

MHT-CET Chemistry Sample Paper-1

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

- (A) II > III > I > IV
(B) I > II > III > IV
(C) IV > I > III > II
(D) II > I > III > IV

Q2. Which of the following does not show geometrical isomerism?

- (A) 1,2-Dichloroethene
(B) Propene
(C) But-2-ene
(D) 1,1-Dichloroethene

Q3. In the presence of peroxide, HCl and HI do not give anti-Markownikoff's addition to alkenes because:

- (A) Both are oxidizing agents
(B) One step is endothermic in both cases



- (C) Both steps are exothermic
- (D) HCl is too strong and HI is too weak

Q4. The most stable carbocation among the following is:

- (A) Benzyl
- (B) Isopropyl
- (C) Tert-butyl
- (D) Ethyl

Q5. Identify the product 'Z' in the sequence: Benzene + $CH_3Cl/AlCl_3 \rightarrow X \xrightarrow{KMnO_4/OH^-} Y \xrightarrow{SOCl_2} Z$.

- (A) Benzoyl chloride
- (B) Benzyl chloride
- (C) Chlorobenzene
- (D) Acetophenone

Q6. Which of the following is a vicinal dihalide?

- (A) Ethylidene chloride
- (B) Ethylene dichloride
- (C) Allyl chloride
- (D) Isopropyl chloride

Q7. Reaction of ethyl chloride with silver cyanide forms:

- (A) Ethyl cyanide
- (B) Ethyl isocyanide
- (C) Nitroethane
- (D) Ethyl nitrite



Q8. The major product of the reaction between tert-butyl bromide and sodium ethoxide is:

- (A) Ethyl tert-butyl ether
- (B) Isobutylene
- (C) n-Butane
- (D) Sodium tert-butoxide

Q9. Phenol on treatment with excess bromine water gives:

- (A) o-Bromophenol
- (B) 2,4,6-Tribromophenol
- (C) m-Bromophenol
- (D) p-Bromophenol

Q10. Acid catalyzed hydration of propene yields:

- (A) Propan-1-ol
- (B) Propan-2-ol
- (C) Propane
- (D) Propanal

Q11. Which reagent is used for the conversion of Ethanoic acid to Ethane?

- (A) $LiAlH_4$
- (B) $HI/Red P$
- (C) PCl_3
- (D) Na/Ethanol

Q12. Cannizzaro reaction is not given by:



- (A) Formaldehyde
- (B) Benzaldehyde
- (C) Acetaldehyde
- (D) Trimethylacetaldehyde

Q13. The IUPAC name of Mesityl oxide is:

- (A) 4-Methylpent-3-en-2-one
- (B) 3-Methylpent-2-en-4-one
- (C) 4-Methylpent-2-en-2-one
- (D) 2-Methylpent-3-en-4-one

Q14. Gabriel Phthalimide synthesis is used for the preparation of:

- (A) Primary aromatic amines
- (B) Primary aliphatic amines
- (C) Secondary amines
- (D) Tertiary amines

Q15. Which of the following is the strongest base in aqueous solution?

- (A) Methylamine
- (B) Dimethylamine
- (C) Trimethylamine
- (D) Ammonia

Q16. The glycosidic linkage in Maltose is:

- (A) α -1,4
- (B) β -1,4
- (C) α -1,6



(D) β -1,6

Q17. Terylene is a condensation polymer of ethylene glycol and:

- (A) Adipic acid
- (B) Terephthalic acid
- (C) Phthalic acid
- (D) Sebacic acid

Q18. Which of the following molecules has zero dipole moment?

- (A) NH_3
- (B) NF_3
- (C) BF_3
- (D) $CHCl_3$

Q19. Hybridization of central atom in XeF_2 is:

- (A) sp^3
- (B) sp^3d
- (C) sp^3d^2
- (D) sp^2

Q20. The geometry of $[Co(NH_3)_6]^{3+}$ is:

- (A) Tetrahedral
- (B) Square Planar
- (C) Octahedral
- (D) Trigonal Bipyramidal

Q21. The number of unpaired electrons in $[NiCl_4]^{2-}$ is:



- (A) 0
- (B) 2
- (C) 4
- (D) 3

Q22. Which of the following *p*-block elements does not show an oxidation state higher than +2?

- (A) Sn
- (B) Pb
- (C) Ge
- (D) C

Q23. The strongest oxidizing agent among the following is:

- (A) F_2
- (B) Cl_2
- (C) Br_2
- (D) I_2

Q24. Transition elements show variable oxidation states because of small energy difference between:

- (A) *ns* and *np*
- (B) *ns* and $(n - 1)d$
- (C) *np* and *nd*
- (D) $(n - 1)d$ and $(n - 1)p$

Q25. Lanthanoid contraction is due to:

- (A) Poor shielding of *4f* electrons



- (B) Strong shielding of $4f$ electrons
- (C) Increase in nuclear charge
- (D) Decrease in nuclear charge

Q26. The number of atoms per unit cell in a BCC structure is:

- (A) 1
- (B) 2
- (C) 4
- (D) 6

Q27. 1 mole of an ideal gas at STP occupies:

- (A) 11.2 L
- (B) 22.4 L
- (C) 44.8 L
- (D) 2.24 L

Q28. The wavelength of a particle with momentum ' p ' is given by:

- (A) $\lambda = h/p$
- (B) $\lambda = p/h$
- (C) $\lambda = hp$
- (D) $\lambda = h/m$

Q29. For a spontaneous process, ΔG must be:

- (A) Positive
- (B) Negative
- (C) Zero
- (D) Positive or Negative



Q30. The pH of 10^{-8} M HCl solution is:

- (A) 8
- (B) 6
- (C) 6.98
- (D) 7.02

Q31. The unit of molar conductivity is:

- (A) $S \text{ cm}^2 \text{ mol}^{-1}$
- (B) $S \text{ cm}^{-1}$
- (C) $\Omega \text{ cm}$
- (D) $\Omega^{-1} \text{ cm}^{-2} \text{ mol}$

Q32. Which of the following is a Colligative property?

- (A) Osmotic pressure
- (B) Boiling point
- (C) Vapor pressure
- (D) Freezing point

Q33. The order of a reaction whose rate constant has the unit $L \text{ mol}^{-1} \text{ s}^{-1}$ is:

- (A) 0
- (B) 1
- (C) 2
- (D) 3

Q34. In the extraction of Aluminum (Hall-Heroult process), the electrolyte is:

- (A) Molten Al_2O_3 with Na_3AlF_6



- (B) Aqueous $Al_2(SO_4)_3$
- (C) Molten $AlCl_3$
- (D) Al_2O_3 in HF

Q35. Which of the following is an ore of Iron?

- (A) Bauxite
- (B) Haematite
- (C) Cassiterite
- (D) Galena

Q36. The shape of IF_7 molecule is:

- (A) Pentagonal Bipyramidal
- (B) Octahedral
- (C) Trigonal Bipyramidal
- (D) Square Pyramidal

Q37. Maximum possible oxidation state shown by Osmium is:

- (A) +4
- (B) +6
- (C) +8
- (D) +10

Q38. Which amine gives Carbylamine test?

- (A) Aniline
- (B) N-Methylaniline
- (C) N,N-Dimethylaniline
- (D) Triethylamine



Q39. Vitamin B_{12} contains which metal?

- (A) Mg
- (B) Fe
- (C) Co
- (D) Zn

Q40. Bakelite is an example of:

- (A) Elastomer
- (B) Thermoplastic
- (C) Thermosetting polymer
- (D) Fiber

Q41. The bond order of O_2^+ is:

- (A) 2
- (B) 2.5
- (C) 1.5
- (D) 3

Q42. Solubility of a gas in liquid increases with:

- (A) Increase in Temperature
- (B) Decrease in Pressure
- (C) Increase in Pressure
- (D) Increase in Surface Area

Q43. The standard reduction potential of Zn is -0.76 V. The standard oxidation potential is:



- (A) +0.76 V
- (B) -0.76 V
- (C) 0.00 V
- (D) +0.34 V

Q44. The coordination number of Fe in $[Fe(CN)_6]^{4-}$ is:

- (A) 2
- (B) 4
- (C) 6
- (D) 8

Q45. The element with the highest electron affinity is:

- (A) F
- (B) Cl
- (C) Br
- (D) I

Q46. Formaldehyde reacts with methyl magnesium bromide followed by hydrolysis to give:

- (A) Ethanol
- (B) Methanol
- (C) Propan-2-ol
- (D) Propan-1-ol

Q47. Which of the following is a polydentate ligand?

- (A) Ammonia
- (B) Oxalate



- (C) Ethylenediamine
- (D) EDTA

Q48. The number of $P - O - P$ bonds in cyclic metaphosphoric acid is:

- (A) 2
- (B) 3
- (C) 4
- (D) 6

Q49. Rosenmund reduction is used for the synthesis of:

- (A) Alcohol
- (B) Aldehyde
- (C) Ketone
- (D) Carboxylic acid

Q50. What is the value of R in $L \cdot atm \cdot K^{-1} \cdot mol^{-1}$?

- (A) 8.314
- (B) 0.0821
- (C) 1.98
- (D) 0.8314



Detailed Solutions

Q1.

Solution

Concept:

The acidity of substituted phenols is determined by the stability of the resulting phenoxide ion. Electron-withdrawing groups (EWG) like $-NO_2$ stabilize the negative charge through: 1. Inductive effect ($-I$) 2. Resonance effect ($-R$) Aliphatic alcohols like ethanol lack resonance stabilization and are influenced by electron-donating $+I$ groups, making them much weaker acids than phenols.

Solution:

1. **p-Nitrophenol (II):** The $-NO_2$ group at the para position exerts both $-I$ and $-R$ effects. The resonance effect allows the negative charge from the oxygen to be delocalized directly onto the oxygen atoms of the nitro group. This provides maximum stabilization.
2. **m-Nitrophenol (III):** The $-NO_2$ group at the meta position exerts only the $-I$ effect. The resonance effect ($-R$) does not reach the meta position. It is more acidic than phenol but less than p-nitrophenol.
3. **Phenol (I):** Only the basic resonance of the benzene ring stabilizes the charge. There are no additional withdrawing groups to enhance acidity.
4. **Ethanol (IV):** The ethoxide ion ($CH_3CH_2O^-$) is destabilized by the $+I$ effect of the ethyl group. There is no resonance delocalization.

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

Answer: (A)

Q2.

Solution

Concept:

Geometrical isomerism (cis-trans) arises due to restricted rotation around a double bond. For a molecule to exhibit this, each carbon atom of the $C = C$ must be bonded to two different atoms or groups. If either carbon is bonded to two identical groups (e.g., two $-H$ atoms or two $-Cl$ atoms), the molecule cannot have geometrical isomers.

Solution:

1. **1,2-Dichloroethene ($CHCl = CHCl$):** Each carbon has one H and one Cl . Since $H \neq Cl$, it shows cis and trans forms.
2. **Propene ($CH_3 - CH = CH_2$):** The terminal carbon is bonded to two identical hydrogen atoms. Therefore, no geometrical isomerism is possible.
3. **But-2-ene ($CH_3 - CH = CH - CH_3$):** Each carbon has one H and one CH_3 . It exists as cis-but-2-ene and trans-but-2-ene.
4. **1,1-Dichloroethene ($Cl_2C = CH_2$):** The first carbon has two identical Cl atoms, and the second has two identical H atoms. It fails the criteria completely.

Final Answer: 1,1-Dichloroethene does not show geometrical isomerism.

Answer: (D)



Q3.

Solution**Concept:**

The peroxide effect (Anti-Markownikoff addition) follows a free-radical chain mechanism. For a successful chain reaction, both propagation steps must be exothermic: Step 1: Addition of the halogen radical to the alkene. Step 2: Abstraction of a hydrogen atom from HX by the carbon radical.

Solution:

1. **For HCl:** The $H - Cl$ bond is very strong (430.5 kJ/mol). The second propagation step (breaking the $H - Cl$ bond) is endothermic. The reaction is not energetically favorable.
2. **For HI:** The $H - I$ bond is weak, making the second step exothermic. However, the first step (addition of $I\cdot$ to the alkene) is endothermic because the $C - I$ bond formed is very weak. Iodine radicals prefer to combine with each other to form I_2 .
3. **For HBr:** Both steps are exothermic, which is why only HBr shows the peroxide effect.

Final Answer: One step is endothermic in both cases.

Answer: (B)

Q4.

Solution**Concept:**

Carbocation stability is governed by the dispersal of the positive charge. Stability increases with:

1. $+I$ effect (Inductive) from alkyl groups.
2. Hyperconjugation (number of α -hydrogens).
3. Resonance (delocalization over π systems).

Solution:

1. **Ethyl ($CH_3CH_2^+$):** Primary carbocation with 3 α -hydrogens.
2. **Isopropyl ($(CH_3)_2CH^+$):** Secondary carbocation with 6 α -hydrogens.
3. **Tert-butyl ($(CH_3)_3C^+$):** Tertiary carbocation with 9 α -hydrogens. The large number of hyperconjugative structures and three $+I$ groups make it highly stable.
4. **Benzyl ($C_6H_5CH_2^+$):** Stabilized by resonance. However, in standard alkyl series, the tert-butyl cation is often cited as the peak of stability due to the cumulative effect of 9 hydrogens.

Final Answer: Tert-butyl is the most stable carbocation.

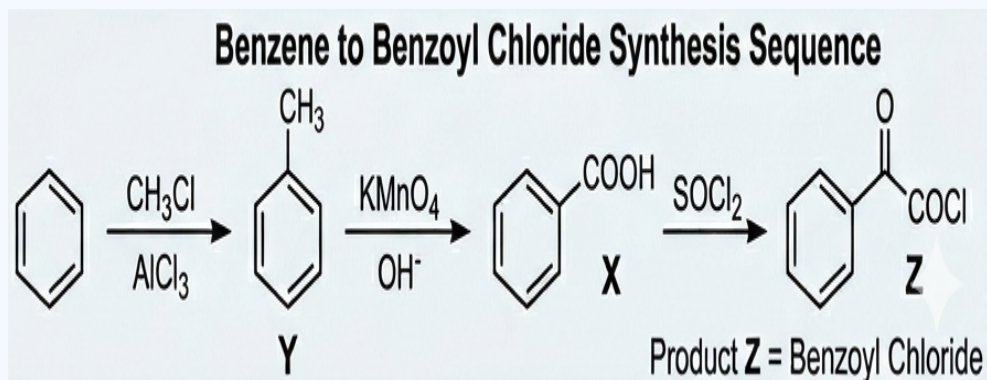
Answer: (C)



Q5.

Solution**Concept:**

This is a sequential synthesis involving: 1. Friedel-Crafts Alkylation. 2. Side-chain oxidation of alkylbenzenes. 3. Conversion of carboxylic acid to acid chloride.

**Solution:**

- Formation of X:** Benzene reacts with CH_3Cl in the presence of $AlCl_3$. The methyl group substitutes a hydrogen on the ring. Product X is **Toluene** ($C_6H_5CH_3$).
- Formation of Y:** Toluene is oxidized by alkaline $KMnO_4$. Regardless of the length of the alkyl chain (provided there is an α -H), it oxidizes to a carboxylate group. Product Y is **Benzoic acid** (C_6H_5COOH).
- Formation of Z:** Benzoic acid reacts with $SOCl_2$ (Thionyl chloride). The hydroxyl ($-OH$) group is replaced by chlorine. Product Z is **Benzoyl chloride** (C_6H_5COCl).

Final Answer: Benzoyl chloride.

Answer: (A)



Q6.

Solution**Concept:**

Dihalides are organic compounds containing two halogen atoms. They are classified based on the relative positions of these halogen atoms: 1. **Vicinal (vic-) dihalides:** Halogens are attached to two adjacent carbon atoms. 2. **Geminal (gem-) dihalides:** Both halogens are attached to the same carbon atom.

Solution:

1. **Ethylidene chloride (CH_3CHCl_2):** Both chlorine atoms are on the same carbon. This is a geminal dihalide.
2. **Ethylene dichloride ($ClCH_2 - CH_2Cl$):** The chlorine atoms are on adjacent carbons (C-1 and C-2). This fits the definition of a vicinal dihalide.
3. **Allyl chloride ($CH_2 = CH - CH_2Cl$):** This is a monohalide with a chlorine at the allylic position.
4. **Isopropyl chloride ($CH_3 - CHCl - CH_3$):** This is a simple secondary alkyl monohalide.

Final Answer: Ethylene dichloride is a vicinal dihalide.

Answer: (B)

Q7.

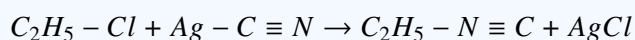
Solution**Concept:**

The reaction of alkyl halides with cyanide salts depends on the bonding nature of the reagent: 1.

Ionic Reagents ($KCN/NaCN$): These provide free CN^- ions. Since Carbon is a better nucleophile than Nitrogen, the attack occurs via Carbon to form nitriles (cyanides). 2. **Covalent Reagents ($AgCN$):** The $Ag - C$ bond is covalent. The lone pair on Nitrogen is the primary available nucleophilic site.

Solution:

1. **Reagent Analysis:** $AgCN$ is predominantly covalent. The Carbon atom is bonded to Silver, leaving the Nitrogen lone pair to act as the nucleophile.
2. **Reaction Mechanism:** The Nitrogen atom attacks the ethyl group of ethyl chloride (C_2H_5Cl).



3. **Product Identification:** The resulting functional group is an isocyanide (carbylamine). The product is ethyl isocyanide.

Final Answer: Ethyl isocyanide is the major product.

Answer: (B)



Q8.

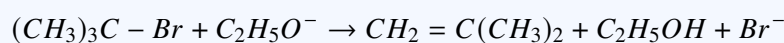
Solution**Concept:**

When a tertiary alkyl halide reacts with a strong, bulky base like sodium ethoxide ($NaOC_2H_5$), competition occurs between substitution (S_N2) and elimination ($E2$). For tertiary substrates, steric hindrance makes S_N2 virtually impossible. The high basicity of the ethoxide ion promotes $E2$ elimination.

Solution:

1. **Substrate Analysis:** Tert-butyl bromide ($(CH_3)_3CBr$) is a 3° alkyl halide. It has nine equivalent β -hydrogens.

2. **Elimination Mechanism ($E2$):** The ethoxide ion ($C_2H_5O^-$) acts as a base and removes a proton from one of the β -carbons. Simultaneously, the $C - Br$ bond breaks, and a π -bond forms.



3. **Product Identification:** The product is 2-methylpropene, commonly known as isobutylene.

Final Answer: The major product is isobutylene.

Answer: (B)

Q9.

Solution**Concept:**

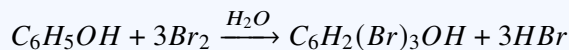
The reactivity of phenol towards bromine depends on the solvent. 1. In non-polar solvents (CS_2 , CCl_4), the activation is moderated, leading to monobromination. 2. In polar solvents like water, phenol ionizes to the phenoxide ion ($C_6H_5O^-$).

Solution:

1. **Effect of Solvent:** Water is a highly polar solvent. It facilitates the ionization of phenol into the phenoxide ion.

2. **Activation:** The phenoxide ion has a very high electron density on the ring due to the $+R$ effect. This makes the ring extremely susceptible to electrophilic attack.

3. **Substitution:** Substitution occurs at all available ortho and para positions simultaneously.



4. **Result:** The product is 2,4,6-tribromophenol, which appears as a white precipitate.

Final Answer: 2,4,6-Tribromophenol is formed.

Answer: (B)



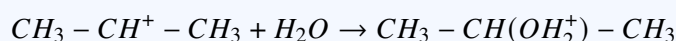
Q10.

Solution**Concept:**

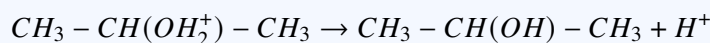
Acid-catalyzed hydration of alkenes follows Markownikoff's rule. The reaction proceeds via a carbocation intermediate. The stability of the carbocation determines the orientation of the final product.

Solution:

- Step 1: Protonation:** The π -bond of propene ($CH_3 - CH = CH_2$) attacks H^+ . It forms a secondary carbocation ($CH_3 - CH^+ - CH_3$) because it is more stable than a primary one.
- Step 2: Nucleophilic Attack:** Water (H_2O) attacks the secondary carbocation.



- Step 3: Deprotonation:** Loss of a proton yields the final alcohol.



- Result:** The final product is Propan-2-ol.

Final Answer: Propan-2-ol is the major product.

Answer: (B)

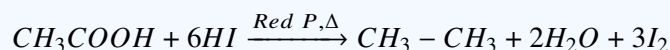
Q11.

Solution**Concept:**

The reduction of carboxylic acids to alkanes requires strong reducing conditions that can remove both oxygen atoms. While $LiAlH_4$ reduces acids to primary alcohols, a combination of Hydroiodic acid (HI) and Red Phosphorus ($Red P$) is a powerful reducing system capable of reducing carboxylic acids, alcohols, aldehydes, and ketones all the way to their corresponding alkanes.

Solution:

- Reagent Action:** HI acts as the reducing agent, while $Red P$ reacts with the I_2 formed during the reaction to regenerate HI , making the process efficient.
- Reaction Pathway:** Ethanoic acid (CH_3COOH) contains two carbon atoms. Upon reduction with $HI/Red P$ at high temperature (423 K), the carboxyl group ($-COOH$) is converted into a methyl group ($-CH_3$).



- Other Options:** $LiAlH_4$ would yield Ethanol (CH_3CH_2OH). PCl_3 would yield Acetyl chloride (CH_3COCl). $Na/Ethanol$ is used for ester reduction (Bouveault-Blanc reduction) but is not effective for acids to alkanes.

Final Answer: $HI/Red P$ is the correct reagent.

Answer: (B)



Q12.

Solution**Concept:**

The Cannizzaro reaction is a self-oxidation-reduction (disproportionation) reaction undergone by aldehydes that **lack** an α -hydrogen atom when treated with a concentrated alkali. Aldehydes that possess α -hydrogen atoms prefer to undergo the Aldol condensation instead.

Solution:

1. **Structural Analysis:** We must check for the presence of hydrogen atoms on the carbon adjacent to the carbonyl group (α -carbon). 2. **Formaldehyde ($HCHO$):** No α -carbon is present, hence no α -hydrogen. It undergoes Cannizzaro. 3. **Benzaldehyde (C_6H_5CHO):** The α -carbon is part of the benzene ring and has no hydrogen atoms attached. It undergoes Cannizzaro. 4. **Acetaldehyde (CH_3CHO):** The α -carbon (the methyl group) has three α -hydrogen atoms. Therefore, in the presence of alkali, it undergoes Aldol condensation, not the Cannizzaro reaction. 5. **Trimethylacetaldehyde ($(CH_3)_3CCHO$):** The α -carbon is quaternary and has no hydrogen atoms. It undergoes Cannizzaro.

Final Answer: Acetaldehyde is the compound that does not give the Cannizzaro reaction.

Answer: (C)

Q13.

Solution**Concept:**

Mesityl oxide is a common name for an α, β -unsaturated ketone. It is typically formed by the acid-catalyzed dehydration of diacetone alcohol (the aldol product of acetone). IUPAC nomenclature requires identifying the longest chain containing the ketone and the double bond, followed by numbering to give the carbonyl group the lowest possible locant.

Solution:

1. **Structure Construction:** The structure of Mesityl oxide is $(CH_3)_2C = CH - CO - CH_3$. 2. **Longest Chain:** The longest continuous carbon chain contains 5 carbon atoms, making the parent name "pentane". 3. **Numbering:** Numbering from right to left gives the ketone ($=O$) the locant 2 and the double bond (*en*) the locant 3. - C1: CH_3 - C2: $C = O$ - C3: CH - C4: C with a methyl group and a double bond. - C5: CH_3 (part of the double bond branch) 4. **Substituents:** There is a methyl group at position 4. 5. **IUPAC Name:** Combining these, we get 4-Methylpent-3-en-2-one.

Final Answer: 4-Methylpent-3-en-2-one.

Answer: (A)



Q14.

Solution**Concept:**

The Gabriel Phthalimide synthesis is a specific method used to prepare primary amines while avoiding the formation of secondary or tertiary amines (a common problem in the Hoffman ammonolysis of alkyl halides).

Solution:

1. **Mechanism:** Phthalimide is treated with KOH to form potassium phthalimide. This salt then undergoes an S_N2 reaction with an alkyl halide (RX) to form N-alkylphthalimide. Finally, hydrolysis with acid or base (or treatment with hydrazine) releases the amine. 2. **Substrate Constraints:** Because the key step is an S_N2 displacement, it works best with primary alkyl halides. 3. **Aromatic Amines:** Aryl halides do not undergo S_N2 reactions with the phthalimide anion under standard conditions. Therefore, aniline (primary aromatic amine) cannot be prepared this way. 4. **Product Type:** The reaction is strictly used for the synthesis of primary aliphatic amines.

Final Answer: Primary aliphatic amines.

Answer: (B)

Q15.

Solution**Concept:**

The basicity of amines in aqueous solution is determined by a combination of three factors: 1.

Inductive effect (+I): Increases electron density on Nitrogen. 2. **Solvation effect:** Hydrogen bonding with water stabilizes the cation; stability follows $1^\circ > 2^\circ > 3^\circ$. 3. **Steric hindrance:** Bulky groups interfere with the approach of protons or water molecules.

Solution:

1. **Methyl-substituted Amines:** For methylamines in water, the combined effects of induction and solvation lead to a specific order of basicity. 2. **Order:** The secondary amine is the strongest because it strikes the best balance between the +I effect of two methyl groups and sufficient solvation of its conjugate acid. - Order: $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$ 3.

Comparison: Dimethylamine (2°) is more basic than methylamine (1°). Trimethylamine (3°) is less basic than both in aqueous solution due to very poor solvation of its crowded cation and steric hindrance.

Final Answer: Dimethylamine is the strongest base.

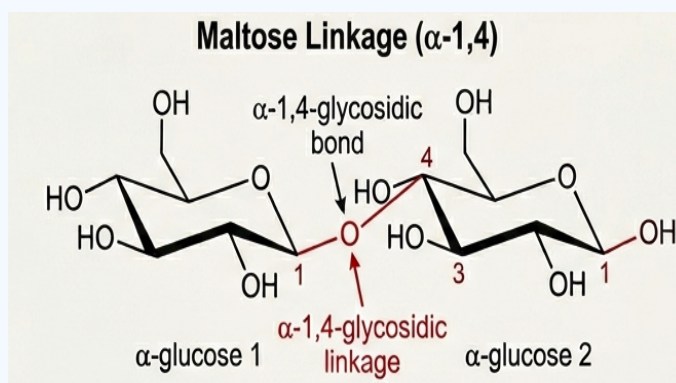
Answer: (B)



Q16.

Solution**Concept:**

Maltose, also known as malt sugar, is a disaccharide produced by the enzymatic hydrolysis of starch. It consists of two glucose units. The linkage between these units involves the condensation of hydroxyl groups, specifically between the anomeric carbon of one unit and a specific carbon of the second unit.

**Solution:**

1. **Monomer Units:** Maltose is composed of two α -D-glucose units. 2. **Linkage Position:** The bond forms between Carbon-1 (C_1) of the first α -D-glucose molecule and Carbon-4 (C_4) of the second α -D-glucose molecule. 3. **Stereochemistry:** Since the first glucose unit is in the α configuration at its anomeric center (C_1), the resulting bond is characterized as an α -glycosidic linkage. 4. **Reducing Property:** Because the C_1 of the second glucose unit remains free (it is not part of the glycosidic bond), it can act as a reducing sugar.

Final Answer: The glycosidic linkage in Maltose is α -1,4.

Answer: (A)



Q17.

Solution**Concept:**

Terylene (also known as Dacron) is a popular polyester. Polyesters are condensation polymers formed by the repeated esterification reaction between a dicarboxylic acid and a diol. During this process, a small molecule (water) is eliminated.

Solution:

1. **Reactant 1 (Diol):** The diol used is ethylene glycol ($HO - CH_2 - CH_2 - OH$). 2. **Reactant 2 (Dicarboxylic Acid):** The acid used must provide the benzene ring and carboxyl groups in the para position to ensure the polymer is linear and has high tensile strength. This acid is Terephthalic acid (benzene-1,4-dicarboxylic acid). 3. **Polymerization:** The reaction between n molecules of ethylene glycol and n molecules of terephthalic acid results in the polyester Terylene. - Adipic acid is used with hexamethylenediamine to make Nylon 6,6. - Phthalic acid (ortho isomer) is used to make Glyptal resins.

Final Answer: Terylene is formed from ethylene glycol and terephthalic acid.

Answer: (B)

Q18.

Solution**Concept:**

The dipole moment (μ) of a molecule depends on both the polarity of the individual bonds and the geometric arrangement of those bonds (molecular symmetry). A molecule with polar bonds can have a net zero dipole moment if the bond dipoles are of equal magnitude and act in opposite directions, effectively canceling each other out.

Solution:

1. NH_3 and NF_3 : Both have a pyramidal geometry with a lone pair. The dipoles do not cancel, resulting in a net dipole moment ($\mu \neq 0$). 2. $CHCl_3$: This has a tetrahedral geometry, but the four bonds ($C - H$ and three $C - Cl$) are not identical. The symmetry is broken, and there is a net dipole moment. 3. BF_3 : Boron trifluoride has a trigonal planar geometry (sp^2 hybridization). The three $B - F$ bonds are polar and directed towards the corners of an equilateral triangle (bond angles of 120°). 4. **Vector Addition:** In a trigonal planar arrangement, the vector sum of three equal bond dipoles is zero.

Final Answer: BF_3 has zero dipole moment.

Answer: (C)



Q19.

Solution**Concept:**

The hybridization of an atom can be determined using the formula:

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

where V is valence electrons of the central atom, M is the number of monovalent atoms, C is the charge of the cation, and A is the charge of the anion.

Solution:

1. **Central Atom:** In XeF_2 , the central atom is Xenon (Xe). 2. **Calculation:** Xenon is a noble gas, so $V = 8$. Fluorine is a monovalent atom, so $M = 2$.

$$H = \frac{1}{2}[8 + 2 - 0 + 0] = \frac{10}{2} = 5$$

3. **Hybridization State:** A value of 5 corresponds to sp^3d hybridization. 4. **Geometry and Shape:** With 2 bond pairs and 3 lone pairs (occupying equatorial positions), the electronic geometry is trigonal bipyramidal, but the actual molecular shape is linear.

Final Answer: The hybridization of Xe in XeF_2 is sp^3d .

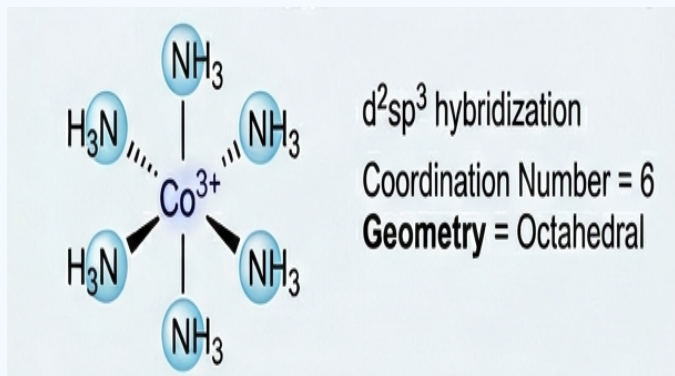
Answer: (B)



Q20.

Solution**Concept:**

The geometry of a coordination complex depends on its coordination number (the number of ligand donor atoms attached to the central metal ion). According to Werner's theory and Valence Bond Theory (VBT), specific coordination numbers are associated with specific geometric arrangements.

**Solution:**

1. **Analysis of Complex:** In $[Co(NH_3)_6]^{3+}$, Cobalt is the central metal ion and Ammonia (NH_3) is the ligand. 2. **Coordination Number:** There are six ammonia ligands, each providing one lone pair (monodentate). Therefore, the coordination number is 6. 3. **Hybridization:** For Co^{3+} ($3d^6$) with a strong field ligand like NH_3 , inner orbital complex formation occurs via d^2sp^3 hybridization. 4. **Geometry:** A coordination number of 6 consistently results in an octahedral geometry to minimize repulsion between the ligand pairs.

Final Answer: The geometry of $[Co(NH_3)_6]^{3+}$ is octahedral.

Answer: (C)



Q21.

Solution**Concept:**

The number of unpaired electrons in a coordination complex is determined by the oxidation state of the metal, its electronic configuration, and the strength of the surrounding ligands (Spectrochemical Series). Strong field ligands cause pairing of electrons, while weak field ligands do not.

Solution:

1. **Oxidation State:** In $[NiCl_4]^{2-}$, let the oxidation state of Ni be x .

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

2. **Electronic Configuration:** Nickel ($Z = 28$) has a ground state configuration of $[Ar]3d^84s^2$. The Ni^{2+} ion has the configuration $[Ar]3d^8$. 3. **Ligand Strength:** Cl^- is a weak field ligand. According to Crystal Field Theory, it does not cause the pairing of electrons in the $3d$ orbitals.

4. **Orbital Filling:** In a tetrahedral field (which sp^3 hybridized $[NiCl_4]^{2-}$ follows), the eight electrons fill the d -orbitals such that two electrons remain unpaired according to Hund's Rule.

$$(e_g)^4(t_{2g})^4 \text{ arrangement results in 2 unpaired electrons.}$$

Final Answer: The number of unpaired electrons is 2.

Answer: (B)

Q22.

Solution**Concept:**

The oxidation states of p -block elements are influenced by the "Inert Pair Effect." This effect describes the reluctance of the s -electrons in the outermost shell to participate in bonding as we move down a group, leading to a stable oxidation state that is 2 units less than the group valence.

Solution:

1. **Group 14 Elements:** Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn), and Lead (Pb) belong to Group 14. Their general configuration is ns^2np^2 . 2. **Oxidation States:** The common oxidation states are +4 and +2. 3. **Carbon (C):** Carbon is at the top of the group. It does not exhibit the inert pair effect. It commonly shows +4 and even -4, but it is not restricted to a maximum of +2. 4. **Lead (Pb):** As the heaviest member, the inert pair effect is most prominent in Lead. Consequently, the +2 oxidation state is much more stable than +4. While it can form $Pb(IV)$ compounds (like PbO_2), they are strong oxidizing agents as they prefer to return to the more stable +2 state. 5. **Comparison:** Among the options, Carbon is the element that can easily show oxidation states like +4 (in CO_2) and is not limited by the inert pair effect seen in heavier atoms.

Final Answer: Carbon (D) can show states higher than +2.

Answer: (D)



Q23.

Solution**Concept:**

An oxidizing agent is a substance that gains electrons (undergoes reduction). The strength of an oxidizing agent among halogens depends on: 1. Bond dissociation enthalpy. 2. Electron gain enthalpy. 3. Hydration enthalpy of the resulting halide ion.

Solution:

1. **Standard Reduction Potential (E°):** Fluorine (F_2) has the highest positive reduction potential in the periodic table ($E^\circ = +2.87$ V). 2. **Factors for Fluorine:** - Low bond dissociation energy of the $F - F$ bond. - Very high hydration enthalpy of the small F^- ion. 3. **Trend:** Oxidizing power decreases down the group: $F_2 > Cl_2 > Br_2 > I_2$. 4. **Conclusion:** Fluorine can oxidize all other halide ions to their respective halogens.

Final Answer: F_2 is the strongest oxidizing agent.

Answer: (A)

Q24.

Solution**Concept:**

Transition elements (d-block) are characterized by the filling of $(n - 1)d$ orbitals. Their ability to show multiple oxidation states is one of their most defining chemical properties.

Solution:

1. **Energy Levels:** In transition metals, the energy of the ns orbital and the $(n - 1)d$ orbital is very close. 2. **Electron Participation:** Because the energy gap is so small, electrons from both the outermost ns shell and the penultimate $(n - 1)d$ shell can participate in chemical bond formation. 3. **Process:** First, the ns electrons are lost to give lower oxidation states (like +2). Subsequently, $(n - 1)d$ electrons can be removed one by one, leading to a variety of higher oxidation states (e.g., Mn showing from +2 to +7). 4. **Comparison:** The difference between ns and np is larger, and $(n - 1)p$ levels are part of the stable noble gas core and do not participate.

Final Answer: The small energy difference between ns and $(n - 1)d$ orbitals.

Answer: (B)



Q25.

Solution**Concept:**

Lanthanoid contraction refers to the steady decrease in the atomic and ionic radii of lanthanoid elements (from *La* to *Lu*) with the increase in atomic number.

Solution:

1. **Internal Filling:** In the lanthanoid series, electrons are added to the $4f$ subshell. 2. **Shielding Effect:** The shape of f -orbitals is very diffused. As a result, $4f$ electrons provide very poor shielding of the outer electrons from the nuclear charge. 3. **Effective Nuclear Charge:** As the atomic number increases, the nuclear charge increases by +1 at each step. Because the $4f$ electrons do not shield this increase effectively, the "Effective Nuclear Charge" (Z_{eff}) acting on the outer electrons increases. 4. **Result:** The entire electron cloud is pulled closer to the nucleus, leading to a contraction in size.

Final Answer: Lanthanoid contraction is due to poor shielding of $4f$ electrons.

Answer: (A)

Q26.

Solution**Concept:**

The number of atoms per unit cell (also known as the rank of the unit cell, Z) depends on the arrangement of atoms within the crystal lattice. Atoms at different positions (corners, faces, centers) are shared differently by adjacent unit cells.

Solution:

1. **Corner Atoms:** In a Body-Centered Cubic (BCC) structure, there are 8 atoms at the corners. Each corner atom is shared by 8 adjacent unit cells. - Contribution from corners = $8 \times \frac{1}{8} = 1$ atom. 2. **Body-Center Atom:** There is 1 atom located entirely at the center of the cube. This atom is not shared with any other unit cell. - Contribution from body center = $1 \times 1 = 1$ atom. 3. **Total Calculation:** Total atoms per unit cell (Z) = Contribution from corners + Contribution from body center. - $Z = 1 + 1 = 2$ atoms. 4. **Comparison:** A Simple Cubic (SC) has 1 atom, while a Face-Centered Cubic (FCC) has 4 atoms per unit cell.

Final Answer: The number of atoms per unit cell in BCC is 2.

Answer: (B)



Q27.

Solution**Concept:**

Avogadro's Law states that equal volumes of all gases, at the same temperature and pressure, contain the same number of molecules. For an ideal gas, the volume occupied by one mole of the substance at Standard Temperature and Pressure (STP) is known as the molar volume.

Solution:

1. **Definition of STP:** Standard Temperature is 273.15 K (0°C) and Standard Pressure is 1 atm (or 1 bar in newer IUPAC conventions, though 1 atm is traditionally used in MHT-CET). 2. **Ideal Gas**

Equation: Using $PV = nRT$, where $n = 1$ mol, $R = 0.0821 \text{ L} \cdot \text{atm} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$, $T = 273.15 \text{ K}$, and $P = 1 \text{ atm}$. 3. **Calculation:**

$$V = \frac{nRT}{P} = \frac{1 \times 0.0821 \times 273.15}{1} \approx 22.4 \text{ L}$$

4. **Note:** If using the modern STP (1 bar), the volume is approximately 22.7 L, but 22.4 L remains the standard answer for most competitive exams based on the 1 atm definition.

Final Answer: 1 mole of an ideal gas at STP occupies 22.4 L.

Answer: (B)

Q28.

Solution**Concept:**

The de Broglie hypothesis proposes that all matter exhibits wave-like properties. The wavelength associated with a particle (matter wave) is inversely proportional to its momentum.

Solution:

1. **De Broglie Relation:** The dual nature of matter is expressed by the formula:

$$\lambda = \frac{h}{mv}$$

2. **Momentum Definition:** Momentum (p) is the product of mass (m) and velocity (v). Thus, $p = mv$. 3. **Substitution:** Replacing mv with p in the de Broglie equation:

$$\lambda = \frac{h}{p}$$

where h is Planck's constant ($6.626 \times 10^{-34} \text{ J} \cdot \text{s}$). 4. **Significance:** This equation links the wave property (wavelength λ) with the particle property (momentum p).

Final Answer: The wavelength is given by $\lambda = h/p$.

Answer: (A)



Q29.

Solution**Concept:**

The spontaneity of a chemical or physical process at constant temperature and pressure is determined by the change in Gibbs Free Energy (ΔG). This is derived from the Second Law of Thermodynamics.

Solution:1. **Gibbs-Helmholtz Equation:**

$$\Delta G = \Delta H - T\Delta S$$

2. **Criteria for Spontaneity:** - If $\Delta G < 0$ (Negative): The process is spontaneous in the forward direction. - If $\Delta G > 0$ (Positive): The process is non-spontaneous (spontaneous in the reverse direction). - If $\Delta G = 0$: The system is at equilibrium. 3. **Physical Meaning:** A negative ΔG indicates that the system's capacity to do useful work has decreased, moving it towards a more stable state.

Final Answer: For a spontaneous process, ΔG must be negative.

Answer: (B)



Q30.

Solution**Concept:**

When calculating the pH of very dilute strong acid solutions (concentration $\leq 10^{-7}$ M), the auto-ionization of water cannot be ignored. Water contributes 10^{-7} M of H^+ ions at 25°C .

Solution:

1. **Total $[H^+]$:** The total concentration of H^+ is the sum of H^+ from the acid and H^+ from the water.

$$[H^+]_{total} = [H^+]_{acid} + [H^+]_{water}$$

$$[H^+]_{total} = 10^{-8} + 10^{-7} \text{ (approximation)}$$

2. **Refined Calculation:** Actually, the presence of acid suppresses the ionization of water (common ion effect). Let x be the $[H^+]$ from water:

$$(10^{-8} + x)(x) = K_w = 10^{-14}$$

3. **Resulting Concentration:** Solving the quadratic gives $[H^+]_{total} \approx 1.05 \times 10^{-7}$ M. 4. **pH Calculation:**

$$\text{pH} = -\log(1.05 \times 10^{-7})$$

$$\text{pH} = 7 - \log(1.05) \approx 6.98$$

5. **Logic Check:** The solution must be slightly acidic ($\text{pH} < 7$) since we are adding an acid. A pH of 8 (which simple calculation would suggest) is impossible for an acid.

Final Answer: The pH is approximately 6.98.

Answer: (C)



Q31.

Solution**Concept:**

Molar conductivity (Λ_m) is defined as the conducting power of all the ions produced by dissolving one mole of an electrolyte in solution. It is related to electrolytic conductivity (κ) by the formula:

$$\Lambda_m = \frac{\kappa}{C}$$

where κ is the conductivity and C is the molar concentration.

Solution:

1. **Conductivity (κ) units:** The units for κ are $S\text{ cm}^{-1}$ (Siemens per centimeter) or $\Omega^{-1}\text{ cm}^{-1}$. 2.

Concentration (C) units: Concentration is typically expressed in mol cm^{-3} for unit consistency in this formula. 3. **Unit Derivation:**

$$\Lambda_m = \frac{S\text{ cm}^{-1}}{\text{mol cm}^{-3}} = S\text{ cm}^2\text{ mol}^{-1}$$

4. **Alternative units:** In SI units, it is expressed as $S\text{ m}^2\text{ mol}^{-1}$. However, in most laboratory measurements and MHT-CET problems, the centimeter-based unit is standard.

Final Answer: The unit of molar conductivity is $S\text{ cm}^2\text{ mol}^{-1}$.

Answer: (A)

Q32.

Solution**Concept:**

Colligative properties are properties of a solution that depend solely on the total number of solute particles (concentration) and not on the chemical nature or identity of the solute. There are four primary colligative properties: 1. Relative lowering of vapor pressure. 2. Elevation in boiling point. 3. Depression in freezing point. 4. Osmotic pressure.

Solution:

1. **Analysis of Options:** - **Boiling point** and **Freezing point** are characteristics of a substance, but their **change** (elevation/depression) is a colligative property. - **Vapor pressure** is a property of the liquid, but its **lowering** is a colligative property. 2. **Osmotic Pressure:** This is the pressure that must be applied to a solution to prevent the inward flow of its pure solvent across a semipermeable membrane. It is directly proportional to the molarity of the solute ($\Pi = CRT$). 3. **Distinction:** While the other options mention the base property, "Osmotic Pressure" is the only one listed in its correct form as a colligative property.

Final Answer: Osmotic pressure is a colligative property.

Answer: (A)



Q33.

Solution**Concept:**

The units of the rate constant (k) for a reaction of order n are given by the general formula:

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

By matching the given units to this formula, we can determine the order of the reaction.

Solution:

1. **Given Units:** The units provided are $\text{L mol}^{-1} \text{ s}^{-1}$. 2. **Rearranging for Comparison:** This is equivalent to $(\text{mol L}^{-1})^{-1} \text{ s}^{-1}$. 3. **Applying the Formula:** Set the exponent equal to the given exponent:

$$1 - n = -1$$

$$n = 1 + 1 = 2$$

4. **Verification:** For a second-order reaction, the rate law is $\text{Rate} = k[A]^2$.

$$k = \frac{\text{Rate}}{[A]^2} = \frac{\text{mol L}^{-1} \text{ s}^{-1}}{(\text{mol L}^{-1})^2} = \text{L mol}^{-1} \text{ s}^{-1}$$

Final Answer: The reaction is of second order ($n = 2$).

Answer: (C)

Q34.

Solution**Concept:**

The Hall-Heroult process is the industrial method for the smelting of aluminum. Pure Al_2O_3 (alumina) has a very high melting point (over 2000°C), which makes direct electrolysis difficult and expensive.

Solution:

1. **The Electrolyte Mixture:** To lower the melting point and increase conductivity, alumina is dissolved in a molten solvent. 2. **Role of Cryolite:** Molten cryolite (Na_3AlF_6) acts as a solvent, lowering the melting point of the mixture to about 950°C . 3. **Role of Fluorspar:** Fluorspar (CaF_2) is also added to further decrease the melting point and increase the fluidity of the melt. 4. **Electrode Reactions:** The aluminum is reduced at the cathode, while oxygen is released at the carbon anode, reacting with it to form CO_2 .

Final Answer: The electrolyte is molten Al_2O_3 mixed with Na_3AlF_6 .

Answer: (A)



Q35.

Solution**Concept:**

The extraction of metals begins with identifying their naturally occurring minerals (ores). Ores are minerals from which a metal can be extracted profitably.

Solution:

1. **Bauxite** ($Al_2O_3 \cdot 2H_2O$): This is the primary ore of Aluminum. 2. **Haematite** (Fe_2O_3): This is the most important oxide ore of Iron. It is used in the blast furnace for the production of pig iron. 3. **Cassiterite** (SnO_2): This is the main ore of Tin (Sn). 4. **Galena** (PbS): This is the primary sulfide ore of Lead (Pb).

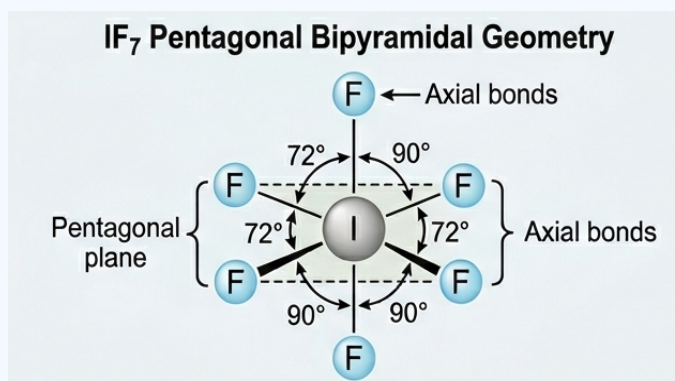
Final Answer: Haematite is an ore of Iron.

Answer: (B)

Q36.

Solution**Concept:**

The shape of a molecule is determined by the number of bonding pairs and lone pairs of electrons around the central atom, according to the Valence Shell Electron Pair Repulsion (VSEPR) theory. For an AX_7 type molecule, the central atom must accommodate seven electron pairs in its valence shell.

**Solution:**

1. **Central Atom Analysis:** In Iodine Heptafluoride (IF_7), Iodine is the central atom. It belongs to Group 17 and has 7 valence electrons. 2. **Bonding:** Iodine forms seven single covalent bonds with seven Fluorine atoms. There are 7 bond pairs and 0 lone pairs. 3. **Hybridization:** The steric number is 7, which corresponds to sp^3d^3 hybridization. 4. **Geometry:** To minimize repulsion, the seven electron pairs arrange themselves directed towards the corners of a pentagonal bipyramid. Five Fluorine atoms occupy the equatorial positions (forming a pentagon) with bond angles of 72° , and two Fluorine atoms occupy the axial positions (above and below the plane) with bond angles of 90° to the plane.

Final Answer: The shape of IF_7 is Pentagonal Bipyramidal.

Answer: (A)



Q37.

Solution**Concept:**

The maximum oxidation state of a transition metal is generally limited by the number of electrons available in its $(n - 1)d$ and ns shells. While most transition metals peak at +7 (like Manganese), some heavy d-block elements in the $4d$ and $5d$ series can reach higher states due to the expansion of their valence shells.

Solution:

1. **Element Position:** Osmium (Os) is a $5d$ transition element (Group 8). Its electronic configuration is $[Xe]4f^{14}5d^66s^2$. 2. **Valence Electrons:** It has 8 electrons available for bonding in its outermost shells ($5d + 6s$). 3. **Oxidation State:** In compounds like Osmium tetroxide (OsO_4), Osmium shares all 8 of these electrons with oxygen atoms.

$$x + 4(-2) = 0 \implies x = +8$$

4. **Comparison:** Ruthenium (Ru) also shows +8, but +8 is the highest recognized oxidation state for Osmium in stable chemical compounds.

Final Answer: The maximum oxidation state shown by Osmium is +8.

Answer: (C)

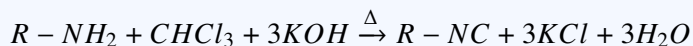
Q38.

Solution**Concept:**

The Carbylamine reaction (also known as the Isocyanide test) is a highly sensitive chemical test used to detect the presence of primary amines. It involves the reaction of the amine with chloroform and alcoholic potassium hydroxide.

Solution:

1. **Reaction Mechanism:** Primary amines react with chloroform ($CHCl_3$) and ethanolic KOH to form isocyanides (carbylamines), which are characterized by an extremely foul or offensive smell.



2. **Specificity:** This reaction is **only** given by primary (1°) aliphatic and aromatic amines. Secondary (2°) and tertiary (3°) amines do not undergo this reaction because they do not have the required two hydrogen atoms on the nitrogen to eliminate. 3. **Analysis of Options:** - **Aniline** ($C_6H_5NH_2$): Primary aromatic amine. Gives the test. - **N-Methylaniline:** Secondary amine. Does not give the test. - **N,N-Dimethylaniline:** Tertiary amine. Does not give the test. - **Triethylamine:** Tertiary amine. Does not give the test.

Final Answer: Aniline gives the Carbylamine test.

Answer: (A)



Q39.

Solution**Concept:**

Many vitamins and biological molecules are coordination complexes that contain a specific metal ion at their center which is essential for their biological activity.

Solution:

1. **Vitamin B_{12}** : Also known as Cyanocobalamin. It is a complex organometallic compound. 2.

Central Metal: The "cobal" in the name refers to the metal Cobalt (Co). The metal ion is situated in the center of a corrin ring (similar to the porphyrin ring in heme). 3. **Comparison with others:**

- **Magnesium (Mg):** Found in Chlorophyll. - **Iron (Fe):** Found in Haemoglobin and Myoglobin. -

Zinc (Zn): Found in enzymes like Carbonic anhydrase and Carboxypeptidase.

Final Answer: Vitamin B_{12} contains Cobalt.

Answer: (C)

Q40.

Solution**Concept:**

Polymers can be classified based on their thermal properties into thermoplastics and thermosetting plastics. 1. **Thermoplastics:** Soften on heating and can be remolded. 2. **Thermosetting polymers:** Undergo permanent chemical change (extensive cross-linking) upon heating and cannot be remolded or reused.

Solution:

1. **Composition:** Bakelite is a phenol-formaldehyde resin. 2. **Structure:** It is formed by the condensation of phenol and formaldehyde. Initially, it forms a linear polymer (Novolac), but upon further heating with formaldehyde, it develops a three-dimensional network of covalent cross-links.

3. **Properties:** Due to this rigid, cross-linked structure, it becomes infusible and insoluble. It does not soften upon reheating. 4. **Classification:** Because of these characteristics, it is the classic example of a thermosetting polymer.

Final Answer: Bakelite is a thermosetting polymer.

Answer: (C)



Q41.

Solution**Concept:**

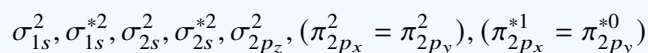
Molecular Orbital Theory (MOT) is used to determine the bond order of diatomic molecules. Bond order is calculated using the formula:

$$\text{Bond Order} = \frac{1}{2}(N_b - N_a)$$

where N_b is the number of electrons in bonding orbitals and N_a is the number of electrons in anti-bonding orbitals.

Solution:

1. **Electronic Configuration:** Oxygen (O_2) has 16 electrons. The O_2^+ ion (Dioxygenyl cation) is formed by losing one electron, so it has 15 electrons. 2. **MO Configuration (O_2^+):** The distribution of 15 electrons is:



3. **Counting Electrons:** - Bonding electrons (N_b): 2 (from σ_{1s}) + 2 (from σ_{2s}) + 2 (from σ_{2p_z}) + 4 (from π_{2p}) = 10 - Anti-bonding electrons (N_a): 2 (from σ_{1s}^*) + 2 (from σ_{2s}^*) + 1 (from π_{2p}^*) = 5

4. **Calculation:**

$$\text{Bond Order} = \frac{10 - 5}{2} = \frac{5}{2} = 2.5$$

5. **Comparison:** The bond order of O_2 is 2.0. Removing an anti-bonding electron increases the bond order and stability.

Final Answer: The bond order of O_2^+ is 2.5.

Answer: (B)



Q42.

Solution**Concept:**

The solubility of a gas in a liquid depends on temperature and pressure. This is quantitatively described by Henry's Law, which states that at a constant temperature, the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas above the liquid.

Solution:

1. **Effect of Pressure:** Increasing the pressure of the gas above the liquid increases the rate at which gas molecules strike the surface and enter the liquid phase. Therefore, solubility **increases** with **increase in pressure**.
2. **Effect of Temperature:** Dissolving a gas in a liquid is generally an exothermic process. According to Le Chatelier's principle, increasing the temperature shifts the equilibrium towards the gas phase, meaning solubility **decreases** with **increase in temperature**.
3. **Conclusion:** Among the given options, the factor that leads to an increase in solubility is the increase in pressure (as seen in carbonated beverages).

Final Answer: Solubility increases with increase in pressure.

Answer: (C)

Q43.

Solution**Concept:**

Standard Electrode Potential can be expressed in two ways: Standard Reduction Potential (SRP) and Standard Oxidation Potential (SOP). According to IUPAC convention, "Standard Electrode Potential" refers specifically to the SRP.

Solution:

1. **Relationship:** For any given half-cell, the Standard Oxidation Potential is the negative of the Standard Reduction Potential.

$$E_{ox}^{\circ} = -E_{red}^{\circ}$$

2. **Given Data:** The standard reduction potential of Zinc ($Zn^{2+} + 2e^{-} \rightarrow Zn$) is given as -0.76 V .
3. **Calculation:** The standard oxidation potential ($Zn \rightarrow Zn^{2+} + 2e^{-}$) is:

$$E_{ox}^{\circ} = -(-0.76\text{ V}) = +0.76\text{ V}$$

4. **Significance:** A positive SOP indicates that the metal has a strong tendency to lose electrons (undergo oxidation) relative to the standard hydrogen electrode.

Final Answer: The standard oxidation potential is $+0.76\text{ V}$.

Answer: (A)



Q44.

Solution**Concept:**

In coordination chemistry, the coordination number (CN) is defined as the total number of coordinate bonds formed between the central metal atom/ion and the ligands. This depends on the number of donor atoms provided by each ligand (denticity).

Solution:

1. **Analysis of Complex:** In the complex ion $[Fe(CN)_6]^{4-}$, Iron (Fe) is the central metal. 2.

Ligand Analysis: The ligand is the cyanide ion (CN^-). Cyanide is a monodentate ligand, meaning each CN^- ion donates exactly one pair of electrons to form one coordinate bond with the metal. 3.

Counting Bonds: Since there are six CN^- ligands attached to the Fe center, there are a total of 6 coordinate bonds. 4. **Result:** The coordination number of Fe in this complex is 6. This leads to an octahedral arrangement of the cyanide groups around the iron.

Final Answer: The coordination number is 6.

Answer: (C)

Q45.

Solution**Concept:**

Electron affinity (or Electron Gain Enthalpy) is the energy change that occurs when an electron is added to a neutral gaseous atom. Generally, it increases across a period and decreases down a group, but the halogen group contains a famous anomaly.

Solution:

1. **Trend:** Halogens have high electron affinities because they need only one electron to achieve a noble gas configuration. 2. **Fluorine vs. Chlorine:** Usually, affinity should decrease from Fluorine to Chlorine. However, the Fluorine atom is very small. When an electron is added to its compact $2p$ subshell, it experiences significant inter-electronic repulsion from the electrons already present. 3. **Chlorine (Cl):** In Chlorine, the incoming electron enters the larger $3p$ subshell. The inter-electronic repulsions are much lower compared to Fluorine. 4. **Result:** Chlorine actually has a more negative electron gain enthalpy (higher electron affinity) than Fluorine. This makes Chlorine the element with the highest electron affinity in the entire periodic table.

Final Answer: Chlorine has the highest electron affinity.

Answer: (B)



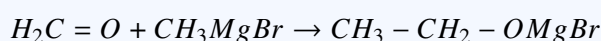
Q46.

Solution**Concept:**

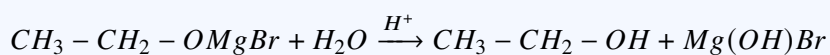
The reaction between a Grignard reagent ($RMgX$) and a carbonyl compound is a nucleophilic addition reaction. The alkyl group of the Grignard reagent acts as a nucleophile (R^-) and attacks the electrophilic carbonyl carbon. 1. Reaction with Formaldehyde yields a primary (1°) alcohol. 2. Reaction with other Aldehydes yields a secondary (2°) alcohol. 3. Reaction with Ketones yields a tertiary (3°) alcohol.

Solution:

1. **Nucleophilic Attack:** Formaldehyde ($HCHO$) reacts with Methyl magnesium bromide (CH_3MgBr). The methyl group (CH_3^-) attacks the carbon of formaldehyde.



2. **Hydrolysis:** The addition product (adduct) is then hydrolyzed in the presence of acid to yield the final alcohol.



3. **Product Identification:** The resulting molecule is CH_3CH_2OH , which is Ethanol.

Final Answer: The product is Ethanol.

Answer: (A)

Q47.

Solution**Concept:**

Ligands are classified based on the number of donor atoms they use to bind to a single metal ion (denticity): 1. **Monodentate:** One donor atom (e.g., NH_3 , H_2O , Cl^-). 2. **Didentate:** Two donor atoms (e.g., Oxalate, Ethylenediamine). 3. **Polydentate:** Three or more donor atoms.

Solution:

1. **Ammonia (NH_3):** Monodentate; only the Nitrogen atom donates a lone pair. 2. **Oxalate ($C_2O_4^{2-}$):** Didentate; two Oxygen atoms donate lone pairs. 3. **Ethylenediamine (en):** Didentate; two Nitrogen atoms donate lone pairs. 4. **EDTA (Ethylenediaminetetraacetate):** EDTA is a hexadentate ligand. It has six donor atoms (two Nitrogen atoms and four Oxygen atoms from the carboxylate groups) that can bind to a single metal ion, forming a very stable ring structure known as a chelate. Because it has many donor sites, it is categorized as a polydentate ligand.

Final Answer: EDTA is a polydentate ligand.

Answer: (D)



Q48.

Solution

Concept:

Metaphosphoric acids are polymers with the general formula $(HPO_3)_n$. They can exist in linear or cyclic forms. The cyclic forms are characterized by a ring of alternating Phosphorus and Oxygen atoms.

Solution:

1. **Cyclic Trimeta-phosphoric Acid:** The most common cyclic form is the trimer, $(HPO_3)_3$.

2. **Structure:** The structure consists of a six-membered ring containing three Phosphorus atoms and three Oxygen atoms in an alternating sequence (P-O-P-O-P-O).

3. **Bond Count:** Because the Phosphorus atoms are linked together by bridging Oxygen atoms in a closed loop, the number of $P-O-P$ linkages is equal to the number of phosphorus atoms in the ring.

4. **Calculation:** In $(HPO_3)_3$, there are 3 Phosphorus atoms, therefore there are 3 $P-O-P$ bonds.

Final Answer: The number of $P-O-P$ bonds is 3.

Answer: (B)

Q49.

Solution

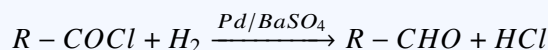
Concept:

The Rosenmund reduction is a specific catalytic hydrogenation reaction used to convert an acid chloride into an aldehyde. To prevent further reduction of the resulting aldehyde into an alcohol, the catalyst must be partially deactivated or "poisoned."

Solution:

1. **Reagents:** The reaction uses Hydrogen gas (H_2) in the presence of Palladium (Pd) supported on Barium sulfate ($BaSO_4$), often with a small amount of sulfur or quinoline as a poison.

2. **Mechanism:** The acid chloride ($RCOCl$) reacts with hydrogen on the surface of the poisoned catalyst.



3. **Product:** The product formed is an Aldehyde. Ketones cannot be prepared by this method because the starting material would need to be a different functional group that does not undergo this specific reduction.

Final Answer: Rosenmund reduction is used for the synthesis of Aldehydes.

Answer: (B)



Q50.

Solution**Concept:**

The ideal gas constant (R) is a physical constant featured in many fundamental equations, such as the Ideal Gas Law ($PV = nRT$). Its numerical value depends on the units used for pressure, volume, and temperature.

Solution:

1. **Standard Values:** In SI units, $R = 8.314 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$ (using Pascals and cubic meters). 2.

Common Units in Chemistry: When Pressure (P) is in atmospheres (atm) and Volume (V) is in liters (L):

$$R = \frac{PV}{nT} = \frac{(1 \text{ atm}) \times (22.414 \text{ L})}{(1 \text{ mol}) \times (273.15 \text{ K})}$$

3. **Numerical Calculation:**

$$R \approx 0.082057 \approx 0.0821 \text{ L} \cdot \text{atm} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$$

4. **Other units:** R can also be expressed as $1.987 \text{ cal} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$ or $8.314 \text{ kPa} \cdot \text{L} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$.

Final Answer: The value of R is $0.0821 \text{ in } \text{L} \cdot \text{atm} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$.

Answer: (B)



Answer Key

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

