MHT-CET Chemistry Sample Paper-2

Duration: 45 Minutes **Maximum Marks: 50**

Instructions

- This paper contains a total of **50** Multiple Choice Questions.
- Each correct answer carries **+1 marks**.
- No negative marking for incorrect questions.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.
- No marks will be deducted for questions that are left unattempted.

Q1. Which of the following molecules has the highest dipole moment considering the effect of resonance and inductive effects?

(A) Chlorobenzene

(B) *o*-Dichlorobenzene

(C) *m*-Dichlorobenzene

(D) *p*-Dichlorobenzene

Q2. The most stable carbocation among the following is:

(A) $(C_6H_5)_3C^+$

(B) $(CH_3)_3C^+$

(C) $C_6H_5CH_2^+$

(D) $CH_2 = CH - CH_2^+$

Q3. Which of the following compounds will exhibit geometrical isomerism?

(A) 1-Phenyl-2-butene

(B) 3-Phenyl-1-butene

(C) 2-Phenyl-1-butene

(D) 1, 1-Diphenyl-1-propene

Q4. The total number of chiral centers present in the open-chain structure of D-glucose is:

(A) 3

(B) 4

(C) 5

(D) 6

Q5. In the following reaction: $C_2H_2 \xrightarrow[HgSO_4]{H_2SO_4} A \xrightarrow[i)CH_3MgBr]{ii)H_2O} B$. The compound B is:

(A) Ethanol

(B) Propan-2-ol

(C) Propan-1-ol

(D) Ethanal

Q6. The correct order of increasing acid strength of the following compounds is: (I) Phenol, (II) *p*-Nitrophenol, (III) *m*-Nitrophenol, (IV) *p*-Cresol.

(A) $IV < I < III < II$

(B) $I < IV < III < II$

(C) $IV < I < II < III$

(D) $I < IV < II < III$

Q7. An organic compound 'X' with molecular formula $C_5H_{10}O$ forms a 2,4-DNP derivative, but does not reduce Tollen's reagent and does not give a positive iodoform test. 'X' is:

(A) Pentan-2-one

(B) Pentan-3-one

(C) Pentanal

(D) 2,2-Dimethylpropanal

Q8. The reaction of $CH_3CH_2NH_2$ with $CHCl_3$ and alcoholic KOH gives an offensive smelling compound. The structure of that compound is:

(A) CH_3CH_2NC

(B) CH_3CH_2CN

(C) $CH_3CH_2NHCH_3$

(D) $CH_3CH_2NH_2$

Q9. Which of the following is a biodegradable polymer?

(A) Buna-S

(B) Nylon-6,6

(C) PHBV

(D) Nylon-6

Q10. According to VSEPR theory, the geometry of XeF_4 is:

(A) Tetrahedral

(B) Square planar

(C) Octahedral

(D) Pyramidal

Q11. The hybridization of the central atom in ICl_2^- is:

(A) sp^3

(B) sp^3d

(C) sp^3d^2

(D) sp^2

Q12. The number of unpaired electrons in the complex $[CoF_6]^{3-}$ is: (Atomic number of $Co = 27$)

(A) 0

(B) 2

(C) 3

(D) 4

Q13. Which of the following p-block elements does not show an allotropic form?

(A) Nitrogen

(B) Phosphorus

(C) Arsenic

(D) Antimony

Q14. The spin-only magnetic moment of Ti^{3+} ion is:

(A) 1.73 BM

(B) 2.83 BM

(C) 3.87 BM

(D) 4.90 BM

Q15. The standard reduction potentials of three metals A, B, and C are +0.5 V, −3.0 V, and −1.2 V respectively. The reducing power of these metals will be in the order:

(A) $A > B > C$

(B) $C > B > A$

(C) $A > C > B$

(D) $B > C > A$

Q16. The number of atoms in 0.1 mol of a triatomic gas is: ($N_A = 6.02 \times 10^{23}$ mol^{-1})

(A) 6.02×10^{22}

(B) 1.806×10^{23}

(C) 3.6×10^{23}

(D) 1.806×10^{22}

Q17. Which of the following electronic transitions in a Hydrogen atom will emit a photon of the highest energy?

(A) $n = 2$ to $n = 1$

(B) $n = 3$ to $n = 2$

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

(D) $n = 5$ to $n = 4$

Q18. For a reversible process at equilibrium, the change in Gibbs free energy (ΔG) is:

(A) Positive

(B) Negative

(C) Zero

(D) Infinite

Q19. The solubility product (K_{sp}) of a sparingly soluble salt AB_2 is 3.2×10^{-11}. Its solubility in pure water is:

(A) 2×10^{-4} mol/L

(B) 4×10^{-4} mol/L

(C) 8×10^{-4} mol/L

(D) 1.6×10^{-4} mol/L

Q20. The amount of electricity required to deposit 1.08 g of Silver from $AgNO_3$ solution is: (Atomic mass of $Ag = 108$)

(A) 965 C

(B) 9650 C

(C) 1 F

(D) 0.1 F

Q21. The IUPAC name of the compound $CH_3 - CH(Cl) - CH(Br) - CH_3$ is:

(A) 2-Bromo-3-chlorobutane

(B) 3-Bromo-2-chlorobutane

(C) 2-Chloro-3-bromobutane

(D) 3-Chloro-2-bromobutane

Q22. Which of the following hydrocarbons is most acidic?

(A) Ethane

(B) Ethene

(C) Ethyne

(D) Benzene

Q23. When Ethyl bromide is treated with silver cyanide, the major product is:

(A) Ethyl cyanide

(B) Ethyl isocyanide

(C) Ethyl nitrite

(D) Nitroethane

Q24. The Lucas reagent is a mixture of:

(A) Conc. HCl + Anhydrous $ZnCl_2$

(B) Conc. HNO_3 + Anhydrous $ZnCl_2$

(C) Conc. HCl + Hydrated $ZnCl_2$

(D) Conc. H_2SO_4 + Anhydrous $ZnCl_2$

Q25. In the Rossemund reduction, the catalyst used is:

(A) $Pd/BaSO_4$

(B) Sn/HCl

(C) $LiAlH_4$

(D) $NaBH_4$

Q26. Which of the following bases is NOT present in DNA?

(A) Adenine

(B) Guanine

(C) Cytosine

(D) Uracil

Q27. The shape of SF_6 molecule according to VSEPR theory is:

(A) Trigonal bipyramidal

(B) Square planar

(C) Octahedral

(D) Tetrahedral

Q28. Which of the following complexes is diamagnetic? (Atomic No: $Fe = 26, Co = 27, Ni = 28$)

(A) $[Ni(CN)_4]^{2-}$

(B) $[NiCl_4]^{2-}$

(C) $[CoF_6]^{3-}$

(D) $[FeF_6]^{3-}$

Q29. The most electronegative element among the following is:

(A) Oxygen

(B) Nitrogen

(C) Fluorine

(D) Chlorine

Q30. The element with the highest second ionization enthalpy is:

(A) Li

(B) Be

(C) B

(D) C

Q31. The oxidation state of Phosphorus in $Ba(H_2PO_2)_2$ is:

(A) +3

(B) +1

(C) +5

(D) −1

Q32. Which of the following noble gases is used in magnetic resonance imaging (MRI)?

(A) He

(B) Ne

(C) Ar

(D) Kr

Q33. The reaction of 1-butene with HBr in the presence of peroxide gives:

(A) 1-Bromobutane

(B) 2-Bromobutane

(C) 1, 2-Dibromobutane

(D) 2, 3-Dibromobutane

Q34. Phenol reacts with $CHCl_3$ and aqueous $NaOH$ to give salicylaldehyde. This reaction is known as:

(A) Reimer-Tiemann reaction

(B) Kolbe's reaction

(C) Rosenmund reaction

(D) Stephen's reaction

Q35. The monomer of Neoprene is:

(A) Isoprene

(B) Chloroprene

(C) Acrylonitrile

(D) Vinyl chloride

Q36. Which of the following is a transition element?

(A) Zn

(B) Cd

(C) Hg

(D) Fe

Q37. The number of radial nodes in $3p$ orbital is:

(A) 0

(B) 1

(C) 2

(D) 3

Q38. For the reaction $N_2 + 3H_2 \rightleftharpoons 2NH_3$, the relationship between K_p and K_c is:

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

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

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

(D) $K_p = K_c(RT)$

Q39. The unit of rate constant for a second-order reaction is:

(A) s^{-1}

(B) mol L^{-1} s^{-1}

(C) L mol^{-1} s^{-1}

(D) L^2 mol^{-2} s^{-1}

Q40. Which of the following is an outer orbital complex?

(A) $[Co(NH_3)_6]^{3+}$

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

(C) $[FeF_6]^{3-}$

(D) $[Fe(CN)_6]^{3-}$

Q41. Which of the following aqueous solutions will have the highest boiling point?

(A) 0.1 M $NaCl$

(B) 0.1 M $BaCl_2$

(C) 0.1 M Urea

(D) 0.1 M $FeCl_3$

Q42. The number of tetrahedral and octahedral voids in a ccp unit cell are respectively:

(A) 4, 8

(B) 8, 4

(C) 12, 6

(D) 6, 12

Q43. For a first-order reaction, the time required for 99.9% completion is approximately how many times the half-life ($t_{1/2}$)?

(A) 2 times

(B) 4 times

(C) 10 times

(D) 100 times

Q44. Which of the following is a neutral amino acid?

(A) Lysine

(B) Glycine

(C) Aspartic acid

(D) Glutamic acid

Q45. The structure of XeF_2 is:

(A) Linear

(B) Bent

(C) V-shaped

(D) Trigonal planar

Q46. Which of the following will give a positive Fehling's test?

(A) Benzaldehyde

(B) Acetone

(C) Acetaldehyde

(D) Ethyl methyl ketone

Q47. The rate of a chemical reaction doubles for every 10°C rise in temperature. If the temperature is increased from 10°C to 50°C, the rate of reaction increases by:

(A) 8 times

(B) 16 times

(C) 32 times

(D) 64 times

Q48. The osmotic pressure of a solution can be increased by:

(A) Increasing the temperature

(B) Decreasing the concentration

(C) Increasing the volume

(D) Decreasing the number of solute particles

Q49. Which of the following is an example of an addition polymer?

(A) Nylon-6,6

(B) Terylene

(C) Polyethene

(D) Bakelite

Q50. In which of the following pairs do both species have the same geometry?

(A) BF_3, NH_3

(B) CH_4, NH_4^+

(C) XeF_2, CO_2

(D) CO_2, SO_2

Detailed Solutions

Q1.

Solution

Concept:

The dipole moment of a molecule depends on the vector sum of individual bond moments. In substituted benzenes, the positions of substituents (ortho, meta, para) significantly affect the resultant vector. Additionally, for atoms like Chlorine, the $-I$ effect (inductive) and $+R$ effect (resonance) are present, though $-I > +R$ for halogens.

Solution:

1. Chlorobenzene has a single $C - Cl$ bond moment. 2. In p-Dichlorobenzene, the two $C - Cl$ bond moments are at 180 degrees to each other. They cancel out perfectly, resulting in a dipole moment of zero. 3. In m-Dichlorobenzene, the angle between the two $C - Cl$ vectors is 120 degrees. 4. In o-Dichlorobenzene, the angle between the two $C - Cl$ vectors is 60 degrees. 5. The resultant dipole moment μ is calculated using the formula:

$$\mu_{res} = \sqrt{\mu_1^2 + \mu_2^2 + 2\mu_1\mu_2 \cos\theta}$$

6. Since $\cos(60°)$ is greater than $\cos(120°)$ and $\cos(180°)$, the value of μ is maximum when the angle θ is minimum. 7. Therefore, o-Dichlorobenzene has the highest dipole moment.

Final Answer: The correct option is o-Dichlorobenzene.

Answer: (B)

Q2.

Solution

Concept:

Carbocation stability is determined by resonance, hyperconjugation, and inductive effects. Resonance (delocalization) generally provides more stability than hyperconjugation.

Solution:

1. $(C_6H_5)_3C^+$ (Triphenylmethyl carbocation): The positive charge is in conjugation with three benzene rings. This allows for extensive delocalization through resonance across all three rings, providing exceptional stability. 2. $(CH_3)_3C^+$ (Tertiary butyl carbocation): This is stabilized by 9 alpha-hydrogens providing hyperconjugation and three $+I$ groups. While stable, resonance is usually a stronger stabilizing factor than hyperconjugation. 3. $C_6H_5CH_2^+$ (Benzyl carbocation): Stabilized by resonance with only one benzene ring. 4. $CH_2 = CH - CH_2^+$ (Allyl carbocation): Stabilized by resonance with one double bond. 5. Comparing $(C_6H_5)_3C^+$ and others, the extent of delocalization is highest in the triphenylmethyl carbocation.

Final Answer: The most stable carbocation is $(C_6H_5)_3C^+$.

Answer: (A)

Q3.

Solution

Concept:

Geometrical isomerism (cis-trans or E-Z) occurs in alkenes when each carbon atom of the double bond is attached to two different groups. If either carbon of the double bond has two identical groups, geometrical isomerism is not possible.

Solution:

1. 1-Phenyl-2-butene: The structure is $C_6H_5-CH_2-CH=CH-CH_3$. The double bond is at C_2. One carbon has H and $CH_2C_6H_5$, the other has H and CH_3. Since both carbons have two different groups, it exhibits geometrical isomerism. 2. 3-Phenyl-1-butene: $CH_2=CH-CH(C_6H_5)CH_3$. The terminal carbon has two H atoms. No geometrical isomerism. 3. 2-Phenyl-1-butene: $CH_2=C(C_6H_5)CH_2CH_3$. The terminal carbon has two H atoms. No geometrical isomerism. 4. 1, 1-Diphenyl-1-propene: $(C_6H_5)_2C=CH-CH_3$. One carbon has two C_6H_5 groups. No geometrical isomerism.

Final Answer: The compound that exhibits geometrical isomerism is 1-Phenyl-2-butene.

Answer: (A)

Q4.

Solution

Concept:

A chiral center (or asymmetric carbon) is a carbon atom attached to four different groups. In the open-chain form of an aldohexose like D-glucose, we examine each carbon in the chain.

Solution:

1. The structure of D-glucose is $CHO-(CHOH)_4-CH_2OH$. 2. C_1: It is part of an aldehyde group (CHO), so it is not chiral (double bond to Oxygen). 3. C_2: Attached to CHO, H, OH, and the rest of the carbon chain (C_3-C_6). It is chiral. 4. C_3: Attached to C_2 group, H, OH, and C_4-C_6. It is chiral. 5. C_4: Attached to C_3 group, H, OH, and C_5-C_6. It is chiral. 6. C_5: Attached to C_4 group, H, OH, and CH_2OH. It is chiral. 7. C_6: Attached to two H atoms (CH_2OH), so it is not chiral. 8. Total chiral centers = $C_2, C_3, C_4, C_5 = 4$.

Final Answer: There are 4 chiral centers.

Answer: (B)

Q5.

Solution

Concept:

This is a two-step synthesis involving Kucherov's reaction (hydration of alkynes) followed by a Grignard reaction with a carbonyl compound.

Solution:

1. Step 1: C_2H_2 (Ethyne) reacts with H_2O in the presence of $HgSO_4/H_2SO_4$. This is hydration. 2. $CH \equiv CH + H_2O \rightarrow [CH_2 = CH - OH]$ (enol) $\rightleftharpoons CH_3 - CHO$ (Ethanal). 3. Therefore, Compound A is Ethanal (Acetaldehyde). 4. Step 2: Grignard reagent CH_3MgBr reacts with Ethanal. 5. $CH_3 - CHO + CH_3MgBr \rightarrow CH_3 - CH(OMgBr) - CH_3$. 6. Step 3: Acidic hydrolysis (H_2O/H^+). 7. $CH_3 - CH(OMgBr) - CH_3 \xrightarrow{H_2O} CH_3 - CH(OH) - CH_3$. 8. The final product B is Propan-2-ol (Isopropyl alcohol).

Final Answer: Compound B is Propan-2-ol.

Answer: (B)

Q6.

Solution

Concept:

The acidity of phenols is governed by the stability of the phenoxide ion formed after the loss of a proton (H^+). Electron-withdrawing groups (EWG) like $-NO_2$ increase acidity by stabilizing the negative charge through $-I$ and $-R$ effects. Electron-donating groups (EDG) like $-CH_3$ decrease acidity by destabilizing the phenoxide ion through $+I$ and hyperconjugation.

Solution:

1. **(II) p-Nitrophenol:** The $-NO_2$ group at the para position exerts both $-I$ and strong $-R$ effects, significantly stabilizing the phenoxide ion. It is the most acidic. 2. **(III) m-Nitrophenol:** The $-NO_2$ group at the meta position exerts only the $-I$ effect (resonance does not operate at the meta position). It is more acidic than phenol but less than p-nitrophenol. 3. **(I) Phenol:** This is the reference compound with no substituents. 4. **(IV) p-Cresol:** The $-CH_3$ group at the para position is an EDG ($+I$ and hyperconjugation). It destabilizes the phenoxide ion, making it the least acidic among the group. 5. Therefore, the increasing order of acid strength is: p-Cresol < Phenol < m-Nitrophenol < p-Nitrophenol.

Final Answer: The correct order is $IV < I < III < II$.

Answer: (A)

Q7.

Solution

Concept:

The molecular formula $C_5H_{10}O$ belongs to the general formula $C_nH_{2n}O$, which corresponds to saturated aldehydes or ketones. - **2,4-DNP test:** Positive for both aldehydes and ketones. - **Tollen's test:** Positive for aldehydes, negative for ketones. - **Iodoform test:** Positive for methyl ketones ($CH_3 - CO - R$) or methyl alcohols ($CH_3 - CH(OH) - R$).

Solution:

1. The compound 'X' reacts with 2,4-DNP, confirming it is a carbonyl compound (aldehyde or ketone). 2. It does **not** reduce Tollen's reagent, meaning it is **not** an aldehyde. Thus, 'X' is a ketone. 3. It does **not** give a positive iodoform test, meaning it is **not** a methyl ketone (it does not have a $CH_3 - CO-$ group). 4. Let's evaluate the options: - Pentan-2-one: $CH_3 - CO - CH_2CH_2CH_3$. It is a methyl ketone (Iodoform positive). Incorrect. - Pentan-3-one: $CH_3CH_2 - CO - CH_2CH_3$. It is a ketone (Tollen's negative) but not a methyl ketone (Iodoform negative). Matches all criteria. - Pentanal: Aldehyde (Tollen's positive). Incorrect. - 2,2-Dimethylpropanal: Aldehyde (Tollen's positive). Incorrect.

Final Answer: The compound 'X' is Pentan-3-one.

Answer: (B)

Q8.

Solution

Concept:

The reaction between a primary amine, chloroform ($CHCl_3$), and alcoholic KOH is known as the **Carbylamine Reaction** (or Isocyanide Test). This reaction is characteristic of primary amines.

Solution:

1. Ethylamine ($CH_3CH_2NH_2$) is a primary aliphatic amine. 2. When heated with chloroform and alcoholic KOH, primary amines undergo the carbylamine reaction to form isocyanides (carbylamines). 3. The chemical equation is:

$$CH_3CH_2NH_2 + CHCl_3 + 3KOH(alc.) \xrightarrow{\Delta} CH_3CH_2NC + 3KCl + 3H_2O$$

4. The product formed is Ethyl Isocyanide (CH_3CH_2NC), which possesses an extremely unpleasant and offensive odor. 5. Secondary and tertiary amines do not undergo this reaction.

Final Answer: The offensive smelling compound is CH_3CH_2NC.

Answer: (A)

Q9.

Solution

Concept:

Biodegradable polymers are those that can be decomposed by microorganisms (bacteria/fungi) in the environment over time. Standard synthetic polymers like polyethylene or Nylon-6,6 are generally non-biodegradable.

Solution:

1. **Buna-S:** A synthetic rubber made of butadiene and styrene. It is non-biodegradable. 2. **Nylon-6,6 and Nylon-6:** These are synthetic polyamides. While they can degrade over very long periods under specific conditions, they are classified as non-biodegradable in common contexts. 3. **PHBV (Poly-β-hydroxybutyrate-co-β-hydroxyvalerate):** This is a copolymer of 3-hydroxybutanoic acid and 3-hydroxypentanoic acid. It is a well-known aliphatic polyester produced naturally by bacteria and is fully biodegradable. 4. It is used in specialty packaging, orthopedic devices, and controlled release of drugs.

Final Answer: PHBV is a biodegradable polymer.

Answer: (C)

Q10.

Solution

Concept:

VSEPR Theory and Molecular Geometry of Noble Gas Compounds.

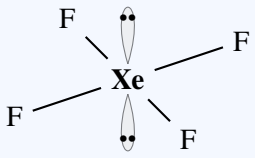
Solution:

Step 1: Calculate the steric number. Xenon (Xe) has 8 valence electrons. In XeF_4, it forms 4 sigma bonds with Fluorine atoms.

Step 2: Calculate lone pairs: Lone Pairs = $\frac{8-4}{2} = 2$.

Step 3: Steric Number = 4 (bond pairs) + 2 (lone pairs) = 6. The electron geometry is octahedral.

Step 4: According to VSEPR, to minimize lone pair-lone pair repulsions, the two lone pairs occupy positions 180° apart. This leaves the four Fluorine atoms in a square around the central Xenon atom.



Square Planar XeF_4

Final Answer:

Square planar

Answer: (B)

Q11.

Solution

Concept:

Hybridization and VSEPR theory for polyatomic ions.

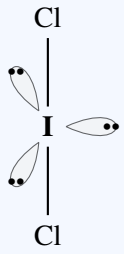
Solution:

Step 1: Identify valence electrons for the central Iodine atom (7) and add 1 for the negative charge (7 + 1 = 8).

Step 2: Iodine forms two sigma (σ) bonds with two Chlorine atoms, using 2 electrons.

Step 3: Calculate the number of lone pairs: Lone Pairs = $\frac{8-2}{2}$ = 3.

Step 4: Determine the Steric Number (SN) = 2 bond pairs + 3 lone pairs = 5. A steric number of 5 corresponds to sp^3d hybridization.



Linear Geometry (sp^3d)

Final Answer:

$$\boxed{sp^3d}$$

Answer: (B)

Q12.

Solution

Concept:

The number of unpaired electrons depends on the oxidation state of the central metal, its electronic configuration, and the strength of the ligands (Crystal Field Theory).

Solution:

1. In $[CoF_6]^{3-}$, let the oxidation state of Co be x.

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

2. The atomic number of Co is 27. The ground state configuration is $[Ar]3d^7 4s^2$. 3. For Co^{3+}, the configuration is $[Ar]3d^6$. 4. F^- is a weak field ligand. According to Spectrochemical Series, it does not cause pairing of electrons in the $3d$ orbitals. 5. In an octahedral field, the d^6 configuration with a weak field ligand follows Hund's rule: - t_{2g} orbitals get 4 electrons (one pair and two unpaired). - e_g orbitals get 2 electrons (both unpaired). 6. Total unpaired electrons = 3 + 1 = 4 (or simply, 4 electrons remain unpaired in the $3d$ subshell as they don't pair up).

Final Answer: The number of unpaired electrons is 4.

Answer: (D)

Q13.

Solution

Concept:

Allotropy is the property of some chemical elements to exist in two or more different forms, in the same physical state. Most p-block elements, especially in the nitrogen and carbon families, exhibit allotropy.

Solution:

1. **Nitrogen (N):** While nitrogen exists as N_2 gas under standard conditions, it does not show distinct allotropic forms like its heavier congeners in the same group under normal laboratory conditions. 2. **Phosphorus (P):** Exhibits several allotropic forms such as White, Red, and Black phosphorus. 3. **Arsenic (As):** Exhibits allotropes like Yellow, Gray (metallic), and Black arsenic. 4. **Antimony (Sb):** Exhibits allotropes like Blue-white (metallic), Yellow, and Explosive antimony. 5. Among the given options, Nitrogen is the element that lacks standard allotropic variations compared to the solid-state structural variations of P, As, and Sb.

Final Answer: Nitrogen does not show an allotropic form.

Answer: (A)

Q14.

Solution

Concept:

The spin-only magnetic moment (μ_s) is calculated using the formula:

$$\mu_s = \sqrt{n(n+2)}\ \text{BM}$$

where n is the number of unpaired electrons.

Solution:

1. The atomic number of Titanium (Ti) is 22. 2. The ground state electronic configuration is $[Ar]3d^2 4s^2$. 3. For the Ti^{3+} ion, three electrons are removed (two from $4s$ and one from $3d$). 4. The electronic configuration of Ti^{3+} is $[Ar]3d^1$. 5. The number of unpaired electrons (n) is 1. 6. Applying the formula:

$$\mu_s = \sqrt{1(1+2)} = \sqrt{3}$$

7. The value of $\sqrt{3}$ is approximately 1.732. 8. Therefore, the magnetic moment is 1.73 BM.

Final Answer: The spin-only magnetic moment is 1.73 BM.

Answer: (A)

Q15.

Solution

Concept:

Reducing power refers to the ability of a substance to reduce others by getting oxidized itself. A substance with a lower (more negative) standard reduction potential (E°) has a greater tendency to lose electrons and thus acts as a stronger reducing agent.

Solution:

1. The given standard reduction potentials are: - E°_A = +0.5 V - E°_B = −3.0 V - E°_C = −1.2 V 2. Compare the values: $-3.0 < -1.2 < +0.5$. 3. The lower the reduction potential, the higher the reducing power. 4. Metal B has the lowest potential (−3.0 V), so it is the strongest reducing agent. 5. Metal C is the next (−1.2 V). 6. Metal A has the highest potential (+0.5 V), making it the weakest reducing agent among the three. 7. The order of reducing power is $B > C > A$.

Final Answer: The order is $B > C > A$.

Answer: (D)

Q16.

Solution

Concept:

The number of atoms in a given amount of gas is calculated by first finding the number of molecules and then multiplying by the atomicity of the gas (the number of atoms per molecule).

Solution:

1. The number of moles of the triatomic gas is $n = 0.1$ mol. 2. The number of molecules is calculated using Avogadro's number (N_A):

$$\text{Number of molecules} = n \times N_A = 0.1 \times 6.02 \times 10^{23} = 6.02 \times 10^{22} \text{ molecules}$$

3. Since the gas is triatomic, each molecule contains 3 atoms. 4. Total number of atoms = $3 \times$ Number of molecules:

$$\text{Total atoms} = 3 \times 6.02 \times 10^{22} = 18.06 \times 10^{22} = 1.806 \times 10^{23} \text{ atoms}$$

Final Answer: The number of atoms is 1.806×10^{23}.

Answer: (B)

Q17.

Solution

Concept:

The energy of an emitted photon during an electronic transition in a Hydrogen atom is given by the Rydberg formula:

$$\Delta E = 13.6\left(\frac{1}{n_{final}^2} - \frac{1}{n_{initial}^2}\right) \text{ eV}$$

The energy gap between successive shells decreases as n increases.

Solution:

1. Transition $n = 2$ to $n = 1$:

$$\Delta E_1 = 13.6\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = 13.6 \times 0.75 = 10.2 \text{ eV}$$

2. Transition $n = 3$ to $n = 2$:

$$\Delta E_2 = 13.6\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = 13.6 \times (0.25 - 0.11) \approx 1.89 \text{ eV}$$

3. Transition $n = 4$ to $n = 3$:

$$\Delta E_3 = 13.6\left(\frac{1}{3^2} - \frac{1}{4^2}\right) = 13.6 \times (0.11 - 0.06) \approx 0.68 \text{ eV}$$

4. Transition $n = 5$ to $n = 4$:

$$\Delta E_4 = 13.6\left(\frac{1}{4^2} - \frac{1}{5^2}\right) = 13.6 \times (0.0625 - 0.04) \approx 0.31 \text{ eV}$$

5. The transition to the ground state ($n = 1$) always involves much larger energy gaps than transitions between higher shells.

Final Answer: The highest energy is emitted in the $n = 2$ to $n = 1$ transition.

Answer: (A)

Q18.

Solution

Concept:

Gibbs free energy (ΔG) is a thermodynamic potential that can be used to calculate the maximum reversible work that may be performed by a thermodynamic system at a constant temperature and pressure. It also serves as a criterion for spontaneity and equilibrium.

Solution:

1. For a spontaneous process at constant T and P, $\Delta G < 0$ (Negative). 2. For a non-spontaneous process, $\Delta G > 0$ (Positive). 3. At the point of chemical equilibrium, there is no net change in the system, and the system can no longer perform useful work. 4. Therefore, at equilibrium, the change in Gibbs free energy is exactly zero.

$$\Delta G = 0$$

Final Answer: For a process at equilibrium, ΔG is zero.

Answer: (C)

Q19.

Solution

Concept:

For a salt of the type AB_2, the dissociation in water is:

$$AB_2(s) \rightleftharpoons A^{2+}(aq) + 2B^-(aq)$$

If the solubility is S, then $[A^{2+}] = S$ and $[B^-] = 2S$.

Solution:

1. The expression for the solubility product K_{sp} is:

$$K_{sp} = [A^{2+}][B^-]^2 = (S)(2S)^2 = 4S^3$$

2. Given $K_{sp} = 3.2 \times 10^{-11}$. 3. Set up the equation:

$$4S^3 = 3.2 \times 10^{-11}$$

$$S^3 = \frac{3.2 \times 10^{-11}}{4} = 0.8 \times 10^{-11} = 8 \times 10^{-12}$$

4. Taking the cube root:

$$S = \sqrt[3]{8 \times 10^{-12}} = 2 \times 10^{-4} \text{ mol/L}$$

Final Answer: The solubility is 2×10^{-4} mol/L.

Answer: (A)

Q20.

Solution

Concept:

According to Faraday's First Law of Electrolysis, the mass of a substance deposited is proportional to the quantity of electricity passed. For Silver (Ag^+), the reduction reaction is:

$$Ag^+ + e^- \rightarrow Ag(s)$$

This means 1 mole of electrons (1 Faraday) deposits 1 mole of Silver.

Solution:

1. 1 mole of Ag = 108 g. 2. Amount of Silver to be deposited = 1.08 g. 3. Number of moles of Ag = $\frac{\text{Given mass}}{\text{Molar mass}}$ = $\frac{1.08}{108}$ = 0.01 moles. 4. Since 1 mole of Ag requires 1 Faraday (1 F) of electricity, 0.01 moles will require:

$$\text{Electricity} = 0.01 \text{ F}$$

5. Convert Faraday to Coulombs (1 F $\approx$ 96500 C):

$$\text{Electricity in Coulombs} = 0.01 \times 96500 = 965 \text{ C}$$

Final Answer: The amount of electricity required is 965 C.

Answer: (A)

Q21.

Solution

Concept:

IUPAC nomenclature rules require selecting the longest carbon chain and numbering it such that the substituents get the lowest possible locants. If locants are identical from both ends, numbering is decided alphabetically.

Solution:

1. The parent chain of $CH_3 - CH(Cl) - CH(Br) - CH_3$ consists of 4 carbon atoms, making it a butane derivative. 2. Numbering from left to right gives substituents at positions 2 (Chloro) and 3 (Bromo). 3. Numbering from right to left gives substituents at positions 2 (Bromo) and 3 (Chloro). 4. Since the set of locants (2,3) is the same from both ends, we follow the alphabetical order of the substituents. 5. "Bromo" comes before "Chloro" alphabetically, so the carbon attached to Bromine is assigned the lower number (2). 6. Thus, the correct name is 2-Bromo-3-chlorobutane.

Final Answer: The IUPAC name is 2-Bromo-3-chlorobutane.

Answer: (A)

Q22.

Solution

Concept:

The acidity of hydrocarbons depends on the hybridization of the carbon atom bonded to the hydrogen. The greater the s-character of the hybrid orbital, the more electronegative the carbon atom, making the $C-H$ bond more polar and the hydrogen more acidic.

Solution:

1. **Ethane (CH_3-CH_3):** Carbon is sp^3 hybridized (25% s-character). It is the least acidic. 2. **Ethene ($CH_2=CH_2$):** Carbon is sp^2 hybridized (33.3% s-character). 3. **Ethyne ($HC\equiv CH$):** Carbon is sp hybridized (50% s-character). High s-character makes the carbon atom highly electronegative, allowing it to hold the negative charge of the conjugate base (acetylide ion) very effectively. 4. **Benzene (C_6H_6):** Carbon is sp^2 hybridized. 5. Comparing sp^3, sp^2, and sp hybridizations, the acidity order is $Alkynes > Alkenes > Alkanes$.

Final Answer: Ethyne is the most acidic hydrocarbon among the choices.

Answer: (C)

Q23.

Solution

Concept:

The reaction of alkyl halides with cyanide salts depends on the nature of the bond in the nucleophile. KCN is ionic, while $AgCN$ is predominantly covalent.

Solution:

1. In $AgCN$, the bond between Silver and Carbon is covalent. Consequently, the lone pair on the Nitrogen atom is more available for nucleophilic attack. 2. When Ethyl bromide (C_2H_5Br) reacts with $AgCN$, the Nitrogen atom attacks the carbon of the ethyl group. 3. This leads to the formation of an isocyanide linkage ($R-NC$). 4. The reaction is: $C_2H_5Br + AgCN \rightarrow C_2H_5NC + AgBr$. 5. If KCN were used, the product would have been Ethyl cyanide (C_2H_5CN) because the cyanide ion is ambident and the $C-C$ bond is stronger than the $C-N$ bond.

Final Answer: The major product is Ethyl isocyanide.

Answer: (B)

Q24.

Solution

Concept:

The Lucas test is used to distinguish between primary, secondary, and tertiary alcohols based on the rate at which they react with the Lucas reagent to form alkyl chlorides.

Solution:

1. Lucas reagent consists of a mixture of Concentrated Hydrochloric acid (HCl) and Anhydrous Zinc Chloride ($ZnCl_2$). 2. The reaction involved is: $R-OH+HCl \xrightarrow{Anhyd.ZnCl_2} R-Cl+H_2O$. 3. Tertiary alcohols react immediately, producing cloudiness/turbidity. 4. Secondary alcohols react within 5 to 10 minutes. 5. Primary alcohols do not react at room temperature. 6. The anhydrous $ZnCl_2$ acts as a Lewis acid catalyst to help break the $C-O$ bond.

Final Answer: Lucas reagent is Conc. HCl + Anhydrous $ZnCl_2$.

Answer: (A)

Q25.

Solution

Concept:

The Rosenmund reduction is a hydrogenation process used specifically to convert acyl chlorides (acid chlorides) into aldehydes.

Solution:

1. In this reaction, hydrogen gas is passed through a solution of the acid chloride in the presence of a catalyst. 2. The catalyst used is Palladium (Pd) supported on Barium Sulfate ($BaSO_4$). 3. $BaSO_4$ acts as a "poison" or a deactivator for the Palladium catalyst (often along with sulfur or quinoline). 4. This poisoning is crucial because it prevents the further reduction of the resulting aldehyde into a primary alcohol. 5. The reaction is: $R-COCl+H_2 \xrightarrow{Pd/BaSO_4} R-CHO+HCl$.

Final Answer: The catalyst used is $Pd/BaSO_4$.

Answer: (A)

Q26.

Solution

Concept:

DNA (Deoxyribonucleic acid) and RNA (Ribonucleic acid) are composed of nitrogenous bases. These are categorized into Purines (Adenine and Guanine) and Pyrimidines (Cytosine, Thymine, and Uracil).

Solution:

1. DNA contains four nitrogenous bases: Adenine (A), Guanine (G), Cytosine (C), and Thymine (T). 2. RNA also contains four bases, but instead of Thymine, it contains Uracil (U). 3. Adenine, Guanine, and Cytosine are common to both DNA and RNA. 4. Uracil is strictly a component of RNA and is not found in the DNA structure under normal biological conditions.

Final Answer: Uracil is NOT present in DNA.

Answer: (D)

Q27.

Solution

Concept:

VSEPR Theory and Geometry of Hypervalent Molecules.

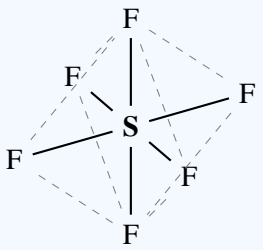
Solution:

Step 1: Identify the central atom, Sulfur (S), which has 6 valence electrons.

Step 2: Sulfur forms 6 sigma (σ) bonds with 6 Fluorine atoms.

Step 3: Calculate lone pairs: Lone Pairs = $\frac{6-6}{2} = 0$.

Step 4: Determine the Steric Number (SN) = 6 bond pairs + 0 lone pairs = 6. According to VSEPR theory, a steric number of 6 with no lone pairs results in an octahedral shape.



Octahedral Geometry (sp^3d^2)

Final Answer:

Octahedral

Answer: (C)

Q28.

Solution

Concept:

Magnetism in coordination compounds is determined by the presence of unpaired electrons. A diamagnetic complex has all its electrons paired, while a paramagnetic complex has one or more unpaired electrons. This is influenced by the oxidation state of the metal and the strength of the ligand.

Solution:

1. **$[Ni(CN)_4]^{2-}$:** Ni is in +2 state ($3d^8$). CN^- is a strong field ligand, causing pairing of electrons in the d orbitals. The configuration becomes $d_{xy}^2, d_{yz}^2, d_{zx}^2, d_{z^2}^2$, leaving $d_{x^2-y^2}$ empty for dsp^2 hybridization. No unpaired electrons exist. It is diamagnetic. 2. **$[NiCl_4]^{2-}$:** Ni^{2+} ($3d^8$) with Cl^- (weak field ligand). No pairing occurs. There are 2 unpaired electrons. It is paramagnetic. 3. **$[CoF_6]^{3-}$:** Co^{3+} ($3d^6$) with F^- (weak field ligand). No pairing occurs. There are 4 unpaired electrons. It is paramagnetic. 4. **$[FeF_6]^{3-}$:** Fe^{3+} ($3d^5$) with F^- (weak field ligand). There are 5 unpaired electrons. It is paramagnetic.

Final Answer: $[Ni(CN)_4]^{2-}$ is diamagnetic.

Answer: (A)

Q29.

Solution

Concept:

Electronegativity is the tendency of an atom to attract a shared pair of electrons towards itself. It generally increases across a period and decreases down a group in the periodic table.

Solution:

1. The elements given are Oxygen (O), Nitrogen (N), Fluorine (F), and Chlorine (Cl). 2. Fluorine is located at the top right of the periodic table (excluding noble gases). 3. According to the Pauling scale, Fluorine is the most electronegative element with a value of 4.0. 4. Oxygen follows with 3.5, Nitrogen with 3.0, and Chlorine with 3.0. 5. Fluorine's small size and high nuclear charge make its pull on electrons the strongest in the periodic table.

Final Answer: Fluorine is the most electronegative element.

Answer: (C)

Q30.

Solution

Concept:

The second ionization enthalpy is the energy required to remove an electron from a unipositive ion (M^+). It is exceptionally high when the first electron removal results in a stable noble gas configuration.

Solution:

1. **Lithium (Li):** Electronic configuration is $1s^2 2s^1$. After losing one electron (Li^+), the configuration is $1s^2$ (stable noble gas configuration of Helium). Removing a second electron from this stable, inner-shell shell requires a massive amount of energy. 2. **Beryllium (Be):** Configuration is $1s^2 2s^2$. Be^+ is $1s^2 2s^1$. Removing the second electron is easier as it is from the valence shell. 3. **Boron (B):** Configuration is $1s^2 2s^2 2p^1$. B^+ is $1s^2 2s^2$. 4. **Carbon (C):** Configuration is $1s^2 2s^2 2p^2$. C^+ is $1s^2 2s^2 2p^1$. 5. Comparing all, Li shows the highest jump between first and second ionization enthalpies due to the transition from a valence shell to a stable core shell.

Final Answer: Li has the highest second ionization enthalpy.

Answer: (A)

Q31.

Solution

Concept:

The oxidation state of an element in a compound is calculated by setting the sum of oxidation states of all atoms equal to the net charge of the species.

Solution:

1. $Ba(H_2PO_2)_2$ is a salt consisting of Ba^{2+} and two hypophosphite ions ($H_2PO_2^-$). 2. We can calculate the oxidation state of Phosphorus (P) within the $H_2PO_2^-$ ion. 3. Let the oxidation state of P be x. 4. The oxidation states of Hydrogen and Oxygen are generally $+1$ and -2 respectively. 5. The sum of oxidation states in $H_2PO_2^-$ is:

$$2(+1) + x + 2(-2) = -1$$

$$2 + x - 4 = -1$$

$$x - 2 = -1$$

$$x = +1$$

6. Thus, Phosphorus is in the $+1$ oxidation state.

Final Answer: The oxidation state of Phosphorus is $+1$.

Answer: (B)

Q32.

Solution

Concept:

Noble gases have specific industrial and medical applications. Helium, due to its low boiling point and non-magnetic properties, is essential in cryogenic applications.

Solution:

1. Magnetic Resonance Imaging (MRI) machines use powerful superconducting magnets. 2. These magnets must be kept at extremely low temperatures (close to absolute zero) to maintain their superconductivity. 3. Liquid Helium (He) has the lowest boiling point of any element (4.2 K). 4. Therefore, liquid Helium is used as a coolant for the superconducting magnets in MRI scanners. 5. Other noble gases like Neon or Argon do not provide the sufficiently low temperatures required for this specific technology.

Final Answer: Helium (He) is used in MRI.

Answer: (A)

Q33.

Solution

Concept:

The addition of HBr to an unsymmetrical alkene follows different rules depending on the presence of peroxides. This is known as the Peroxide Effect or Kharasch Effect.

Solution:

1. 1-Butene is $CH_2 = CH - CH_2 - CH_3$. 2. In the absence of peroxide, addition follows Markovnikov's rule (Br attaches to the carbon with fewer hydrogens), forming 2-bromobutane. 3. In the presence of organic peroxides, the reaction proceeds via a free-radical mechanism. 4. This follows **Anti-Markovnikov's rule**, where the Bromine atom attaches to the terminal carbon (the carbon with more hydrogens). 5. The reaction is:

$$CH_2 = CH - CH_2 - CH_3 + HBr \xrightarrow{\text{Peroxide}} Br - CH_2 - CH_2 - CH_2 - CH_3$$

6. The product is 1-Bromobutane.

Final Answer: The product is 1-Bromobutane.

Answer: (A)

Q34.

Solution

Concept:

Specific named reactions in organic chemistry involve the formylation of aromatic rings using specific reagents.

Solution:

1. The reaction of Phenol with Chloroform ($CHCl_3$) in the presence of sodium hydroxide ($NaOH$) introduces an aldehyde group ($-CHO$) at the ortho position of the phenol ring. 2. The intermediate formed is a substituted benzal chloride which hydrolyzes to an aldehyde. 3. The main product is salicylaldehyde (o-hydroxybenzaldehyde). 4. This specific sequence (Phenol + $CHCl_3$ + base $\rightarrow$ Salicylaldehyde) is known as the **Reimer-Tiemann reaction**. 5. Kolbe's reaction, by contrast, uses CO_2 to form salicylic acid.

Final Answer: This is the Reimer-Tiemann reaction.

Answer: (A)

Q35.

Solution

Concept:

Polymers are made of repeating structural units called monomers. Neoprene is a synthetic rubber-like polymer.

Solution:

1. Neoprene (also known as polychloroprene) is produced by the free-radical polymerization of a specific diene. 2. The monomer is 2-chloro-1,3-butadiene. 3. This molecule is commonly known as **Chloroprene**. 4. The structure of chloroprene is $CH_2 = C(Cl) - CH = CH_2$. 5. Isoprene is the monomer for natural rubber (2-methyl-1,3-butadiene).

Final Answer: The monomer of Neoprene is Chloroprene.

Answer: (B)

Q36.

Solution

Concept:

According to the IUPAC definition, a transition element is an element whose atom has a partially filled d subshell, or which can give rise to cations with an incomplete d subshell.

Solution:

1. **Zinc (Zn), Cadmium (Cd), and Mercury (Hg):** These elements belong to Group 12. Their electronic configurations are $(n-1)d^{10}ns^2$. Even in their most common oxidation states (like +2), they have completely filled d^{10} configurations. Therefore, they are often referred to as "non-typical" transition elements or d-block elements that are not transition elements. 2. **Iron (Fe):** The atomic number is 26. Its configuration is $[Ar]3d^6 4s^2$. 3. In its ground state, Iron has a partially filled d orbital ($3d^6$). 4. In its common oxidation states, such as Fe^{2+} ($3d^6$) and Fe^{3+} ($3d^5$), it maintains a partially filled d subshell. 5. Thus, Iron fits the definition of a transition element perfectly.

Final Answer: Fe is a transition element.

Answer: (D)

Q37.

Solution

Concept:

Nodes are regions in an orbital where the probability of finding an electron is zero. Radial nodes (also known as spherical nodes) depend on the principal quantum number (n) and the azimuthal quantum number (l).

Solution:

1. The formula for the number of radial nodes is:

$$\text{Radial Nodes} = n - l - 1$$

2. For a $3p$ orbital: - The principal quantum number $n = 3$. - The azimuthal quantum number l for a p orbital is 1. 3. Substitute the values into the formula:

$$\text{Radial Nodes} = 3 - 1 - 1 = 1$$

4. For comparison, the number of angular nodes is equal to l (which is 1 for $3p$), and the total number of nodes is $n-1$ (which is 2 for $3p$).

Final Answer: The number of radial nodes in a $3p$ orbital is 1.

Answer: (B)

Q38.

Solution

Concept:

The relationship between the equilibrium constant expressed in terms of partial pressures (K_p) and the equilibrium constant in terms of molar concentrations (K_c) is given by the equation:

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

where Δn_g is the change in the number of moles of gaseous products and reactants.

Solution:

1. The balanced chemical equation is: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$. 2. Calculate Δn_g:

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

$$\Delta n_g = 2 - (1 + 3) = 2 - 4 = -2$$

3. Substitute $\Delta n_g = -2$ into the relationship formula:

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

4. This can also be written as $K_p = \frac{K_c}{(RT)^2}$.

Final Answer: The relationship is $K_p = K_c(RT)^{-2}$.

Answer: (A)

Q39.

Solution

Concept:

The units of the rate constant (k) vary depending on the overall order of the reaction (n). The general formula for the units of k is:

$$\text{Units of } k = (\text{mol L}^{-1})^{1-n}\ \text{s}^{-1}$$

Solution:

1. For a second-order reaction, the order $n = 2$. 2. Substitute $n = 2$ into the general formula:

$$\text{Units} = (\text{mol L}^{-1})^{1-2}\ \text{s}^{-1}$$

$$\text{Units} = (\text{mol L}^{-1})^{-1}\ \text{s}^{-1}$$

3. Simplify the expression:

$$\text{Units} = \text{mol}^{-1}\ \text{L}\ \text{s}^{-1}$$

$$\text{Units} = \text{L mol}^{-1}\ \text{s}^{-1}$$

4. This reflects that the rate ($molL^{-1}s^{-1}$) is equal to $k \times (\text{concentration})^2$.

Final Answer: The unit is L mol^{-1} s^{-1}.

Answer: (C)

Q40.

Solution

Concept:

An outer orbital complex (or high-spin complex) is one where the metal ion uses its outer nd orbitals for hybridization (sp^3d^2) instead of its inner $(n-1)d$ orbitals. This usually occurs when the ligands are weak field ligands.

Solution:

1. **$[Co(NH_3)_6]^{3+}$:** NH_3 is a strong field ligand for Co^{3+}, causing electron pairing. It uses inner $3d$ orbitals (d^2sp^3). It is an inner orbital complex. 2. **$[Mn(CN)_6]^{4-}$:** CN^- is a strong field ligand. It uses inner $3d$ orbitals (d^2sp^3). Inner orbital complex. 3. **$[FeF_6]^{3-}$:** F^- is a weak field ligand. It cannot cause pairing of electrons in the $3d$ subshell of Fe^{3+}. Therefore, the metal must use the outer $4d$ orbitals for bonding. The hybridization is sp^3d^2. 4. **$[Fe(CN)_6]^{3-}$:** CN^- is a strong field ligand, resulting in an inner orbital complex (d^2sp^3).

Final Answer: $[FeF_6]^{3-}$ is an outer orbital complex.

Answer: (C)

Q41.

Solution

Concept:

Boiling point elevation is a colligative property that depends on the number of solute particles in the solution. It is given by $\Delta T_b = iK_b m$. For solutions with the same molarity, the one with the highest van't Hoff factor (i) will have the highest boiling point.

Solution:

1. **0.1 M $NaCl$:** Dissociates into Na^+ and Cl^-. $i = 2$. 2. **0.1 M $BaCl_2$:** Dissociates into Ba^{2+} and $2Cl^-$. $i = 3$. 3. **0.1 M Urea:** Non-electrolyte, does not dissociate. $i = 1$. 4. **0.1 M $FeCl_3$:** Dissociates into Fe^{3+} and $3Cl^-$. $i = 4$. 5. Since $FeCl_3$ produces the maximum number of particles ($i = 4$) per formula unit, it will cause the maximum elevation in boiling point.

Final Answer: 0.1 M $FeCl_3$ will have the highest boiling point.

Answer: (D)

Q42.

Solution

Concept:

In a close-packed structure (ccp or fcc), if the number of atoms in the unit cell is N, then the number of octahedral voids is N and the number of tetrahedral voids is $2N$.

Solution:

1. In a cubic close-packed (ccp) or face-centered cubic (fcc) unit cell, the number of atoms per unit cell (N) is 4. 2. Number of octahedral voids = $N = 4$. 3. Number of tetrahedral voids = $2N = 2 \times 4 = 8$. 4. The question asks for tetrahedral and octahedral voids respectively. 5. Therefore, the values are 8 and 4.

Final Answer: The number of voids are 8 and 4 respectively.

Answer: (B)

Q43.

Solution

Concept:

For a first-order reaction, the integrated rate equation is $t = \frac{2.303}{k} \log\left(\frac{[A]_0}{[A]}\right)$. The half-life is $t_{1/2} = \frac{0.693}{k}$.

Solution:

1. For 99.9% completion, the remaining concentration $[A]$ is 0.1% of $[A]_0$.

$$[A] = 0.001[A]_0$$

2. Substitute into the rate equation:

$$t_{99.9\%} = \frac{2.303}{k} \log\left(\frac{[A]_0}{0.001[A]_0}\right) = \frac{2.303}{k} \log(1000)$$

3. Since $\log(1000) = 3$:

$$t_{99.9\%} = \frac{2.303 \times 3}{k} = \frac{6.909}{k}$$

4. Compare this to $t_{1/2} = \frac{0.693}{k}$:

$$\frac{t_{99.9\%}}{t_{1/2}} = \frac{6.909/k}{0.693/k} \approx 10$$

5. Thus, $t_{99.9\%}$ is approximately 10 times the half-life.

Final Answer: It is 10 times the half-life.

Answer: (C)

Q44.

Solution

Concept:

Amino acids are classified as acidic, basic, or neutral based on the relative number of amino groups ($-NH_2$) and carboxyl groups ($-COOH$) in their structure.

Solution:

1. **Lysine:** Contains two amino groups and one carboxyl group. It is a basic amino acid. 2. **Aspartic acid and Glutamic acid:** Contain two carboxyl groups and one amino group. These are acidic amino acids. 3. **Glycine ($H_2N - CH_2 - COOH$):** Contains exactly one amino group and one carboxyl group. The side chain is just a Hydrogen atom. 4. Because the acidic and basic groups are balanced, it is classified as a neutral amino acid.

Final Answer: Glycine is a neutral amino acid.

Answer: (B)

Q45.

Solution

Concept:

VSEPR Theory and Molecular Geometry of Xe compounds.

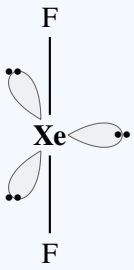
Solution:

Step 1: Identify valence electrons for the central Xenon (Xe) atom, which is 8.

Step 2: Xenon forms 2 sigma (σ) bonds with 2 Fluorine atoms.

Step 3: Calculate the number of lone pairs: Lone Pairs = $\frac{8-2}{2} = 3$.

Step 4: Determine the Steric Number (SN) = 2 bond pairs + 3 lone pairs = 5. This corresponds to sp^3d hybridization. To minimize repulsion, lone pairs occupy equatorial positions, resulting in a linear shape.



Linear Geometry (180°)

Final Answer:

Linear

Answer: (A)

Q46.

Solution

Concept:

Fehling's test is used to distinguish between aliphatic aldehydes and ketones. Aliphatic aldehydes reduce the blue-colored Cu^{2+} ions in Fehling's solution to a red-brown precipitate of Cuprous oxide (Cu_2O).

Solution:

1. **Benzaldehyde:** Although it is an aldehyde, aromatic aldehydes do not usually give a positive Fehling's test because they lack the necessary reducing power under these specific conditions. 2. **Acetone and Ethyl methyl ketone:** These are ketones. Ketones generally do not react with Fehling's reagent as they are not easily oxidized. 3. **Acetaldehyde (CH_3CHO):** This is an aliphatic aldehyde. It reacts with Fehling's solution (A and B) to form a reddish-brown precipitate. 4. The reaction is:

$$R - CHO + 2Cu^{2+} + 5OH^- \rightarrow R - COO^- + Cu_2O \downarrow + 3H_2O$$

5. Therefore, acetaldehyde gives a positive test.

Final Answer: Acetaldehyde will give a positive Fehling's test.

Answer: (C)

Q47.

Solution

Concept:

The effect of temperature on the rate of reaction is often described by the temperature coefficient (η), which is the ratio of rate constants at temperatures differing by 10°C.

$$\text{Rate}_2 = \text{Rate}_1 \times \eta^{\frac{\Delta T}{10}}$$

Solution:

1. Given that the rate doubles for every 10°C rise, the temperature coefficient $\eta = 2$. 2. The initial temperature $T_1 = 10°C$ and the final temperature $T_2 = 50°C$. 3. The change in temperature $\Delta T = 50 - 10 = 40°C$. 4. Number of 10°C intervals $(n) = \frac{40}{10} = 4$. 5. The increase in rate is calculated as:

$$\text{Increase} = 2^n = 2^4$$

6. $2 \times 2 \times 2 \times 2 = 16$. 7. Thus, the rate of reaction increases by 16 times.

Final Answer: The rate increases by 16 times.

Answer: (B)

Q48.

Solution

Concept:

Osmotic pressure (π) is a colligative property defined by the van't Hoff equation:

$$\pi = iCRT$$

where i is the van't Hoff factor, C is the molar concentration, R is the gas constant, and T is the absolute temperature.

Solution:

1. From the formula $\pi = iCRT$, it is evident that osmotic pressure is directly proportional to both the molar concentration (C) and the absolute temperature (T). 2. **Increasing the temperature:** According to the equation, if T increases, π increases proportionally. 3. **Decreasing concentration:** This would lead to a decrease in osmotic pressure. 4. **Increasing volume:** Since $C = \frac{n}{V}$, increasing volume at a constant number of moles decreases concentration, thereby decreasing osmotic pressure. 5. **Decreasing solute particles:** This reduces the value of i or n, which decreases the osmotic pressure.

Final Answer: Osmotic pressure can be increased by increasing the temperature.

Answer: (A)

Q49.

Solution

Concept:

Polymers are classified by their mode of polymerization. Addition polymers are formed by the repeated addition of monomer molecules possessing double or triple bonds, without the elimination of small molecules. Condensation polymers involve the elimination of molecules like H_2O or HCl.

Solution:

1. **Nylon-6,6:** Formed by the condensation of adipic acid and hexamethylenediamine with the loss of water. 2. **Terylene (Dacron):** Formed by the condensation of ethylene glycol and terephthalic acid. 3. **Bakelite:** A condensation polymer of phenol and formaldehyde. 4. **Polyethene:** Formed by the addition polymerization of ethene ($CH_2 = CH_2$) monomers. There is no loss of any small molecule during the process. 5. The double bond of ethene opens up to link with other ethene molecules.

Final Answer: Polyethene is an addition polymer.

Answer: (C)

Q50.

Solution

Concept:

VSEPR Theory and Isostructural Species.

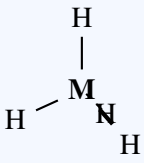
Solution:

Step 1: Analyze Pair (B). CH_4 has 4 valence electrons from C and 4 from H. Steric number = 4 (4 bond pairs + 0 lone pairs). Geometry = Tetrahedral.

Step 2: NH_4^+ has 5 valence electrons from N, minus 1 for the positive charge, plus 4 from H. Steric number = 4 (4 bond pairs + 0 lone pairs). Geometry = Tetrahedral.

Step 3: Analyze Pair (C). XeF_2 has 8 valence electrons + 2 from F. Steric number = 5 (2 bond pairs + 3 lone pairs). Shape = Linear. CO_2 has 2 double bonds and 0 lone pairs. Shape = Linear.

Step 4: Since both (B) and (C) show identical geometry within their pairs, we prioritize the standard tetrahedral pair (B) often found in competitive exams.



Tetrahedral (CH_4/NH_4^+)

Final Answer:

$$\boxed{CH_4, NH_4^+}$$

Answer: (B)

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	A	3	A	4	B	5	B
6	A	7	B	8	A	9	C	10	B
11	B	12	D	13	A	14	A	15	D
16	B	17	A	18	C	19	A	20	A
21	A	22	C	23	B	24	A	25	A
26	D	27	C	28	A	29	C	30	A
31	B	32	A	33	A	34	A	35	B
36	D	37	B	38	A	39	C	40	C
41	D	42	B	43	C	44	B	45	A
46	C	47	B	48	A	49	C	50	B