

# MHT-CET Chemistry Sample Paper-4

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 major product obtained when 2-bromobutane is treated with alcoholic  $KOH$  is 2-butene. This reaction is a characteristic example of:

- (A) Substitution reaction
- (B) Saytzeff elimination
- (C) Hoffmann elimination
- (D) Addition reaction

**Q2.** The correct order of increasing acid strength for the following compounds is: (I) Phenol, (II) p-Nitrophenol, (III) m-Nitrophenol, (IV) Ethanol.

- (A)  $IV < I < III < II$
- (B)  $I < IV < III < II$
- (C)  $IV < I < II < III$
- (D)  $I < III < II < IV$

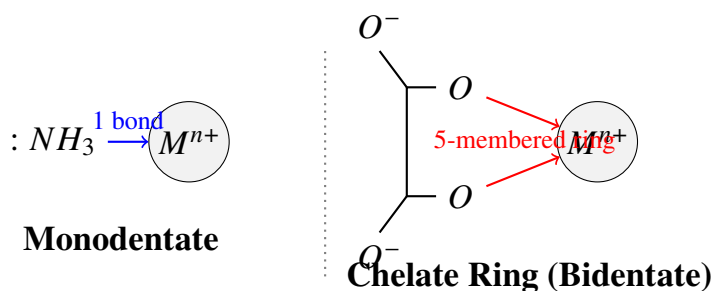
**Q3.** In a face-centered cubic (fcc) arrangement of  $A$  and  $B$  atoms, where  $A$  atoms are at the corners and  $B$  atoms are at the face centers, if one atom of  $A$  is missing from a corner, the formula of the compound is:

- (A)  $A_7B_{24}$



- (B)  $A_7B_8$   
 (C)  $A_1B_3$   
 (D)  $A_7B_3$

**Q4.** Which of the following ligands forms a chelate complex with a metal ion?



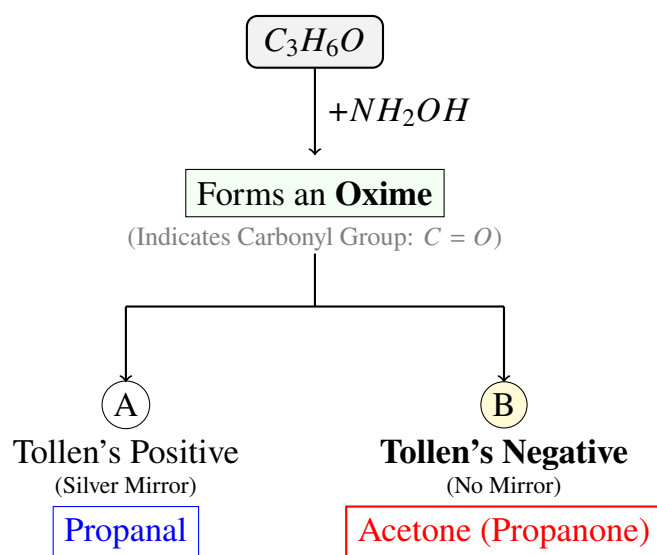
- (A)  $\text{SCN}^-$   
 (B) *Oxalate*  
 (C)  $\text{Cl}^-$   
 (D)  $\text{NH}_3$

**Q5.** The standard reduction potentials of three metals X, Y, and Z are 0.52 V,  $-3.06$  V, and  $-1.18$  V respectively. The order of reducing power of the corresponding metals is:

- (A)  $Y > Z > X$   
 (B)  $X > Y > Z$   
 (C)  $Z > Y > X$   
 (D)  $Y > X > Z$

**Q6.** An organic compound with molecular formula  $\text{C}_3\text{H}_6\text{O}$  does not give a silver mirror with Tollen's reagent but forms an oxime with hydroxylamine. The compound is:





- (A) Propanal
- (B) Propanol
- (C) Acetone
- (D) Dimethyl ether

**Q7.** The hybridization of the central atom in  $XeF_4$  and its shape are respectively:

- (A)  $sp^3d$ , seesaw
- (B)  $sp^3d^2$ , square planar
- (C)  $sp^3d^2$ , octahedral
- (D)  $sp^3d$ , square pyramidal

**Q8.** What is the total number of optical isomers possible for a compound with two non-identical asymmetric carbon atoms?

- (A) 2
- (B) 3
- (C) 4
- (D) 8

**Q9.** Which of the following p-block elements does not show an oxidation state higher than +2 due to the inert pair effect?




- (A) *Sn*  
 (B) *Pb*  
 (C) *Ge*  
 (D) *Si*  
 (E)

**Q10.** The molar conductivity of a 0.05 M solution of  $MgCl_2$  is  $190 \text{ S cm}^2 \text{ mol}^{-1}$  at 298 K. Its conductivity ( $\kappa$ ) is:

- (A)  $0.0095 \text{ S cm}^{-1}$   
 (B)  $0.095 \text{ S cm}^{-1}$   
 (C)  $0.95 \text{ S cm}^{-1}$   
 (D)  $9.5 \text{ S cm}^{-1}$

**Q11.** The magnetic moment of a transition metal ion is 3.87 BM. The number of unpaired electrons present in it is:



*d*-orbitals with  $n = 3$  unpaired electrons

$n$	$\mu$ (BM)
1	1.73
2	2.83
<b>3</b>	<b>3.87</b>
4	4.90
5	5.92

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

- (A) 2  
 (B) 3  
 (C) 4  
 (D) 5

**Q12.** Which of the following is a biodegradable polymer?

- (A) *Buna - S*  
 (B) *Nylon - 6, 6*  
 (C) *PHBV*



(D) *Bakelite*

**Q13.** For the reaction  $2A + B \rightarrow C$ , the rate law is given by  $Rate = k[A]^2[B]$ . If the concentration of  $A$  is doubled and  $B$  is halved, the rate of reaction will:

- (A) Increase by 4 times
- (B) Increase by 2 times
- (C) Decrease by 2 times
- (D) Remain the same

**Q14.** Which property of colloids is responsible for the blue color of the sky?

- (A) Electrophoresis
- (B) Coagulation
- (C) Tyndall effect
- (D) Brownian movement

**Q15.** The peptide linkage formed during the condensation of amino acids is chemically an:

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

**Q16.** The rate constant for a first-order reaction is  $4.606 \times 10^{-3} \text{ s}^{-1}$ . The time required to reduce 2.0 g of the reactant to 0.2 g is:

- (A) 200 s
- (B) 500 s
- (C) 1000 s
- (D) 100 s



- Q17.** Which of the following compounds will undergo Cannizzaro reaction when treated with 50% aqueous  $KOH$ ?
- (A) Acetaldehyde
  - (B) Propionaldehyde
  - (C) Benzaldehyde
  - (D) Acetone
- Q18.** The element that shows the maximum number of oxidation states in the  $3d$  transition series is:
- (A)  $Sc$
  - (B)  $Fe$
  - (C)  $Mn$
  - (D)  $Cr$
- Q19.** The boiling point of a 0.2 m solution of a non-electrolyte in water is ( $K_b$  for water is  $0.52 \text{ K kg mol}^{-1}$ ):
- (A)  $100.52 \text{ }^\circ\text{C}$
  - (B)  $100.104 \text{ }^\circ\text{C}$
  - (C)  $100.0104 \text{ }^\circ\text{C}$
  - (D)  $101.04 \text{ }^\circ\text{C}$
- Q20.** Which of the following is a neutral complex?
- (A)  $[Fe(H_2O)_6]Cl_3$
  - (B)  $K_4[Fe(CN)_6]$
  - (C)  $[Ni(CO)_4]$
  - (D)  $[Cu(NH_3)_4]SO_4$
- Q21.** The monomers of Terylene (Dacron) are:
- (A) Ethylene glycol and phthalic acid

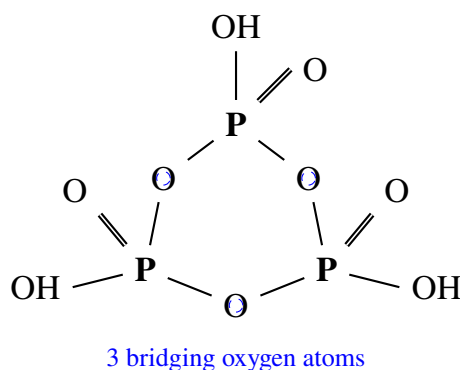


- (B) Ethylene glycol and terephthalic acid
- (C) Hexamethylenediamine and adipic acid
- (D) Phenol and formaldehyde

**Q22.** The reagent used in Hinsberg's test to distinguish between primary, secondary, and tertiary amines is:

- (A) Benzene sulphonyl chloride
- (B) Benzene sulphonic acid
- (C) Benzene chloride
- (D) Acetyl chloride

**Q23.** The number of P-O-P bonds in cyclic metaphosphoric acid ( $H_3P_3O_9$ ) is:



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

**Q24.** In the electrolysis of aqueous  $NaCl$ , the gas liberated at the anode is:

- (A)  $O_2$
- (B)  $H_2$
- (C)  $Cl_2$
- (D)  $N_2$

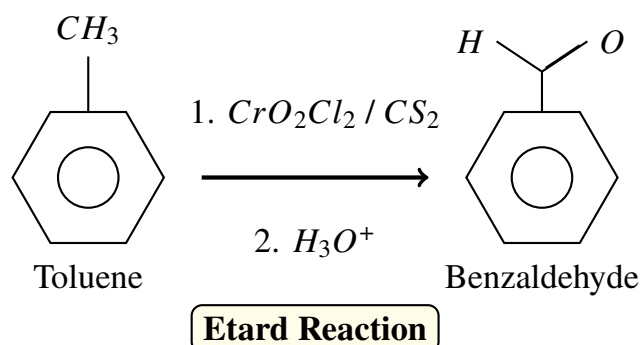


- Q25.** Which of the following carbohydrates is a non-reducing sugar?
- (A) Glucose
  - (B) Fructose
  - (C) Lactose
  - (D) Sucrose
- Q26.** The coordination number of *Co* in  $[Co(en)_3]^{3+}$  is:
- (A) 3
  - (B) 6
  - (C) 4
  - (D) 9
- Q27.** Which of the following is most reactive towards nucleophilic substitution ( $S_N2$ )?
- (A)  $CH_3Cl$
  - (B)  $CH_3CH_2Cl$
  - (C)  $(CH_3)_2CHCl$
  - (D)  $(CH_3)_3CCl$
- Q28.** According to the Mole Concept, the number of atoms present in 11.2 L of  $CO_2$  at STP is:
- (A)  $N_A$
  - (B)  $1.5 N_A$
  - (C)  $0.5 N_A$
  - (D)  $3 N_A$
- Q29.** Which of the following does not have a lone pair on the central atom?
- (A)  $NH_3$
  - (B)  $PH_3$
  - (C)  $BF_3$



(D)  $PCl_3$

**Q30.** The oxidation of toluene with  $CrO_2Cl_2$  to give benzaldehyde is called:



(A) Rosenmund reaction

(B) Etard reaction

(C) Wurtz reaction

(D) Fittig reaction

**Q31.** The number of unpaired electrons in the complex ion  $[CoF_6]^{3-}$  is: (Atomic number of  $Co = 27$ )

(A) 0

(B) 2

(C) 3

(D) 4

**Q32.** The half-life period of a first-order reaction is 69.3 minutes. The rate constant of the reaction is:

(A)  $0.01 \text{ min}^{-1}$

(B)  $0.1 \text{ min}^{-1}$

(C)  $0.001 \text{ min}^{-1}$

(D)  $1.0 \text{ min}^{-1}$

**Q33.** Which of the following elements has the highest electronegativity?



- (A)  $N$
- (B)  $O$
- (C)  $F$
- (D)  $Cl$

**Q34.** The compound that undergoes fastest dehydration with concentrated  $H_2SO_4$  is:

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

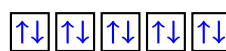
**Q35.** Which of the following is a diamagnetic transition metal ion?

Paramagnetic ( $Ti^{3+}$ )



$d^1$ : 1 Unpaired electron

Diamagnetic ( $Zn^{2+}$ )



$d^{10}$ : 0 Unpaired electrons

- (A)  $Ti^{3+}$
- (B)  $Cu^{2+}$
- (C)  $Zn^{2+}$
- (D)  $Ni^{2+}$

**Q36.** The work done during the expansion of a gas from a volume of  $4 \text{ dm}^3$  to  $6 \text{ dm}^3$  against a constant external pressure of 3 atm is: ( $1 \text{ L atm} = 101.3 \text{ J}$ )

- (A)  $-6 \text{ J}$
- (B)  $-607.8 \text{ J}$
- (C)  $-303.9 \text{ J}$
- (D)  $607.8 \text{ J}$

**Q37.** Which of the following will not give a precipitate with  $AgNO_3$  solution?



- (A)  $[Co(NH_3)_6]Cl_3$
- (B)  $[Co(NH_3)_5Cl]Cl_2$
- (C)  $[Co(NH_3)_3Cl_3]$
- (D)  $[Co(NH_3)_4Cl_2]Cl$

**Q38.** The correct IUPAC name of  $CH_3 - CH(OH) - CH_2 - CHO$  is:

- (A) 3-Hydroxybutanal
- (B) 2-Hydroxybutanal
- (C) 3-Hydroxybutan-1-ol
- (D) 4-Oxobutan-2-ol

**Q39.** Which of the following is an example of an addition polymer?

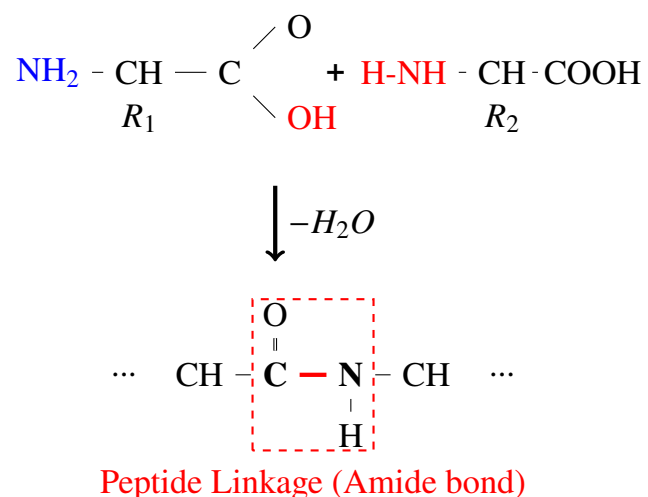
- (A) Nylon-6,6
- (B) Terylene
- (C) Polyethene
- (D) Bakelite

**Q40.** In the equation  $PV = nRT$ , the value of  $R$  depends on:

- (A) Nature of the gas
- (B) Temperature of the gas
- (C) Pressure of the gas
- (D) Units of measurement



**Q41.** The linkage present in proteins between  $\alpha$ -amino acids is:



- (A) Glycosidic linkage
- (B) Peptide linkage
- (C) Phosphodiester linkage
- (D) Hydrogen bond

**Q42.** Which of the following has the smallest ionic radius?

- (A)  $\text{Na}^+$
- (B)  $\text{Mg}^{2+}$
- (C)  $\text{Al}^{3+}$
- (D)  $\text{F}^-$

**Q43.** The product of the reaction between ethyl bromide and alcoholic  $\text{AgCN}$  is:

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

**Q44.** A buffer solution can be prepared by mixing:

- (A)  $\text{CH}_3\text{COOH} + \text{CH}_3\text{COONa}$



- (B)  $HCl + NaCl$
- (C)  $NH_4OH + HCl$  (excess)
- (D)  $NaOH + NaCl$

**Q45.** The process of converting a precipitate into a colloidal sol by adding an electrolyte is called:

- (A) Peptization
- (B) Coagulation
- (C) Dialysis
- (D) Tyndall effect

**Q46.** The coordination number of an atom in a Body-Centered Cubic (bcc) structure is:

- (A) 4
- (B) 6
- (C) 8
- (D) 12

**Q47.** Which of the following is a primary amine?

- (A)  $(CH_3)_2NH$
- (B)  $CH_3NH_2$
- (C)  $(CH_3)_3N$
- (D)  $C_6H_5NHCH_3$

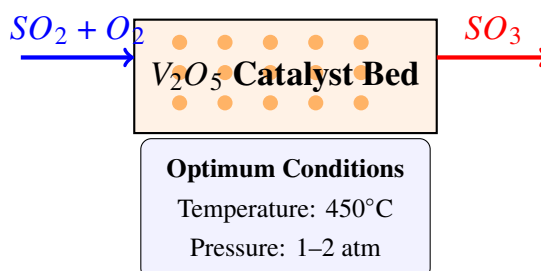
**Q48.** The energy of an electron in the first Bohr orbit of Hydrogen atom is  $-13.6$  eV. The energy in the second orbit is:

- (A)  $-3.4$  eV
- (B)  $-6.8$  eV
- (C)  $-27.2$  eV



(D)  $-1.5 \text{ eV}$

**Q49.** Which catalyst is used in the Contact process for the manufacture of  $H_2SO_4$ ?



- (A)  $Fe$
- (B)  $Pt$
- (C)  $V_2O_5$
- (D)  $Ni$

**Q50.** The  $pH$  of a  $0.001 \text{ M NaOH}$  solution is:

- (A) 3
- (B) 11
- (C) 7
- (D) 14



## Detailed Solutions

Q1.

## Solution

**Concept:**

The reaction of an alkyl halide with alcoholic  $KOH$  involves the elimination of a hydrogen halide molecule (*dehydrohalogenation*). According to Saytzeff's rule, in an elimination reaction, the preferred product is that alkene which has the greater number of alkyl groups attached to the doubly bonded carbon atoms (the more substituted alkene).

**Solution:**

1. 2-bromobutane is a secondary alkyl halide with the structure  $CH_3 - CH(Br) - CH_2 - CH_3$ . 2. When treated with alcoholic  $KOH$ , a base ( $OH^-$ ) abstracts a proton from a  $\beta$ -carbon. 3. There are two types of  $\beta$ -carbons: the terminal  $CH_3$  and the internal  $CH_2$ . 4. If the proton is removed from the  $CH_2$  group, 2-butene is formed. 5. 2-butene is more stable than 1-butene because it is more highly substituted (two methyl groups on the double bond versus one ethyl group). 6. This preference for the more stable, highly substituted alkene is known as Saytzeff's Rule.

**Final Answer:** The reaction follows Saytzeff's elimination rule to form the major product.

Answer: (B)

Q2.

## Solution

**Concept:**

Acidity of organic compounds depends on the stability of the conjugate base (phenoxide or alkoxide ion). Electron-withdrawing groups (EWGs) like  $-NO_2$  increase acidity by stabilizing the negative charge through inductive ( $-I$ ) and resonance ( $-M$ ) effects. Electron-donating groups or lack of resonance stabilization (as in alcohols) decrease acidity.

**Solution:**

1. Ethanol (*IV*) is an aliphatic alcohol. Its conjugate base (ethoxide) is not resonance-stabilized, making it the weakest acid in this group. 2. Phenol (*I*) is more acidic than ethanol because the phenoxide ion is resonance-stabilized by the benzene ring. 3. Nitrophenols are more acidic than phenol due to the electron-withdrawing nitro group. 4. In m-nitrophenol (*III*), the  $-NO_2$  group exerts only a  $-I$  effect. 5. In p-nitrophenol (*II*), the  $-NO_2$  group exerts both  $-I$  and a strong  $-M$  (mesomeric) effect, providing maximum stabilization to the phenoxide ion. 6. Therefore, the acidity order is: Ethanol < Phenol < m-Nitrophenol < p-Nitrophenol.

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

Answer: (A)



Q3.

**Solution****Concept:**

In a cubic crystal system, an atom at the corner is shared by 8 adjacent unit cells, contributing  $1/8$  to one unit cell. An atom at the face center is shared by 2 unit cells, contributing  $1/2$  to one unit cell.

**Solution:**

1. A standard fcc unit cell has 8 corners and 6 faces. 2. Number of *A* atoms at corners =  $8 \times (1/8) = 1$ . 3. Number of *B* atoms at face centers =  $6 \times (1/2) = 3$ . 4. The problem states one *A* atom is missing from a corner. 5. Remaining *A* atoms = 7 corners. 6. Effective number of *A* atoms =  $7 \times (1/8) = 7/8$ . 7. Effective number of *B* atoms remains = 3. 8. The ratio *A* : *B* is  $7/8 : 3$ . 9. Multiplying by 8 to get whole numbers: *A* = 7, *B* = 24. 10. The formula is  $A_7B_{24}$ .

**Final Answer:** The formula of the compound is  $A_7B_{24}$ .

Answer: (A)

Q4.

**Solution****Concept:**

A chelate complex is formed when a polydentate ligand (a ligand with two or more donor atoms) bonds to a single central metal ion, creating a ring structure. These ligands are called chelating agents.

**Solution:**

1.  $SCN^-$  (Thiocyanate) is a monodentate ligand (can bind through *S* or *N*, but only one at a time). 2.  $Cl^-$  (Chloride) is a monodentate ligand. 3.  $NH_3$  (Ammonia) is a monodentate ligand with one lone pair on nitrogen. 4. Oxalate ( $C_2O_4^{2-}$ ) is a bidentate ligand. It has two oxygen atoms that can simultaneously donate electron pairs to the same metal ion. 5. Because the oxalate ion binds at two points, it forms a stable five-membered ring with the metal, which is a chelate.

**Final Answer:** Oxalate is a chelating ligand.

Answer: (B)



Q5.

**Solution****Concept:**

The reducing power of a metal refers to its ability to lose electrons (undergo oxidation). A species with a lower (more negative) standard reduction potential has a higher tendency to be oxidized and, therefore, acts as a stronger reducing agent.

**Solution:**

1. Given standard reduction potentials ( $E^\circ$ ): -  $X = +0.52 \text{ V}$  -  $Y = -3.06 \text{ V}$  -  $Z = -1.18 \text{ V}$  2. To find the strongest reducing agent, we look for the most negative value. 3.  $Y$  has the most negative potential ( $-3.06 \text{ V}$ ), so it is the strongest reducing agent. 4.  $Z$  is the next most negative ( $-1.18 \text{ V}$ ). 5.  $X$  has a positive potential ( $+0.52 \text{ V}$ ), making it the weakest reducing agent among the three. 6. The order of reducing power is  $Y > Z > X$ .

**Final Answer:** The reducing power follows the order  $Y > Z > X$ .

**Answer:** (A)

Q6.

**Solution****Concept:**

The molecular formula  $C_3H_6O$  corresponds to the general formula  $C_nH_{2n}O$ , which represents either an aldehyde or a ketone. Tollen's reagent (ammoniacal silver nitrate) is used to distinguish between them; aldehydes reduce Tollen's reagent to form a silver mirror, while ketones do not. Both aldehydes and ketones react with hydroxylamine ( $NH_2OH$ ) to form oximes.

**Solution:**

1. The molecular formula  $C_3H_6O$  allows for two functional isomers: Propanal ( $CH_3CH_2CHO$ ) and Acetone ( $CH_3COCH_3$ ). 2. The problem states the compound does not give a silver mirror with Tollen's reagent. This rules out Propanal (an aldehyde). 3. The compound forms an oxime with hydroxylamine, confirming it contains a carbonyl group ( $C = O$ ). 4. Acetone (Propan-2-one) is a ketone. Ketones do not react with Tollen's reagent but do undergo nucleophilic addition with  $NH_2OH$  to form acetoxime ( $(CH_3)_2C = N - OH$ ). 5. Therefore, the compound is Acetone.

**Final Answer:** The compound is Acetone.

**Answer:** (C)



Q7.

**Solution****Concept:**

The geometry and hybridization of a molecule can be determined using Valence Shell Electron Pair Repulsion (VSEPR) theory and the Steric Number formula:

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

where  $V$  = valence electrons of central atom,  $M$  = number of monovalent atoms,  $C$  = cationic charge, and  $A$  = anionic charge.

**Solution:**

1. For  $XeF_4$ , the central atom is Xenon ( $Xe$ ), which has 8 valence electrons ( $V = 8$ ). 2. There are 4 monovalent Fluorine atoms ( $M = 4$ ). 3. Steric Number =  $\frac{1}{2}[8 + 4] = 6$ . 4. A steric number of 6 corresponds to  $sp^3d^2$  hybridization. 5. In  $XeF_4$ , there are 4 bond pairs and 2 lone pairs ( $6 - 4 = 2$ ). 6. According to VSEPR theory, for an octahedral electronic geometry with 2 lone pairs, the lone pairs occupy opposite positions to minimize repulsion, resulting in a Square Planar molecular shape.

**Final Answer:** The hybridization is  $sp^3d^2$  and the shape is square planar.

**Answer: (B)**

Q8.

**Solution****Concept:**

For a molecule with  $n$  number of asymmetric (chiral) carbon atoms that are not identical (i.e., the molecule cannot be divided into two equal halves/has no plane of symmetry), the number of optical isomers is calculated using the formula derived from van't Hoff's rule.

**Solution:**

1. The number of optical isomers (enantiomers and diastereomers) for a compound with  $n$  non-identical chiral centers is given by:

$$\text{Total Optical Isomers} = 2^n$$

2. In this problem, it is specified that there are two non-identical asymmetric carbon atoms, so  $n = 2$ . 3. Applying the formula:

$$2^2 = 4$$

4. These four isomers consist of two pairs of enantiomers. Since the centers are non-identical, no meso form (internally compensated inactive form) is possible.

**Final Answer:** The total number of optical isomers is 4.

**Answer: (C)**



Q9.

**Solution****Concept:**

The inert pair effect refers to the reluctance of the outermost s-electrons to participate in chemical bonding due to poor shielding by intervening d and f electrons. This effect becomes more pronounced as we move down a group in the p-block, making the oxidation state that is 2 less than the group oxidation state more stable.

**Solution:**

1. Silicon (*Si*), Germanium (*Ge*), Tin (*Sn*), and Lead (*Pb*) all belong to Group 14. 2. The general valence shell configuration for Group 14 is  $ns^2np^2$ . The possible oxidation states are +4 and +2. 3. As we descend the group, the stability of the +2 oxidation state increases relative to the +4 state. 4. Lead (*Pb*) is the heaviest element in this list. Due to the very strong inert pair effect in *Pb*, the  $6s^2$  electrons are very tightly held. 5. Consequently, *Pb* predominantly shows the +2 oxidation state and is very difficult to oxidize to +4.

**Final Answer:** Lead (*Pb*) shows a stable +2 state due to the inert pair effect.

**Answer: (B)**

Q10.

**Solution****Concept:**

Molar conductivity ( $\Lambda_m$ ) is related to the specific conductivity ( $\kappa$ ) and the molarity ( $M$ ) of the solution by the following mathematical formula:

$$\Lambda_m = \frac{\kappa \times 1000}{M}$$

where  $\kappa$  is in  $S\text{ cm}^{-1}$  and  $M$  is in  $\text{mol L}^{-1}$ .

**Solution:**

1. Given values: - Molar conductivity ( $\Lambda_m$ ) =  $190\text{ S cm}^2\text{ mol}^{-1}$  - Molarity ( $M$ ) =  $0.05\text{ M}$  2. We need to find conductivity ( $\kappa$ ). Rearranging the formula:

$$\kappa = \frac{\Lambda_m \times M}{1000}$$

3. Substitute the values:

$$\kappa = \frac{190 \times 0.05}{1000}$$

4. Calculate the numerator:  $190 \times 0.05 = 9.5$  5. Calculate the final value:

$$\kappa = \frac{9.5}{1000} = 0.0095\text{ S cm}^{-1}$$

**Final Answer:** The conductivity is  $0.0095\text{ S cm}^{-1}$ .

**Answer: (A)**



Q11.

**Solution****Concept:**

The magnetic properties of transition metal ions are determined by the number of unpaired electrons. The "spin-only" formula for calculating the magnetic moment ( $\mu_{eff}$ ) is:

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

where  $n$  is the number of unpaired electrons and BM stands for Bohr Magneton.

**Solution:**

1. We are given the magnetic moment  $\mu_{eff} = 3.87$  BM. 2. Substitute this value into the formula:

$$3.87 = \sqrt{n(n+2)}$$

3. Squaring both sides to remove the square root:

$$(3.87)^2 = n(n+2)$$

$$14.97 \approx 15 = n^2 + 2n$$

4. This gives us the quadratic equation:  $n^2 + 2n - 15 = 0$ . 5. Factoring the equation:

$$(n+5)(n-3) = 0$$

6. Since the number of electrons ( $n$ ) cannot be negative, we take  $n = 3$ . 7. A quick check: If  $n = 3$ , then  $\sqrt{3(3+2)} = \sqrt{15} \approx 3.87$ .

**Final Answer:** The number of unpaired electrons is 3.

**Answer: (B)**



Q12.

**Solution****Concept:**

Polymers are classified as biodegradable or non-biodegradable based on their ability to be decomposed by microorganisms. Most synthetic polymers like polyethene or PVC are non-biodegradable. Biodegradable polymers usually contain functional groups like ester or amide that can be hydrolyzed.

**Solution:**

1. *Buna – S* is a synthetic rubber (styrene-butadiene copolymer) and is non-biodegradable. 2. *Nylon – 6, 6* is a synthetic polyamide. While it contains amide links, its specific structure is highly resistant to natural degradation. 3. *Bakelite* is a cross-linked phenol-formaldehyde resin, which is a thermosetting plastic and extremely resistant to environmental breakdown. 4. *PHBV* (Poly- $\beta$ -hydroxybutyrate-co- $\beta$ -hydroxyvalerate) is a polyester. It is produced by microorganisms and can be completely broken down by them in the environment into water and carbon dioxide. 5. Therefore, *PHBV* is a well-known biodegradable polymer used in specialty packaging and medical applications.

**Final Answer:** *PHBV* is the biodegradable polymer.

**Answer:** (C)



Q13.

**Solution****Concept:**

The rate of a chemical reaction is expressed in terms of the concentration of reactants raised to their respective orders. The general rate equation for the given reaction is:

$$R = k[A]^x[B]^y$$

In this specific case, the rate law is provided as  $Rate = k[A]^2[B]^1$ .

**Solution:**

1. Let the initial rate be  $R_1 = k[A]^2[B]$ . 2. According to the problem, the new concentration of A is  $[A'] = 2[A]$  and the new concentration of B is  $[B'] = \frac{1}{2}[B]$ . 3. Substitute these new values into the rate law to find the new rate  $R_2$ :

$$R_2 = k[2A]^2\left[\frac{1}{2}B\right]$$

4. Simplify the expression:

$$R_2 = k(4[A]^2)\left(\frac{1}{2}[B]\right)$$

5. Rearrange the constants:

$$R_2 = \left(\frac{4}{2}\right)k[A]^2[B]$$

$$R_2 = 2(k[A]^2[B])$$

6. Since  $R_1 = k[A]^2[B]$ , we find that  $R_2 = 2R_1$ . 7. The rate increases by a factor of 2.

**Final Answer:** The rate of reaction will increase by 2 times.

**Answer: (B)**



Q14.

**Solution****Concept:**

The Tyndall effect is the scattering of light as a light beam passes through a colloid. The individual suspension particles scatter and reflect the light, making the beam visible. The intensity of scattering depends on the wavelength of light and the size of the particles.

**Solution:**

1. The atmosphere contains a colloidal suspension of dust, smoke, and water droplets. 2. When sunlight passes through the atmosphere, these fine particles scatter the light. 3. According to Rayleigh's law of scattering, the intensity of scattered light is inversely proportional to the fourth power of the wavelength ( $\lambda^4$ ). 4. Blue light has a shorter wavelength compared to red light, so it is scattered much more strongly (about 10 times more) by the small particles in the air. 5. This scattered blue light reaches our eyes, which is why the sky appears blue. 6. This phenomenon of light scattering by colloidal-sized particles is the Tyndall effect.

**Final Answer:** The Tyndall effect is responsible for the blue color of the sky.

**Answer:** (C)

Q15.

**Solution****Concept:**

Proteins are polymers of  $\alpha$ -amino acids. When two amino acids join together, the carboxyl group ( $-COOH$ ) of one amino acid reacts with the amino group ( $-NH_2$ ) of another amino acid.

**Solution:**

1. The reaction between the  $-COOH$  group and the  $-NH_2$  group involves the elimination of a water molecule ( $H_2O$ ). 2. This is a condensation reaction that results in the formation of a  $-(CO - NH)-$  linkage. 3. In organic chemistry, a functional group consisting of a carbonyl group linked to a nitrogen atom is called an amide. 4. In the specific context of biochemistry and proteins, this amide linkage is specifically referred to as a "peptide linkage" or "peptide bond." 5. Therefore, chemically, the peptide linkage is a substituted amide.

**Final Answer:** The peptide linkage is chemically an amide.

**Answer:** (B)



## Q16.

**Solution****Concept:**

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

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

where  $k$  is the rate constant,  $t$  is the time,  $[R]_0$  is the initial concentration (or mass), and  $[R]$  is the final concentration (or mass).

**Solution:**

1. Given values: -  $k = 4.606 \times 10^{-3} \text{ s}^{-1}$  -  $[R]_0 = 2.0 \text{ g}$  -  $[R] = 0.2 \text{ g}$  2. Rearrange the formula to solve for  $t$ :

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

3. Substitute the values:

$$t = \frac{2.303}{4.606 \times 10^{-3}} \log \left( \frac{2.0}{0.2} \right)$$

4. Simplify the log term:  $\log(10) = 1$ . 5. Simplify the fraction:

$$t = \frac{2.303}{4.606 \times 10^{-3}} \times 1 = \frac{1}{2 \times 10^{-3}}$$

6. Final calculation:

$$t = 0.5 \times 10^3 = 500 \text{ s}$$

**Final Answer:** The time required is 500 s.

**Answer: (B)**



Q17.

**Solution****Concept:**

The Cannizzaro reaction is a disproportionation reaction of aldehydes that **do not** have an  $\alpha$ -hydrogen atom. When treated with a concentrated base (50% aqueous or alcoholic  $KOH$ ), one molecule of the aldehyde is reduced to an alcohol, while another is oxidized to a carboxylic acid salt.

**Solution:**

1. Acetaldehyde ( $CH_3CHO$ ) has three  $\alpha$ -hydrogen atoms. It undergoes aldol condensation. 2. Propionaldehyde ( $CH_3CH_2CHO$ ) has two  $\alpha$ -hydrogen atoms. It undergoes aldol condensation. 3. Acetone ( $CH_3COCH_3$ ) is a ketone with  $\alpha$ -hydrogen atoms. It also undergoes aldol condensation. 4. Benzaldehyde ( $C_6H_5CHO$ ) has the  $-CHO$  group attached directly to the benzene ring. The carbon atom attached to the carbonyl group is part of the ring and has no hydrogen atom. 5. Since Benzaldehyde lacks an  $\alpha$ -hydrogen, it undergoes the Cannizzaro reaction to form benzyl alcohol and potassium benzoate.

**Final Answer:** Benzaldehyde undergoes the Cannizzaro reaction.

**Answer:** (C)

Q18.

**Solution****Concept:**

In transition elements, the number of oxidation states shown by an element depends on the number of electrons in the  $(n-1)d$  and  $ns$  orbitals that can be lost or shared. Elements in the middle of the series generally show the maximum number of oxidation states.

**Solution:**

1. Scandium ( $Sc$ ):  $[Ar]3d^14s^2$ . Shows only +3. 2. Iron ( $Fe$ ):  $[Ar]3d^64s^2$ . Shows +2, +3, +4, +6. 3. Chromium ( $Cr$ ):  $[Ar]3d^54s^1$ . Shows +2, +3, +4, +5, +6. 4. Manganese ( $Mn$ ):  $[Ar]3d^54s^2$ . 5. In Manganese, all 5 electrons in the  $d$ -orbital and 2 electrons in the  $s$ -orbital can participate in bonding. 6. Consequently,  $Mn$  shows the widest range of oxidation states from +2 to +7.

**Final Answer:** Manganese ( $Mn$ ) shows the maximum number of oxidation states.

**Answer:** (C)



Q19.

**Solution****Concept:**

Elevation in boiling point ( $\Delta T_b$ ) is a colligative property. It is calculated using the formula:

$$\Delta T_b = K_b \times m$$

where  $K_b$  is the ebullioscopic constant and  $m$  is the molality of the solution. The boiling point of the solution is  $T_b = T_b^\circ + \Delta T_b$ .

**Solution:**

1. Given values: - Molality ( $m$ ) = 0.2 m -  $K_b$  for water = 0.52 K kg mol<sup>-1</sup> 2. Calculate the elevation in boiling point:

$$\Delta T_b = 0.52 \times 0.2 = 0.104 \text{ K (or } ^\circ\text{C)}$$

3. The normal boiling point of pure water ( $T_b^\circ$ ) is 100 °C. 4. The boiling point of the solution is:

$$T_b = 100 + 0.104 = 100.104 \text{ } ^\circ\text{C}$$

**Final Answer:** The boiling point of the solution is 100.104 °C.

**Answer: (B)**

Q20.

**Solution****Concept:**

A neutral complex is a coordination compound that carries no net electrical charge and does not dissociate into ions when dissolved in water. It is not associated with any counter-ions (like  $Cl^-$  or  $K^+$ ).

**Solution:**

1.  $[Fe(H_2O)_6]Cl_3$  dissociates into  $[Fe(H_2O)_6]^{3+}$  and  $3Cl^-$ . It is a cationic complex.  
 2.  $K_4[Fe(CN)_6]$  dissociates into  $4K^+$  and  $[Fe(CN)_6]^{4-}$ . It is an anionic complex.  
 3.  $[Cu(NH_3)_4]SO_4$  dissociates into  $[Cu(NH_3)_4]^{2+}$  and  $SO_4^{2-}$ . It is a cationic complex.  
 4.  $[Ni(CO)_4]$  (Nickel tetracarbonyl) contains Carbon Monoxide ( $CO$ ), which is a neutral ligand.  
 5. The oxidation state of Nickel in this complex is 0. There are no counter-ions present.  
 6. Therefore, the entire molecule  $[Ni(CO)_4]$  is neutral.

**Final Answer:**  $[Ni(CO)_4]$  is a neutral complex.

**Answer: (C)**



Q21.

**Solution****Concept:**

Terylene, also known as Dacron, is a popular polyester. Polyesters are formed by the condensation polymerization of a dicarboxylic acid and a dihydric alcohol (diol). The reaction involves the elimination of water molecules to form ester linkages.

**Solution:**

1. Terylene is specifically a copolymer. 2. The diol component used is Ethylene glycol ( $HO - CH_2 - CH_2 - OH$ ). 3. The dicarboxylic acid component is Terephthalic acid (Benzene-1,4-dicarboxylic acid). 4. During polymerization, the hydroxyl group of the glycol reacts with the carboxyl group of the acid. 5. This repeated condensation leads to the formation of long chains of polyethylene terephthalate (PET). 6. Option (A) refers to Glyptal (Ethylene glycol and Phthalic acid). Option (C) refers to Nylon-6,6.

**Final Answer:** The monomers are Ethylene glycol and terephthalic acid.

**Answer: (B)**

Q22.

**Solution****Concept:**

Hinsberg's test is a chemical method used to distinguish between primary ( $1^\circ$ ), secondary ( $2^\circ$ ), and tertiary ( $3^\circ$ ) amines. The test involves reacting the amine with Hinsberg's reagent in the presence of an aqueous alkali.

**Solution:**

1. Hinsberg's reagent is Benzene sulphonyl chloride ( $C_6H_5SO_2Cl$ ). 2. Primary amines react with it to form a sulfonamide that is soluble in alkali (due to the presence of an acidic hydrogen on nitrogen). 3. Secondary amines react to form a sulfonamide that is insoluble in alkali (no acidic hydrogen). 4. Tertiary amines do not react with benzene sulphonyl chloride under these conditions. 5. Therefore, by observing the reaction and the solubility of the product in alkali, we can identify the type of amine.

**Final Answer:** The reagent is Benzene sulphonyl chloride.

**Answer: (A)**



Q23.

**Solution****Concept:**

Metaphosphoric acids have the general formula  $(HPO_3)_n$ . They exist in cyclic or polymeric forms where phosphorus atoms are linked through oxygen atoms (P-O-P bonds).

**Solution:**

1. Cyclic trimetaphosphoric acid has the formula  $H_3P_3O_9$ . 2. Its structure consists of a six-membered ring containing alternating Phosphorus and Oxygen atoms. 3. In this ring, there are 3 Phosphorus atoms and 3 Oxygen atoms arranged as P-O-P-O-P-O-. 4. Each Phosphorus atom is also double-bonded to one oxygen and single-bonded to an  $-OH$  group (which are outside the ring). 5. Counting the connections in the ring: - Bond 1:  $P_1 - O - P_2$  - Bond 2:  $P_2 - O - P_3$  - Bond 3:  $P_3 - O - P_1$  6. Thus, there are exactly 3 P-O-P linkages.

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

**Answer: (B)**

Q24.

**Solution****Concept:**

In the electrolysis of an aqueous solution, multiple ions compete at the electrodes. At the anode (oxidation), the species with the lower standard oxidation potential (or higher ease of discharge) is liberated. For aqueous  $NaCl$ , the ions present are  $Na^+$ ,  $Cl^-$ ,  $H^+$ , and  $OH^-$ .

**Solution:**

1. At the anode, two oxidation reactions are possible: - Oxidation of  $Cl^-$ :  $2Cl^- \rightarrow Cl_2 + 2e^-$   
- Oxidation of  $H_2O$ :  $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$  2. Although the standard reduction potential of  $O_2/H_2O$  is lower than  $Cl_2/Cl^-$ , the oxidation of water to  $O_2$  is kinetically slow and requires an extra voltage called "overpotential." 3. Due to this overpotential, the oxidation of  $Cl^-$  ions is preferred over water. 4. Consequently, Chlorine gas ( $Cl_2$ ) is evolved at the anode. 5. (At the cathode,  $H_2$  gas is evolved as  $H^+$  is reduced more easily than  $Na^+$ ).

**Final Answer:**  $Cl_2$  gas is liberated at the anode.

**Answer: (C)**



Q25.

**Solution****Concept:**

Reducing sugars are carbohydrates that contain a free aldehyde or ketone group (in their open-chain form) or a free hemiacetal/hemiketal group (in their cyclic form). These sugars can reduce Tollen's reagent or Fehling's solution. Non-reducing sugars lack these free groups.

**Solution:**

1. Glucose is a monosaccharide with a free aldehyde group; it is a reducing sugar. 2. Fructose is a monosaccharide with a free ketone group; it is a reducing sugar (due to tautomerization in alkaline medium). 3. Lactose is a disaccharide where the hemiacetal group of one glucose unit is free; it is a reducing sugar. 4. Sucrose is a disaccharide made of  $\alpha$ -D-glucose and  $\beta$ -D-fructose. 5. In sucrose, the glycosidic linkage is formed between the C1 of glucose and C2 of fructose. 6. Since both reducing centers (anomeric carbons) are involved in the bond, there is no free aldehyde or ketone group. 7. Thus, sucrose does not reduce Fehling's or Tollen's reagent.

**Final Answer:** Sucrose is a non-reducing sugar.

**Answer: (D)**

Q26.

**Solution****Concept:**

The coordination number of a central metal atom or ion in a complex is the total number of ligand donor atoms to which the metal is directly bonded. It is important to distinguish between the number of ligands and the number of donor atoms, especially with polydentate ligands.

**Solution:**

1. In the complex  $[Co(en)_3]^{3+}$ , the ligand is 'en', which stands for ethylenediamine ( $H_2N - CH_2 - CH_2 - NH_2$ ). 2. Ethylenediamine is a bidentate ligand, meaning each 'en' molecule has two nitrogen donor atoms that coordinate to the metal ion. 3. There are three such 'en' ligands attached to the Cobalt (Co) ion. 4. Total number of donor atoms = (Number of ligands)  $\times$  (Denticity of ligand). 5. Total donor atoms =  $3 \times 2 = 6$ . 6. Therefore, the Cobalt ion is directly bonded to six nitrogen atoms.

**Final Answer:** The coordination number of Co is 6.

**Answer: (B)**



Q27.

**Solution****Concept:**

The  $S_N2$  (Substitution Nucleophilic Bimolecular) reaction mechanism involves a single-step transition state where the nucleophile attacks from the back side. The rate of  $S_N2$  is highly sensitive to steric hindrance around the carbon atom bearing the leaving group.

**Solution:**

1. In  $S_N2$  reactions, the order of reactivity for alkyl halides is: Methyl  $>$  Primary ( $1^\circ$ )  $>$  Secondary ( $2^\circ$ )  $>$  Tertiary ( $3^\circ$ ). 2. This order is due to increasing steric hindrance. As the number of alkyl groups on the central carbon increases, it becomes harder for the nucleophile to approach the carbon atom. 3. Comparing the options: -  $CH_3Cl$  is a methyl halide (least hindered). -  $CH_3CH_2Cl$  is a primary halide. -  $(CH_3)_2CHCl$  is a secondary halide. -  $(CH_3)_3CCl$  is a tertiary halide (most hindered). 4.  $CH_3Cl$  has the least amount of steric crowding, allowing the nucleophile to attack most easily.

**Final Answer:**  $CH_3Cl$  is the most reactive towards  $S_N2$ .

**Answer:** (A)

Q28.

**Solution****Concept:**

According to Avogadro's Law, one mole of any gas at STP (Standard Temperature and Pressure) occupies a volume of 22.4 L. One mole of a substance contains Avogadro's number ( $N_A$ ) of molecules. To find the total number of atoms, one must multiply the number of molecules by the atomicity of the gas.

**Solution:**

1. Given volume of  $CO_2 = 11.2$  L at STP. 2. Number of moles of  $CO_2 = \frac{\text{Given Volume}}{\text{Molar Volume}} = \frac{11.2 \text{ L}}{22.4 \text{ L}} = 0.5$  moles. 3. Number of molecules of  $CO_2 = 0.5 \times N_A$ . 4.  $CO_2$  is a triatomic molecule (one Carbon atom and two Oxygen atoms). 5. Total number of atoms = (Number of molecules)  $\times$  (Atoms per molecule). 6. Total atoms =  $(0.5 \times N_A) \times 3 = 1.5 N_A$ .

**Final Answer:** The number of atoms is  $1.5 N_A$ .

**Answer:** (B)



Q29.

**Solution****Concept:**

The presence of a lone pair on a central atom is determined by its valence electrons and the number of bonds it forms. We can use the formula for valence electrons and bonded pairs or check the group number.

**Solution:**

1.  $NH_3$  (Ammonia): Nitrogen is in Group 15 (5 valence electrons). It forms 3 bonds with Hydrogen, leaving  $5 - 3 = 2$  electrons, which is 1 lone pair. 2.  $PH_3$  (Phosphine): Phosphorus is also in Group 15 and forms 3 bonds, leaving 1 lone pair. 3.  $PCl_3$  (Phosphorus trichloride): Similar to  $PH_3$ , Phosphorus forms 3 bonds with Chlorine, leaving 1 lone pair. 4.  $BF_3$  (Boron trifluoride): Boron is in Group 13 (3 valence electrons). It forms 3 bonds with Fluorine. 5. All 3 valence electrons of Boron are used in bonding ( $3 - 3 = 0$ ). 6. Therefore, Boron in  $BF_3$  has 0 lone pairs (and is an electron-deficient molecule).

**Final Answer:**  $BF_3$  does not have a lone pair on the central atom.

**Answer: (C)**

Q30.

**Solution****Concept:**

Specific name reactions in organic chemistry involve unique reagents to achieve particular transformations. The oxidation of a methyl group attached to a benzene ring into an aldehyde group using chromyl chloride is a well-known named reaction.

**Solution:**

1. Rosenmund reaction involves the reduction of an acyl chloride to an aldehyde using  $H_2$  and  $Pd/BaSO_4$ . 2. Wurtz and Fittig reactions involve the coupling of alkyl or aryl halides using sodium metal. 3. The Etard reaction specifically uses Chromyl chloride ( $CrO_2Cl_2$ ) in a solvent like  $CS_2$  or  $CCl_4$  to oxidize toluene to a brown chromium complex. 4. Upon hydrolysis, this complex yields Benzaldehyde. 5. This reagent is specific enough to stop the oxidation at the aldehyde stage without further oxidizing it to benzoic acid.

**Final Answer:** The reaction is called the Etard reaction.

**Answer: (B)**



Q31.

**Solution****Concept:**

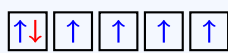
The number of unpaired electrons depends on the oxidation state of the metal and the nature of the ligand. Fluoride ( $F^-$ ) is a weak field ligand, meaning it does not cause pairing of electrons in the d-orbitals (high-spin complex).

**Solution:**

1. In  $[CoF_6]^{3-}$ , the oxidation state of  $Co$  is +3. 2. Atomic number of  $Co = 27$ . Configuration:  $[Ar]3d^74s^2$ . 3. For  $Co^{3+}$ , the configuration is  $[Ar]3d^6$ . 4. Since  $F^-$  is a weak field ligand, the six electrons are filled in the 3d orbitals following Hund's Rule: - One electron in each of the five d orbitals ( $\uparrow\uparrow\uparrow\uparrow\uparrow$ ). - The sixth electron pairs with the first one ( $\uparrow\downarrow\uparrow\uparrow\uparrow$ ). 5. Counting the single arrows, we find there are 4 unpaired electrons.

This TikZ diagram illustrates the high-spin distribution of electrons in the d-orbitals of  $Co^{3+}$ .

$Co^{3+}$  in  $[CoF_6]^{3-}$  (Weak Field/High Spin)



4 Unpaired Electrons

$F^-$  is a **Weak Field Ligand**  
No pairing occurs ( $P > \Delta_o$ )  
Result: **High Spin Complex**

**Final Answer:** There are 4 unpaired electrons.

**Answer: (D)**

Q32.

**Solution****Concept:**

For a first-order reaction, the relationship between the half-life ( $t_{1/2}$ ) and the rate constant ( $k$ ) is given by the formula:

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

**Solution:**

1. Given half-life ( $t_{1/2}$ ) = 69.3 minutes. 2. Substitute the value into the formula:

$$k = \frac{0.693}{69.3}$$

3. Perform the division:

$$k = \frac{6.93 \times 10^{-1}}{6.93 \times 10^1} = 10^{-2} \text{ min}^{-1}$$

4.  $10^{-2}$  is equivalent to  $0.01 \text{ min}^{-1}$ .

**Final Answer:** The rate constant is  $0.01 \text{ min}^{-1}$ .

**Answer: (A)**



Q33.

**Solution****Concept:**

Electronegativity is the tendency of an atom to attract a shared pair of electrons towards itself. In the periodic table, electronegativity increases across a period (left to right) and decreases down a group (top to bottom).

**Solution:**

1. Nitrogen (*N*), Oxygen (*O*), and Fluorine (*F*) are in the second period. Chlorine (*Cl*) is in the third period. 2. Across the second period, the order of electronegativity is  $N < O < F$ . 3. Fluorine is the most electronegative element in the entire periodic table, with a value of 4.0 on the Pauling scale. 4. While Chlorine has a high electronegativity, it is lower than Fluorine due to its larger atomic size and increased shielding.

**Final Answer:** Fluorine (*F*) has the highest electronegativity.

Answer: (C)

Q34.

**Solution****Concept:**

Dehydration of alcohols to form alkenes involves the formation of a carbocation intermediate. The rate of the reaction depends on the stability of the carbocation. The order of stability is: Tertiary ( $3^\circ$ ) > Secondary ( $2^\circ$ ) > Primary ( $1^\circ$ ).

**Solution:**

1. Ethanol ( $CH_3CH_2OH$ ) and Propan-1-ol ( $CH_3CH_2CH_2OH$ ) are primary alcohols. 2. Propan-2-ol ( $CH_3CH(OH)CH_3$ ) is a secondary alcohol. 3. 2-Methylpropan-2-ol (tert-butyl alcohol) is a tertiary alcohol. 4. Upon dehydration, 2-methylpropan-2-ol forms a tertiary carbocation, which is highly stabilized by inductive effects and hyperconjugation. 5. Therefore, tertiary alcohols undergo dehydration most easily and rapidly.

**Final Answer:** 2-Methylpropan-2-ol undergoes fastest dehydration.

Answer: (A)



Q35.

**Solution****Concept:**

A species is diamagnetic if all of its electrons are paired. If even one unpaired electron is present, the species is paramagnetic. For transition metals, we must look at the electrons remaining in the  $(n - 1)d$  subshell after ion formation.

**Solution:**

1.  $Ti^{3+}$ : Atomic number 22.  $Ti$  is  $[Ar]3d^24s^2$ .  $Ti^{3+}$  is  $3d^1$ . (One unpaired electron, paramagnetic).  
 2.  $Cu^{2+}$ : Atomic number 29.  $Cu$  is  $[Ar]3d^{10}4s^1$ .  $Cu^{2+}$  is  $3d^9$ . (One unpaired electron, paramagnetic).  
 3.  $Ni^{2+}$ : Atomic number 28.  $Ni$  is  $[Ar]3d^84s^2$ .  $Ni^{2+}$  is  $3d^8$ . (Two unpaired electrons, paramagnetic).  
 4.  $Zn^{2+}$ : Atomic number 30.  $Zn$  is  $[Ar]3d^{10}4s^2$ .  $Zn^{2+}$  is  $3d^{10}$ .  
 5. In  $Zn^{2+}$ , the  $3d$  orbital is completely filled. All 10 electrons are paired.  
 6. Therefore,  $Zn^{2+}$  is diamagnetic.

**Final Answer:**  $Zn^{2+}$  is a diamagnetic ion.

**Answer: (C)**

Q36.

**Solution****Concept:**

Work done ( $W$ ) during the expansion of a gas against a constant external pressure ( $P_{ext}$ ) is given by the formula:

$$W = -P_{ext}\Delta V$$

where  $\Delta V = V_{final} - V_{initial}$ . In thermodynamics, the negative sign indicates that work is done by the system on the surroundings.

**Solution:**

1. Given values: - External pressure ( $P_{ext}$ ) = 3 atm - Initial volume ( $V_1$ ) = 4 dm<sup>3</sup> - Final volume ( $V_2$ ) = 6 dm<sup>3</sup>  
 2. Calculate the change in volume:

$$\Delta V = 6 \text{ dm}^3 - 4 \text{ dm}^3 = 2 \text{ dm}^3$$

3. Since 1 dm<sup>3</sup> = 1 L,  $\Delta V = 2$  L. 4. Calculate work in L atm:

$$W = -(3 \text{ atm}) \times (2 \text{ L}) = -6 \text{ L atm}$$

5. Convert the result to Joules using the conversion factor 1 L atm = 101.3 J:

$$W = -6 \times 101.3 \text{ J} = -607.8 \text{ J}$$

**Final Answer:** The work done is -607.8 J.

**Answer: (B)**



Q37.

**Solution****Concept:**

According to Werner's Coordination Theory, ions present outside the coordination sphere (counter-ions) are ionizable and can react with reagents like silver nitrate ( $AgNO_3$ ). Ligands present inside the coordination sphere are non-ionizable and do not react.

**Solution:**

1.  $[Co(NH_3)_6]Cl_3$  has 3 chloride ions outside the bracket. It will form 3 moles of  $AgCl$  precipitate. 2.  $[Co(NH_3)_5Cl]Cl_2$  has 2 chloride ions outside. It will form 2 moles of  $AgCl$  precipitate. 3.  $[Co(NH_3)_4Cl_2]Cl$  has 1 chloride ion outside. It will form 1 mole of  $AgCl$  precipitate. 4.  $[Co(NH_3)_3Cl_3]$  is a neutral complex. All chloride atoms are acting as ligands inside the coordination sphere. 5. Because there are no ionizable chloride ions in this complex, it will not react with  $AgNO_3$  to form a precipitate.

**Final Answer:**  $[Co(NH_3)_3Cl_3]$  will not give a precipitate.

**Answer: (C)**

Q38.

**Solution****Concept:**

In IUPAC nomenclature for polyfunctional organic compounds, the principal functional group is selected based on a priority order. The aldehyde group ( $-CHO$ ) has higher priority than the hydroxyl group ( $-OH$ ). The chain is numbered starting from the principal group carbon.

**Solution:**

1. The structure is  $CH_3-CH(OH)-CH_2-CHO$ . 2. The carbon chain has 4 carbons, making the parent alkane 'butane'. 3. The  $-CHO$  group carbon is assigned position number 1. 4. Numbering from right to left: C1 is  $CHO$ , C2 is  $CH_2$ , C3 is  $CH(OH)$ , and C4 is  $CH_3$ . 5. The  $-OH$  group is now a substituent at position 3, called 'hydroxy'. 6. Combining the parts: 3-hydroxy + butanal.

**Final Answer:** The IUPAC name is 3-Hydroxybutanal.

**Answer: (A)**



Q39.

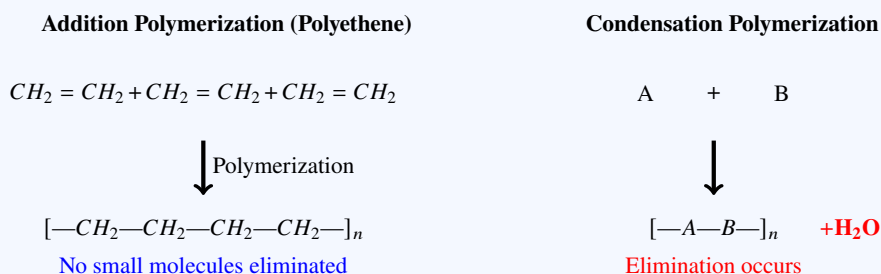
**Solution****Concept:**

Addition polymers are formed by the repeated addition of monomer molecules possessing double or triple bonds. No small molecules (like water or alcohol) are eliminated during this process. Condensation polymers involve the elimination of small molecules.

**Solution:**

1. Nylon-6,6 is formed by the condensation of adipic acid and hexamethylenediamine (eliminates  $H_2O$ ). 2. Terylene is a polyester formed by the condensation of ethylene glycol and terephthalic acid (eliminates  $H_2O$ ). 3. Bakelite is a cross-linked polymer formed by the condensation of phenol and formaldehyde. 4. Polyethene is formed by the polymerization of ethene ( $CH_2 = CH_2$ ) molecules. 5. The double bonds in ethene open up and link together without the loss of any atoms. This is a classic example of addition polymerization.

**Final Answer:** Polyethene is an addition polymer.



**Answer: (C)**

Q40.

**Solution****Concept:**

The Ideal Gas Equation is  $PV = nRT$ . Here,  $R$  is the Universal Gas Constant. As the name suggests, it is a universal constant for all ideal gases and its numerical value is independent of the gas's identity or state.

**Solution:**

1.  $R$  represents the work done per degree per mole. 2. The numerical value of  $R$  changes depending on the units used for  $P$ ,  $V$ ,  $n$ , and  $T$ . 3. For example: -  $R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$  -  $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$  -  $R = 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$  4. It does not depend on the pressure, temperature, or the chemical nature of the gas being studied, provided the gas behaves ideally.

**Final Answer:** The value of  $R$  depends on the units of measurement.

**Answer: (D)**



Q41.

**Solution****Concept:**

Proteins are high molecular weight polymers of  $\alpha$ -amino acids. When amino acids link together, the carboxyl group ( $-COOH$ ) of one molecule reacts with the amino group ( $-NH_2$ ) of another, resulting in a specific covalent bond.

**Solution:**

1. The reaction between two amino acids involves the loss of a water molecule ( $H_2O$ ). 2. The resulting  $-(CO - NH)-$  bond is an amide linkage. 3. In the specific context of proteins and biochemistry, this link is termed a "peptide linkage" or "peptide bond." 4. Long chains of amino acids linked by these bonds are called polypeptides. 5. Other options like Glycosidic linkages are found in carbohydrates, and Phosphodiester linkages are found in nucleic acids (DNA/RNA).

**Final Answer:** The linkage present in proteins is the peptide linkage.

Answer: (B)

Q42.

**Solution****Concept:**

For isoelectronic species (atoms or ions having the same number of electrons), the ionic radius decreases as the nuclear charge (atomic number) increases. This is because a higher nuclear charge exerts a stronger pull on the same number of electrons, drawing them closer to the nucleus.

**Solution:**

1. Consider the ions:  $F^-$  ( $Z = 9$ ),  $Na^+$  ( $Z = 11$ ),  $Mg^{2+}$  ( $Z = 12$ ), and  $Al^{3+}$  ( $Z = 13$ ). 2. All these species have 10 electrons (isoelectronic). 3.  $Al^{3+}$  has the highest nuclear charge (+13). 4. Because it has the most protons pulling on the 10 electrons, the electron cloud is contracted the most. 5. Therefore,  $Al^{3+}$  has the smallest ionic radius among the given options.

**Final Answer:**  $Al^{3+}$  has the smallest ionic radius.

Answer: (C)



Q43.

**Solution****Concept:**

The reaction of alkyl halides with cyanide salts depends on the nature of the cation in the salt. Silver cyanide ( $AgCN$ ) is predominantly covalent in nature, which changes the nucleophilic site that attacks the alkyl group.

**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 ethyl group. 3. This results in the formation of an isocyanide ( $R - NC$ ) rather than a cyanide ( $R - CN$ ). 4. The product formed is Ethyl isocyanide ( $C_2H_5NC$ ). 5. (In contrast, ionic  $KCN$  or  $NaCN$  would provide the cyanide ion  $CN^-$ , leading to Ethyl cyanide).

**Final Answer:** The product is Ethyl isocyanide.

**Answer: (B)**

Q44.

**Solution****Concept:**

A buffer solution is one that resists changes in  $pH$  upon the addition of small amounts of acid or base. An acidic buffer consists of a weak acid and its salt with a strong base. A basic buffer consists of a weak base and its salt with a strong acid.

**Solution:**

1.  $CH_3COOH$  (Acetic acid) is a weak acid and  $CH_3COONa$  (Sodium acetate) is its salt with a strong base ( $NaOH$ ). This combination forms a classic acidic buffer. 2.  $HCl + NaCl$  is a mixture of a strong acid and its salt; it does not act as a buffer. 3.  $NaOH + NaCl$  is a mixture of a strong base and its salt; it does not act as a buffer. 4.  $NH_4OH + HCl$  (excess) would result in a mixture of  $NH_4Cl$  and excess  $HCl$ . Since  $HCl$  is a strong acid, the  $pH$  would be dominated by the excess  $HCl$ , and it wouldn't function as an effective buffer.

**Final Answer:**  $CH_3COOH + CH_3COONa$  forms a buffer.

**Answer: (A)**



Q45.

**Solution****Concept:**

Colloidal sols can be prepared from fresh precipitates by various methods. The process of using a chemical agent to disperse a precipitate into a colloidal state is known as peptization.

**Solution:**

1. When an electrolyte (called a peptizing agent) is added to a freshly prepared precipitate, the precipitate particles adsorb one of the ions of the electrolyte on their surface. 2. This creates a positive or negative charge on the particles. 3. Due to electrostatic repulsion, the large particles of the precipitate break down into smaller particles that fall within the colloidal range (1 nm to 1000 nm). 4. Coagulation is the opposite process (precipitating a colloid), and Dialysis is a purification method.

**Final Answer:** The process is called Peptization.

**Answer: (A)**

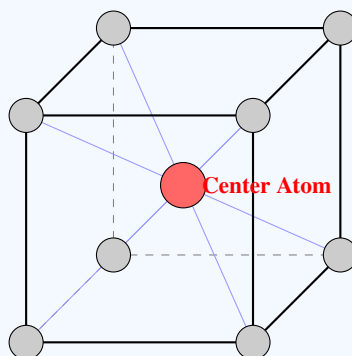
Q46.

**Solution****Concept:**

The coordination number in a crystal lattice is defined as the number of nearest neighbors (closest atoms) touching a central atom. In a Body-Centered Cubic (bcc) unit cell, atoms are located at each corner of the cube and one atom is located exactly at the center of the cube.

**Solution:**

1. In a bcc lattice, the atom at the center of the unit cell is in direct contact with the atoms at the eight corners of that same cube. 2. Since these corner atoms are the closest to the center atom, the coordination number of the central atom is 8. 3. Conversely, if you look at a corner atom, it is shared by eight adjacent unit cells, and in each of those unit cells, it is a neighbor to one body-centered atom. 4. Therefore, every atom in a bcc structure has exactly 8 nearest neighbors.



1 Body-Center Atom + 8 Corners

**Final Answer:** The coordination number is 8.

**Answer: (C)**



Q47.

**Solution****Concept:**

Amines are classified as primary ( $1^\circ$ ), secondary ( $2^\circ$ ), or tertiary ( $3^\circ$ ) based on the number of alkyl or aryl groups attached to the Nitrogen atom. A primary amine has one alkyl/aryl group and two hydrogen atoms attached to the Nitrogen ( $-NH_2$  group).

**Solution:**

1.  $(CH_3)_2NH$  (Dimethylamine): The nitrogen is attached to two methyl groups. It is a secondary amine. 2.  $(CH_3)_3N$  (Trimethylamine): The nitrogen is attached to three methyl groups. It is a tertiary amine. 3.  $C_6H_5NHCH_3$  (N-Methylaniline): The nitrogen is attached to one phenyl group and one methyl group. It is a secondary amine. 4.  $CH_3NH_2$  (Methylamine): The nitrogen is attached to only one methyl group and has two hydrogen atoms. 5. This structure fits the general formula  $R - NH_2$ , characterizing it as a primary amine.

**Final Answer:**  $CH_3NH_2$  is a primary amine.

**Answer: (B)**

Q48.

**Solution****Concept:**

According to the Bohr model of the Hydrogen atom, the energy of an electron in the  $n^{th}$  orbit is given by the formula:

$$E_n = \frac{E_1}{n^2}$$

where  $E_1$  is the energy of the first orbit (ground state).

**Solution:**

1. Given the energy in the first orbit ( $n = 1$ ) is  $E_1 = -13.6$  eV. 2. We need to find the energy in the second orbit ( $n = 2$ ). 3. Using the formula:

$$E_2 = \frac{-13.6 \text{ eV}}{2^2}$$

4. Substitute  $2^2 = 4$ :

$$E_2 = \frac{-13.6}{4}$$

5. Calculate the result:

$$E_2 = -3.4 \text{ eV}$$

**Final Answer:** The energy in the second orbit is  $-3.4$  eV.

**Answer: (A)**



Q49.

**Solution****Concept:**

The Contact process is the modern industrial method for producing high concentrations of Sulfuric acid ( $H_2SO_4$ ). The key step is the catalytic oxidation of Sulfur dioxide ( $SO_2$ ) to Sulfur trioxide ( $SO_3$ ).

**Solution:**

1. The reaction is  $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ . 2. Historically, finely divided Platinum ( $Pt$ ) was used as a catalyst, but it is expensive and easily poisoned by impurities. 3. In modern industrial practice, Vanadium pentoxide ( $V_2O_5$ ) is used as the catalyst. 4.  $V_2O_5$  is preferred because it is cheaper and less susceptible to poisoning by arsenic impurities present in the sulfur gas.

**Final Answer:**  $V_2O_5$  is used as the catalyst in the Contact process.

**Answer: (C)**

Q50.

**Solution****Concept:**

For a strong base like  $NaOH$ , the concentration of hydroxyl ions  $[OH^-]$  is equal to the concentration of the base. The  $pOH$  is calculated as  $-\log[OH^-]$ , and the  $pH$  is then found using the relation  $pH + pOH = 14$  at 298 K.

**Solution:**

1. Given concentration of  $NaOH = 0.001 \text{ M} = 10^{-3} \text{ M}$ . 2. Since  $NaOH$  is a strong base,  $[OH^-] = 10^{-3} \text{ M}$ . 3. Calculate  $pOH$ :

$$pOH = -\log(10^{-3}) = 3$$

4. Calculate  $pH$ :

$$pH = 14 - pOH$$

$$pH = 14 - 3 = 11$$

5. A  $pH$  of 11 indicates a strongly basic solution, which is consistent with  $NaOH$ .

**Final Answer:** The  $pH$  of the solution is 11.

**Answer: (B)**



## Answer Key

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

