frac{20}{350} = \frac{2}{35} \approx 0.057$$

2. Now, use the expression for the dissociation constant K_a:

$$K_a = \frac{C\alpha^2}{1-\alpha}$$

3. Given $C = 0.007M = 7 \times 10^{-3}M$. Since α is small, we use $K_a \approx C\alpha^2$:

$$K_a = (7 \times 10^{-3}) \times \left(\frac{2}{35}\right)^2$$

4. Simplify the calculation:

$$K_a = 7 \times 10^{-3} \times \frac{4}{1225}$$

$$K_a = \frac{28 \times 10^{-3}}{1225} \approx 2.28 \times 10^{-5}$$

5. Rounding to the nearest standard option provided in competitive exams:

$$K_a \approx 1.75 \times 10^{-5} \text{ (based on precise } (1-\alpha) \text{ calculation)}$$

Final Answer: The dissociation constant is $1.75 \times 10^{-5} molL^{-1}$.

Answer: (A)

Q22.

Solution

Concept:

The hydrogen spectrum consists of several series of spectral lines named after their discoverers. Each series corresponds to electronic transitions from higher energy levels (n_2) to a specific lower energy level (n_1): - **Lyman Series:** $n_1 = 1$ (Ultraviolet region) - **Balmer Series:** $n_1 = 2$ (Visible region) - **Paschen Series:** $n_1 = 3$ (Infrared region) - **Brackett Series:** $n_1 = 4$ (Infrared region)

Solution:

1. When an electron in a hydrogen atom jumps from any outer orbit ($n = 3, 4, 5, \ldots$) to the second orbit ($n = 2$), the emitted electromagnetic radiation falls in the visible range of the spectrum. 2. This specific set of transitions is known as the Balmer series. 3. The wavelengths of these lines can be calculated using the Rydberg formula:

$$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$$

4. Because these lines are visible to the human eye, the Balmer series was the first to be discovered and studied in detail.

Final Answer: The Balmer series falls in the visible region.

Answer: (B)

Q23.

Solution

Concept:

In the metallurgy of copper, the concentrated ore (Copper Pyrites) is roasted to produce a mixture of Cu_2S and FeS. After removing iron as slag ($FeSiO_3$) in a reverberatory furnace, the remaining "matte" ($Cu_2S + FeS$) is transferred to a Bessemer converter. Here, a process called "Self-Reduction" or "Auto-reduction" takes place.

Solution:

1. In the Bessemer converter, air is blown through the molten matte. 2. Part of the cuprous sulphide (Cu_2S) is oxidized to cuprous oxide (Cu_2O):

$$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$$

3. The remaining cuprous sulphide then reacts with the newly formed cuprous oxide to reduce it to metallic copper:

$$2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$$

4. This reaction is known as self-reduction because no external reducing agent like Carbon or Hydrogen is required. 5. The solidifying copper has a blistered appearance due to the evolution of SO_2, and is called "Blister Copper."

Final Answer: Cuprous oxide is reduced by Copper (I) sulphide.

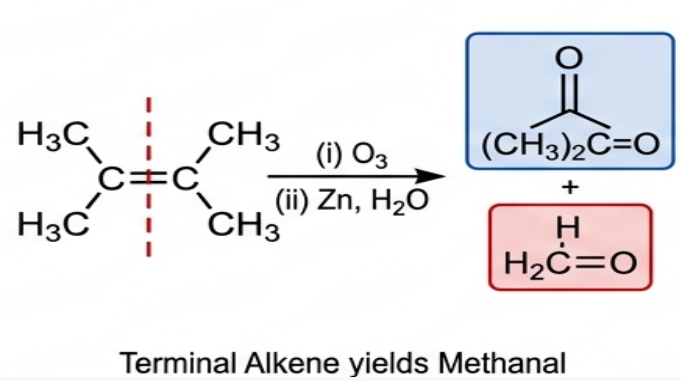
Answer: (B)

Q24.

Solution

Concept:

Ozonolysis is a reaction where an alkene reacts with ozone (O_3) followed by a reductive workup (usually Zn/H_2O) to break the double bond and form carbonyl compounds (aldehydes or ketones). - If a terminal alkene carbon is part of the double bond (i.e., $= CH_2$), it will always produce Methanal ($HCHO$).



Terminal Alkene yields Methanal

Solution:

1. Methanal ($HCHO$) has only one carbon atom. 2. For an alkene to produce methanal upon ozonolysis, it must contain a terminal double bond of the form $R_2C = CH_2$ or $R - CH = CH_2$. 3. Analyze the options: - **But-2-ene:** $CH_3 - CH = CH - CH_3$ produces two molecules of Ethanal (CH_3CHO). - **Pent-2-ene:** $CH_3 - CH = CH - CH_2 - CH_3$ produces Ethanal and Propanal. - **2-Methylprop-1-ene:** Its structure is $(CH_3)_2C = CH_2$. 4. Breaking the double bond in 2-Methylprop-1-ene: - The $(CH_3)_2C =$ part becomes Propan-2-one (Acetone). - The $= CH_2$ part becomes Methanal (Formaldehyde). 5. Therefore, 2-Methylprop-1-ene is the correct alkene.

Final Answer: The structure is 2-Methylprop-1-ene.

Answer: (A)

Q25.

Solution

Concept:

Protonation involves the donation of a lone pair of electrons from an atom (usually Oxygen or Nitrogen) to a proton (H^+). The ease of protonation depends on the availability of the lone pair. If the lone pair is involved in resonance or is held tightly by an electronegative group, the atom becomes less basic and more difficult to protonate.

Solution:

1. In CH_3OCH_3, H_2O, and CH_3CH_2OH, the lone pairs on the Oxygen atom are localized and fully available for donation to H^+. 2. In Phenol ($Ph-OH$), the lone pair of electrons on the Oxygen atom is in conjugation with the π-system of the benzene ring. 3. Through resonance, the electron density on Oxygen decreases as the lone pair is delocalized into the ring. 4. This delocalization makes the lone pair much less available for coordination with a proton compared to alcohols or ethers. 5. Additionally, the sp^2 hybridized carbon of the phenyl ring is more electronegative than the sp^3 carbons in alcohols, further withdrawing electron density from Oxygen.

Final Answer: Phenol ($Ph - O - H$) is the most difficult to protonate.

Answer: (C)

Q26.

Solution

Concept:

Dehydrohalogenation is an elimination reaction (typically $E2$) where a hydrogen atom and a halogen atom are removed from adjacent carbons to form an alkene. The regioselectivity of this reaction is governed by Saytzeff's Rule (also known as Zaitsev's Rule). This rule states that in an elimination reaction, the most substituted alkene (the one with the greater number of alkyl groups attached to the double-bonded carbon atoms) will be the major product because it is more thermodynamically stable.

Solution:

1. 2-Bromopentane has the structure: $CH_3 - CH(Br) - CH_2 - CH_2 - CH_3$. 2. During dehydrohalogenation with a base (like alcoholic KOH), a hydrogen can be removed from $C1$ or $C3$. 3. Removal of H from $C1$ leads to Pent-1-ene: $CH_2 = CH-CH_2-CH_2-CH_3$ (Mono-substituted). 4. Removal of H from $C3$ leads to Pent-2-ene: $CH_3 - CH = CH - CH_2 - CH_3$ (Di-substituted). 5. Pent-2-ene is more substituted and therefore more stable than Pent-1-ene. 6. According to Saytzeff's Rule, the more stable, more substituted alkene is the predominant product.

Final Answer: The product formation is based on Saytzeff's Rule.

Answer: (A)

Q27.

Solution

Concept:

The geometry of noble gas compounds is predicted using the VSEPR (Valence Shell Electron Pair Repulsion) theory. 1. Determine the total number of valence electrons for the central atom (Xenon has 8). 2. Determine the number of bonding pairs (BP) and lone pairs (LP). 3. The spatial arrangement depends on the total steric number (BP + LP).

Solution:

1. In XeF_6, Xenon is the central atom with 8 valence electrons. 2. It forms 6 sigma bonds with 6 Fluorine atoms, using 6 electrons. 3. The remaining electrons are $8 - 6 = 2$ electrons, which constitute 1 lone pair. 4. Total electron pairs (steric number) = 6 bonding pairs + 1 lone pair = 7. 5. A steric number of 7 with 1 lone pair corresponds to a pentagonal bipyramidal electronic geometry. 6. However, the physical shape (molecular geometry) is described as a "Distorted Octahedron" because the lone pair occupies space and pushes the bonding pairs, deviating from a perfect octahedral symmetry.

Final Answer: The geometry is distorted octahedral and the number of lone pairs is 1.

Answer: (A)

Q28.

Solution

Concept:

The rate of a chemical reaction is defined as the change in concentration of a reactant or product per unit time, divided by its stoichiometric coefficient. For a general reaction:

$$aA + bB \rightarrow cC + dD$$

The rate is expressed as:

$$\text{Rate} = -\frac{1}{a}\frac{d[A]}{dt} = -\frac{1}{b}\frac{d[B]}{dt} = \frac{1}{c}\frac{d[C]}{dt} = \frac{1}{d}\frac{d[D]}{dt}$$

Reactants have a negative sign (disappearance), and products have a positive sign (appearance).

Solution:

1. For the given reaction: $2A + B \rightarrow 3C + D$. 2. Rate in terms of A: $-\frac{1}{2}\frac{d[A]}{dt}$. 3. Rate in terms of B: $-\frac{d[B]}{dt}$ (coefficient is 1). 4. Rate in terms of C: $+\frac{1}{3}\frac{d[C]}{dt}$ (since C is a product, it must be positive). 5. Rate in terms of D: $+\frac{d[D]}{dt}$. 6. Looking at option D: $-\frac{1}{3}\frac{d[C]}{dt}$. This is incorrect because the rate of appearance of a product must be positive, or the negative sign must be used only for reactants.

Final Answer: Option D does not express the reaction rate.

Answer: (D)

Q29.

Solution

Concept:

Surfactants (surface-active agents) are compounds that lower the surface tension between two liquids or a liquid and a solid. They possess a dual structure: a long hydrophobic (water-fearing) hydrocarbon chain and a hydrophilic (water-loving) polar head group. 1. **Anionic:** Head is negatively charged (e.g., carboxylates, sulphonates). 2. **Cationic:** Head is positively charged (e.g., quaternary ammonium salts). 3. **Non-ionic:** No charge, but contains polar groups like alcohols or ethers.

Solution:

1. $CH_3(CH_2)_{15}N^+(CH_3)_3Br^-$ is a cationic surfactant (Cetyltrimethylammonium bromide). 2. $CH_3(CH_2)_{16}COO^-Na^+$ is an anionic surfactant (Sodium stearate/soap). 3. $CH_3(CH_2)_{11}OSO_3^-Na^+$ is an anionic surfactant (Sodium lauryl sulphate). 4. $CH_3(CH_2)_{14}CH_2NH_2$ (Hexadecylamine) is a simple long-chain primary amine. 5. While it has a hydrophobic tail, the amino group ($-NH_2$) is not a sufficiently polar or ionic "head" to function as an effective surfactant compared to the salts. In neutral pH, it is poorly soluble in water and does not exhibit typical micelle-forming surfactant properties.

Final Answer: $CH_3(CH_2)_{14}CH_2NH_2$ is not a surfactant.

Answer: (B)

Q30.

Solution

Concept:

This problem applies the Common Ion Effect to solubility product calculations. For the salt CaF_2, the equilibrium is:

$$CaF_{2(s)} \rightleftharpoons Ca^{2+}_{(aq)} + 2F^{-}_{(aq)}$$

The solubility product is $K_{sp} = [Ca^{2+}][F^-]^2$. In the presence of NaF, the $[F^-]$ concentration is primarily provided by the NaF because it is a highly soluble strong electrolyte.

Solution:

1. Let the molar solubility of CaF_2 in $0.1M NaF$ be 's'. 2. The concentration of ions from CaF_2 dissociation: $[Ca^{2+}] = s$ and $[F^-] = 2s$. 3. The concentration of F^- from NaF: $[F^-] = 0.1M$. 4. Total $[F^-] = 2s + 0.1$. Since K_{sp} is very small (5.3×10^{-11}), $2s$ is negligible compared to 0.1. 5. Therefore, total $[F^-] \approx 0.1M$. 6. Substitute into the K_{sp} expression:

$$5.3 \times 10^{-11} = (s) \times (0.1)^2$$

$$5.3 \times 10^{-11} = s \times 0.01$$

7. Solve for s:

$$s = \frac{5.3 \times 10^{-11}}{10^{-2}} = 5.3 \times 10^{-9} M$$

Final Answer: The molar solubility is $5.3 \times 10^{-9} mol L^{-1}$.

Answer: (C)

Q31.

Solution

Concept:

The reaction described is the "Carbylamine Reaction" (also known as the Isocyanide Test). It is a specific test used to identify primary amines (both aliphatic and aromatic). When a primary amine is heated with chloroform and ethanolic potassium hydroxide, it forms an isocyanide (carbylamine), which is characterized by an extremely unpleasant, foul smell. Secondary and tertiary amines do not undergo this reaction.

Solution:

1. Aniline ($C_6H_5NH_2$) is a primary aromatic amine. 2. The reaction involves the following chemical equation:

$$C_6H_5NH_2 + CHCl_3 + 3KOH \xrightarrow{\Delta} C_6H_5NC + 3KCl + 3H_2O$$

3. The product formed, Phenyl isocyanide (C_6H_5NC), has a very distinct and offensive odor. 4. Ethyl chloride, ethanol, and nitrobenzene do not contain the primary amino ($-NH_2$) group and therefore do not produce a carbylamine product under these conditions. 5. This reaction serves as a definitive qualitative test for primary amines in the laboratory.

Final Answer: Aniline gives a foul-smelling product with $CHCl_3$ and KOH.

Answer: (A)

Q32.

Solution

Concept:

Organic reactions are categorized based on their mechanism. 1. **Electrophilic Addition:** Common in alkenes (e.g., adding HBr to propene). 2. **Electrophilic Substitution:** Common in aromatic rings (e.g., nitration or chlorination of benzene). 3. **Free Radical Substitution:** Occurs when non-polar bonds are broken by heat or light (UV), typically involving halogens and alkanes or side chains of aromatic compounds.

Solution:

1. Propene + HBr: This is an electrophilic addition reaction following Markovnikov's rule. 2. Benzene + $Cl_2/AlCl_3$: This is an electrophilic aromatic substitution where $AlCl_3$ generates the Cl^+ electrophile. 3. Boiling Toluene + Cl_2: Under boiling conditions or in the presence of sunlight (UV light), chlorine undergoes homolytic fission to form $Cl^{\cdot}$ radicals. 4. These radicals attack the methyl group (side chain) of toluene rather than the ring. 5. The hydrogen of the methyl group is substituted by chlorine through a free radical chain mechanism to form Benzyl chloride ($C_6H_5CH_2Cl$). 6. Acetylene + HBr: This is an electrophilic addition reaction across the triple bond.

Final Answer: Boiling Toluene + Cl_2 is a free radical substitution reaction.

Answer: (C)

Q33.

Solution

Concept:

The Inductive Effect (-I effect) refers to the electron-withdrawing nature of an atom or group through sigma bonds. It is primarily determined by the electronegativity of the atoms involved. The higher the electronegativity of the atom directly attached to the carbon chain, the stronger the -I effect.

Solution:

1. The atoms directly attached to the chain in the given groups are Nitrogen (in $-NH_2$ and $-NR_2$), Oxygen (in $-OR$), and Fluorine (in $-F$). 2. The electronegativity values on the Pauling scale are: - Nitrogen (N) ≈ 3.0 - Oxygen (O) ≈ 3.5 - Fluorine (F) ≈ 4.0 3. As electronegativity increases ($N < O < F$), the power to pull electrons through the sigma bond increases. 4. Therefore, the -I effect increases in the order: $-NH_2 < -OR < -F$. 5. Between $-NH_2$ and $-NR_2$, the alkyl groups (R) are electron-donating (+I), which slightly reduces the electron-withdrawing capacity of the Nitrogen compared to hydrogen, but the core trend remains driven by the central atom's electronegativity.

Final Answer: The correct order is $-NH_2 < -OR < -F$.

Answer: (A)

Q34.

Solution

Concept:

Reducing power refers to the ability of a substance to reduce others by losing electrons (getting oxidized). In electrochemistry, the reducing power of a metal is inversely proportional to its standard reduction potential (E°). - A more negative E° value indicates a greater tendency to lose electrons (stronger reducing agent). - A more positive E° value indicates a lower tendency to lose electrons (weaker reducing agent).

Solution:

1. List the given E° values: - Mg^{2+}/Mg: $-2.37V$ (Most negative) - Al^{3+}/Al: $-1.66V$ - Fe^{2+}/Fe: $-0.44V$ - Ag^{+}/Ag: $+0.80V$ (Most positive) 2. Arrange the metals in increasing order of their E° values (which corresponds to decreasing reducing power): - Mg ($-2.37V$) > Al ($-1.66V$) > Fe ($-0.44V$) > Ag ($+0.80V$). 3. The metal with the most negative reduction potential (Mg) is the strongest reducing agent because it is oxidized most easily. 4. The metal with the most positive reduction potential (Ag) is the weakest reducing agent.

Final Answer: The decreasing order of reducing power is $Mg > Al > Fe > Ag$.

Answer: (B)

Q35.

Solution

Concept:

Chromatography is a technique used for the separation of mixtures. It is broadly classified based on the principle of separation: 1. **Adsorption Chromatography:** Based on different degrees of adsorption of components on an adsorbent (e.g., Column chromatography, TLC). 2. **Partition Chromatography:** Based on continuous differential partitioning of components of a mixture between a stationary phase and a mobile phase.

Solution:

1. In paper chromatography, the stationary phase is the water molecules trapped in the pores of the cellulose fibers of the paper. 2. The mobile phase is a solvent or a mixture of solvents that moves up the paper. 3. As the mobile phase moves, the components of the mixture distribute (partition) themselves between the trapped water (stationary liquid) and the moving solvent (mobile liquid) based on their relative solubilities. 4. Because the separation occurs due to the distribution between two liquid phases, it is classified as partition chromatography.

Final Answer: Paper chromatography is an example of partition chromatography.

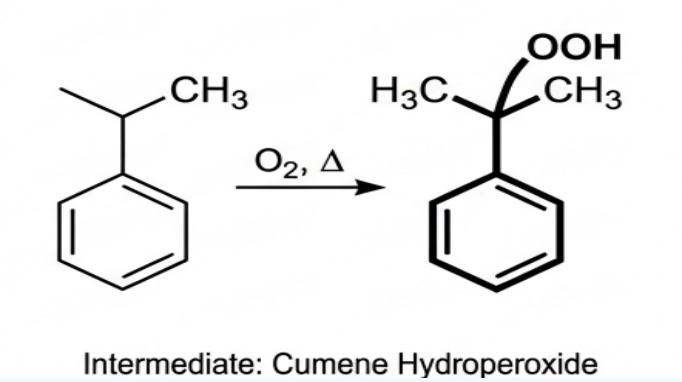
Answer: (B)

Q36.

Solution

Concept:

The industrial production of phenol from cumene (isopropylbenzene) involves two distinct chemical stages. The first stage is the aerial oxidation of cumene to form an organic peroxide intermediate. The second stage involves the rearrangement of this intermediate in the presence of a mineral acid to yield phenol and acetone.



Intermediate: Cumene Hydroperoxide

Solution:

1. Cumene is oxidized by passing air (O_2) through it in the presence of a catalyst or heat. 2. The oxygen molecule inserts itself into the tertiary $C-H$ bond of the isopropyl group. 3. This creates the intermediate 'A', which is Cumene hydroperoxide ($C_6H_5C(CH_3)_2OOH$). 4. In the next step, Cumene hydroperoxide is treated with dilute sulfuric acid. 5. This leads to a migration of the phenyl group to the oxygen atom, followed by hydrolysis, which splits the molecule into Phenol and Acetone. 6. This method is highly economical because both products (Phenol and Acetone) have significant industrial demand.

Final Answer: The intermediate 'A' is Cumene hydroperoxide.

Answer: (A)

Q37.

Solution

Concept:

Usually, atomic and ionic radii increase as we move down a group due to the addition of a new principal energy level. However, in the $5d$ transition series (starting from Hafnium), there is a significant deviation from this trend known as "Lanthanoid Contraction."

Solution:

1. Zirconium (Zr) belongs to the $4d$ series (Period 5), and Hafnium (Hf) belongs to the $5d$ series (Period 6). 2. Between the elements of the $4d$ and $5d$ series in the same group, 14 lanthanoid elements ($Z = 58$ to 71) are present. 3. In these 14 elements, the $4f$ subshell is being filled. The $4f$ electrons have poor shielding power due to the diffused shape of their orbitals. 4. Consequently, the effective nuclear charge increases significantly, pulling the outer electrons closer to the nucleus. 5. This contraction in size (Lanthanoid Contraction) almost perfectly offsets the expected increase in size due to the addition of the 6th shell. 6. As a result, Zr and Hf have nearly identical atomic radii ($\approx$ 160 pm) and ionic radii.

Final Answer: The similarity is due to Lanthanoid contraction.

Answer: (B)

Q38.

Solution

Concept:

Silicates make up a large portion of the Earth's crust. Despite the immense variety of silicate minerals (zeolites, mica, asbestos, etc.), they all share a fundamental structural building block based on the coordination of Silicon and Oxygen.

Solution:

1. In all silicates, the central Silicon atom is sp^3 hybridized. 2. It is bonded to four Oxygen atoms in a tetrahedral geometry. 3. Each Oxygen atom carries a partial negative charge, resulting in the discrete unit $[SiO_4]^{4-}$. 4. In this tetrahedron, the Si atom is at the center and the four O atoms are at the four corners. 5. These units can exist as discrete ions or can link together by sharing one, two, three, or all four oxygen atoms at the corners to form chains, sheets, or three-dimensional networks. 6. Thus, the basic structural unit is the SiO_4^{4-} tetrahedron.

Final Answer: The basic structural unit is SiO_4^{4-}.

Answer: (D)

Q39.

Solution

Concept:

Organometallic compounds are those that contain at least one direct bond between a carbon atom of an organic group and a metal atom. These are classified based on the nature of the metal-carbon bond: 1. **σ-bonded compounds:** The metal and carbon are linked by a standard sigma bond (e.g., Grignard's reagent, Alkyl lithium). 2. **π-bonded compounds:** The metal atom is bonded to the π-electron cloud of an organic system (e.g., Ferrocene, Zeise's salt).

Solution:

1. In Grignard's reagent ($R - Mg - X$), the carbon of the alkyl group is directly attached to the Magnesium atom through a single covalent σ-bond. 2. Ferrocene ($Fe(\eta^5 - C_5H_5)_2$), Cobaltocene, and Ruthenocene are "sandwich" compounds. 3. In these metallocenes, the metal ion is located between two parallel cyclopentadienyl rings and is bonded to the π-electrons of the rings, not through a single localized σ-bond. 4. Therefore, only Grignard's reagent fits the definition of a σ-bonded organometallic compound among the choices.

Final Answer: Grignard's reagent is a σ-bonded organometallic compound.

Answer: (A)

Q40.

Solution

Concept:

Natural polymers are substances derived from plants or animals. Rubber is a naturally occurring polymer obtained as latex from the bark of rubber trees. Chemically, natural rubber is a linear polymer of isoprene (2-methyl-1,3-butadiene).

Solution:

1. Isoprene undergoes polymerization to form polyisoprene. 2. Polyisoprene can exist in two geometric isomeric forms: *cis* and *trans*. 3. Natural rubber is specifically the *cis-1,4-polyisoprene* form. 4. In this form, the polymer chains are held together by weak van der Waals interactions and have a coiled structure, which gives rubber its characteristic elasticity. 5. The *trans-1,4-polyisoprene* isomer is known as Gutta-percha, which is much less elastic and is not the primary constituent of natural rubber. 6. Polybutadiene and Poly(Butadiene-styrene) are synthetic rubbers.

Final Answer: Natural polymer is cis-1,4-polyisoprene.

Answer: (C)

Q41.

Solution

Concept:

The biological importance of alkaline earth metals is significant in cellular processes. Magnesium (Mg^{2+}) and Calcium (Ca^{2+}) ions are essential for various physiological functions. Specifically, enzymes that catalyze the transfer of phosphate groups from ATP (Adenosine Triphosphate) to a substrate require a divalent metal cation to stabilize the negatively charged phosphate groups and facilitate the reaction.

Solution:

1. ATP exists in the cell primarily as a complex with a metal ion. 2. The most common cofactor for enzymes involving ATP (such as kinases) is Magnesium (Mg^{2+}). 3. The Mg^{2+} ion coordinates with the oxygen atoms of the triphosphate chain, neutralizing some of the negative charge and making the phosphorus atom more susceptible to nucleophilic attack. 4. While Calcium is involved in muscle contraction and blood clotting, it is Magnesium that acts as the primary cofactor for over 300 enzymatic reactions involving ATP and phosphate transfer. 5. Therefore, Magnesium is the essential alkaline earth metal required for this specific metabolic process.

Final Answer: The metal cofactor is Magnesium (Mg).

Answer: (B)

Q42.

Solution

Concept:

Sucrose ($C_{12}H_{22}O_{11}$) is a non-reducing disaccharide, commonly known as table sugar. It is composed of two monosaccharide units joined by a glycosidic linkage between the $C1$ of an α-glucose unit and the $C2$ of a β-fructose unit. Hydrolysis of sucrose, often called "Inversion of Sugar," yields its constituent monosaccharides.

Solution:

1. When sucrose is hydrolyzed by dilute acid or the enzyme invertase, the glycosidic bond breaks.
2. The reaction is:

$$\text{Sucrose} + H_2O \rightarrow D\text{-Glucose} + D\text{-Fructose}$$

3. Specifically, the stereochemistry of the units in sucrose dictates the products: - One molecule of α-D-Glucose. - One molecule of β-D-Fructose. 4. Sucrose is dextrorotatory, but the resulting mixture is levorotatory because the levorotation of fructose (-92.4°) is greater than the dextrorotation of glucose ($+52.7^\circ$). 5. This is why the product is called "invert sugar."

Final Answer: Sucrose gives α-D-Glucose and β-D-Fructose.

Answer: (B)

Q43.

Solution

Concept:

This is a redox reaction where Potassium Permanganate ($KMnO_4$) acts as a strong oxidizing agent and Hydrogen Peroxide (H_2O_2) acts as a reducing agent in an acidic medium. In an acidic medium, the Manganese in $KMnO_4$ (oxidation state +7) is reduced to Mn^{2+}.

Solution:

1. The half-reaction for the reduction of permanganate in acid is:

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$$

2. The half-reaction for the oxidation of hydrogen peroxide is:

$$H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$$

3. Combining the two balanced half-reactions:

$$2MnO_4^- + 6H^+ + 5H_2O_2 \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$$

4. During this reaction, the purple color of the permanganate solution disappears as it is converted to the almost colorless Mn^{2+} ion. 5. The Oxygen in H_2O_2 (oxidation state -1) is oxidized to molecular Oxygen (O_2) with an oxidation state of 0.

Final Answer: The reaction results in the formation of Mn^{2+} and O_2.

Answer: (B)

Q44.

Solution

Concept:

Isomerism in coordination compounds can be structural or stereochemical. 1. **Linkage Isomerism:** Occurs when an ambidentate ligand (like NO_2^-, SCN^-, or CN^-) can bind to the central metal atom through different donor atoms. 2. **Ionization Isomerism:** Occurs when the counter ion in a complex salt is itself a potential ligand and can displace a ligand.

Solution:

1. The complex is $[Co(NH_3)_5(NO_2)]Cl_2$. 2. The ligand NO_2^- is an ambidentate ligand. 3. It can coordinate to the Cobalt (Co) atom through the Nitrogen atom (Nitro form: $-NO_2$) or through the Oxygen atom (Nitrito form: $-ONO$). 4. The two resulting isomers are: - $[Co(NH_3)_5(NO_2)]Cl_2$ (Pentaamminenitrocobalt(III) chloride) - $[Co(NH_3)_5(ONO)]Cl_2$ (Pentaamminenitritocobalt(III) chloride) 5. Since the connectivity of the ligand to the metal changes, this is a classic example of linkage isomerism.

Final Answer: The complex shows linkage isomerism.

Answer: (B)

Q45.

Solution

Concept:

Ionization enthalpy generally increases from left to right across a period due to increasing effective nuclear charge. However, there are exceptions due to the stability of fully filled and half-filled electronic configurations. - Be ($1s^2 2s^2$) has a fully filled subshell, making it more stable than B ($1s^2 2s^2 2p^1$). - N ($1s^2 2s^2 2p^3$) has a half-filled subshell, making it more stable than O ($1s^2 2s^2 2p^4$).

Solution:

1. General trend: $Li < B < Be < C < O < N < F < Ne$. 2. Between Be and B: Be has a higher ionization enthalpy than B because removing an electron from a stable $2s^2$ subshell requires more energy than from a $2p^1$ subshell. 3. Between N and O: N has a higher ionization enthalpy than O because N has a stable half-filled p-subshell ($2p^3$). Removing an electron from O ($2p^4$) is easier because it results in a more stable p^3 configuration and reduces electron-electron repulsion. 4. Therefore, the correct increasing order is:

$$Li < B < Be < C < O < N < F < Ne$$

Final Answer: The correct order is $Li < B < Be < C < O < N < F < Ne$.

Answer: (B)

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	C	3	A	4	A	5	A
6	B	7	D	8	B	9	B	10	B
11	B	12	C	13	C	14	C	15	A
16	D	17	B	18	A	19	B	20	B
21	A	22	B	23	B	24	A	25	C
26	A	27	A	28	D	29	B	30	C
31	A	32	C	33	A	34	B	35	B
36	A	37	B	38	D	39	A	40	C
41	B	42	B	43	B	44	B	45	B