

# MHT-CET Chemistry Sample Paper-5

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 relationship between the solubility ( $S$ ) and solubility product ( $K_{sp}$ ) for the sparingly soluble salt  $PbI_2$  is given by:

- (A)  $K_{sp} = S^2$   
 (B)  $K_{sp} = 4S^3$   
 (C)  $K_{sp} = 27S^4$   
 (D)  $K_{sp} = 108S^5$

**Q2.** Which of the following compounds will exhibit the highest boiling point?

(A) *n*-Pentane  
 $CH_3(CH_2)_3CH_3$



*Linear, Max Surface Area*

(B) 2-Methylbutane  
 $(CH_3)_2CHCH_2CH_3$



*Branched, Less Surface Area*

(C) 2,2-Dimethylpropane  
 $(CH_3)_4C$



*Highly Branched, Spherical*

(D) *n*-Butane  
 $CH_3(CH_2)_2CH_3$



*Linear, Smaller than (A)*

(A) *n*-Pentane



- (B) 2-Methylbutane
- (C) 2, 2-Dimethylpropane
- (D) *n*-Butane

**Q3.** In the reaction of phenol with  $CHCl_3$  and aqueous  $NaOH$ , the intermediate formed is:

- (A) Carbene
- (B) Carbonium ion
- (C) Carbanion
- (D) Dichlorocarbene

**Q4.** The coordination number and oxidation state of  $Cr$  in  $K_3[Cr(C_2O_4)_3]$  are respectively:

- (A) 3, +3
- (B) 3, +6
- (C) 6, +3
- (D) 6, +6

**Q5.** Which of the following is a non-polar molecule despite having polar bonds?

- (A)  $H_2O$
- (B)  $NH_3$
- (C)  $BF_3$
- (D)  $SO_2$

**Q6.** The number of atoms per unit cell in a simple cubic, body-centered cubic, and face-centered cubic unit cell are respectively:

- (A) 1, 2, 4
- (B) 8, 2, 1
- (C) 1, 4, 2



(D) 2, 4, 8

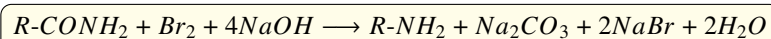
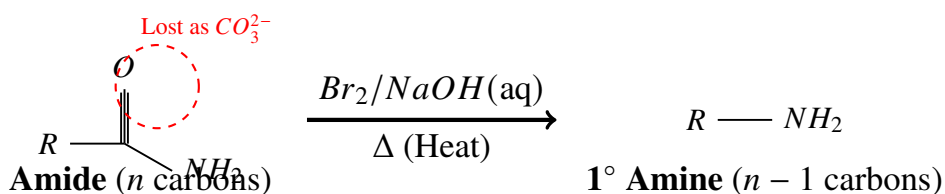
**Q7.** The IUPAC name of the compound  $(CH_3)_2CH - CH(Cl) - CH_3$  is:

- (A) 2-Chloro-3-methylbutane
- (B) 3-Chloro-2-methylbutane
- (C) 2-Isopropylchloropropane
- (D) 2-Chloropentane

**Q8.** Which of the following elements has the lowest first ionization enthalpy?

- (A) *N*
- (B) *O*
- (C) *P*
- (D) *S*

**Q9.** The conversion of an amide to a primary amine with one less carbon atom is known as:



- (A) Gabriel phthalimide synthesis
- (B) Hofmann bromamide degradation
- (C) Friedel-Crafts reaction
- (D) Reimer-Tiemann reaction

**Q10.** What is the oxidation state of Phosphorus in  $H_3PO_3$ ?

- (A) +1



- (B) +3
- (C) +5
- (D) -3

**Q11.** Which among the following is the strongest base in aqueous solution?

- (A)  $NH_3$
- (B)  $CH_3NH_2$
- (C)  $(CH_3)_2NH$
- (D)  $(CH_3)_3N$

**Q12.** The enthalpy of neutralization of a strong acid and a strong base is approximately:

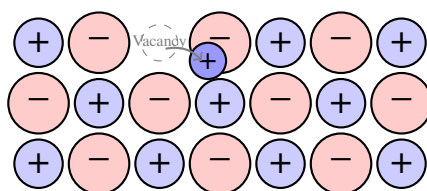
- (A)  $-57.1 \text{ kJ/mol}$
- (B)  $+57.1 \text{ kJ/mol}$
- (C)  $-13.7 \text{ kJ/mol}$
- (D)  $0 \text{ kJ/mol}$

**Q13.** The reagent used to convert  $R - COOH$  to  $R - CH_2OH$  is:

- (A)  $LiAlH_4$
- (B)  $NaBH_4$
- (C)  $H_2/Ni$
- (D)  $P/HI$

**Q14.** Which of the following exhibits Frenkel defect?

This TikZ diagram illustrates the Frenkel Defect in a crystal lattice.



**Frenkel Defect:** Cation moves to an interstitial site.



- (A)  $NaCl$
- (B)  $KCl$
- (C)  $CsCl$
- (D)  $AgBr$

**Q15.** The osmotic pressure of a solution can be increased by:

- (A) Increasing the temperature
- (B) Decreasing the concentration
- (C) Increasing the volume
- (D) Adding more solvent

**Q16.** Which of the following is a "natural" polymer?

- (A) Nylon
- (B) Terylene
- (C) Cis-polyisoprene
- (D) Bakelite

**Q17.** The rate of a reaction  $A + B \rightarrow Products$  is given by  $Rate = k[A]^1[B]^2$ . The overall order of the reaction is:

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

**Q18.** Which gas is evolved when sodium metal reacts with ethanol?

- (A)  $O_2$
- (B)  $H_2$
- (C)  $CO_2$



(D)  $CH_4$

**Q19.** The most stable carbocation among the following is:

(A)  $(CH_3)_3C^+$

(B)  $(CH_3)_2CH^+$

(C)  $CH_3CH_2^+$

(D)  $CH_3^+$

**Q20.** Which of the following d-block elements is not considered a transition element?

(A) *Fe*

(B) *Sc*

(C) *Zn*

(D) *Cu*

**Q21.** The product of the reaction between benzaldehyde and concentrated *NaOH* is a mixture of:

(A) Benzyl alcohol and Sodium benzoate

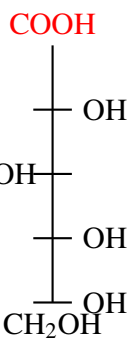
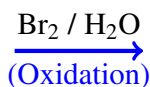
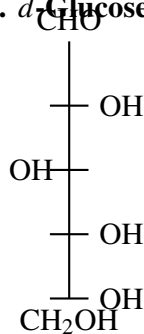
(B) Benzene and Sodium formate

(C) Phenol and Sodium acetate

(D) Benzoic acid and Benzyl chloride

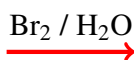
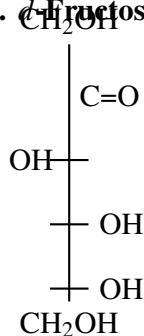
**Q22.** Which property is used to distinguish between *d*-glucose and *d*-fructose?



1. *d*-Glucose (Aldose)

Gluconic Acid

(Positive Result)

2. *D*-Fructose (Ketose)**NO REACTION**

(Ketone is not oxidized by Bromine water)

- (A) Molisch test
- (B) Tollen's test
- (C) Bromine water test
- (D) Osazone formation

**Q23.** The magnetic moment of  $\text{Ni}^{2+}$  (Atomic number = 28) in Bohr Magnetons is approximately:

- (A) 1.73
- (B) 2.83
- (C) 3.87
- (D) 4.90

**Q24.** Identify the most acidic compound among the following:

- (A) Water
- (B) Ethanol
- (C) Phenol

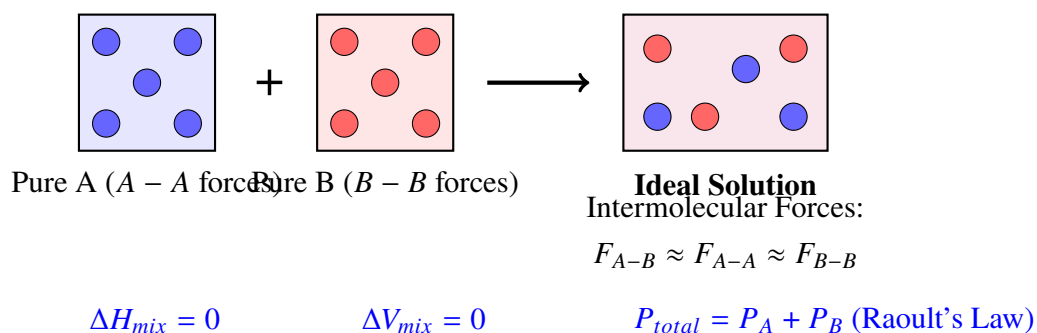


(D) Acetone

**Q25.** The number of  $P - OH$  bonds in orthophosphoric acid is:

- (A) 1
- (B) 2
- (C) 3
- (D) 4

**Q26.** Which of the following pairs forms an ideal solution, characterized by the behavior shown in the molecular interaction diagram below?



- (A) Benzene and Toluene
- (B) Ethanol and Water
- (C) Chloroform and Acetone
- (D) Phenol and Aniline

**Q27.** The shape of  $NH_3$  molecule according to VSEPR theory is:

- (A) Tetrahedral
- (B) Trigonal planar
- (C) Pyramidal
- (D) Linear

**Q28.** Which halogen has the highest electron gain enthalpy?

- (A)  $F$



- (B)  $Cl$
- (C)  $Br$
- (D)  $I$

**Q29.** In the electrolysis of alumina, cryolite is added to:

- (A) Decrease the melting point
- (B) Increase the conductivity
- (C) Both (A) and (B)
- (D) Remove impurities

**Q30.** A reaction follows first order kinetics. If the initial concentration is 0.1 M and after 10 minutes it becomes 0.05 M, the rate constant is:

- (A)  $0.0693 \text{ min}^{-1}$
- (B)  $0.693 \text{ min}^{-1}$
- (C)  $0.00693 \text{ min}^{-1}$
- (D)  $6.93 \text{ min}^{-1}$

**Q31.** Which of the following ligands is ambidentate?

- (A)  $H_2O$
- (B)  $NO_2^-$
- (C)  $NH_3$
- (D)  $C_2O_4^{2-}$

**Q32.** The monomer of Neoprene is:

- (A) Isoprene
- (B) Chloroprene
- (C) Acrylonitrile
- (D) Styrene



- Q33.** Which of the following is a greenhouse gas?
- (A)  $N_2$
  - (B)  $O_2$
  - (C)  $CH_4$
  - (D)  $Ar$
- Q34.** The standard EMF of a cell is 1.10 V. The Gibbs free energy change ( $\Delta G^\circ$ ) for the cell reaction  $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$  is ( $F = 96500 \text{ C/mol}$ ):
- (A)  $-212.3 \text{ kJ}$
  - (B)  $+212.3 \text{ kJ}$
  - (C)  $-106.1 \text{ kJ}$
  - (D)  $+106.1 \text{ kJ}$
- Q35.** In the  $SN_2$  reaction, the configuration of the product is:
- (A) Retained
  - (B) Inverted
  - (C) Racemized
  - (D) Unchanged
- Q36.** The transition element with the electronic configuration  $[Ar]3d^54s^1$  is:
- (A)  $Mn$
  - (B)  $Cr$
  - (C)  $Fe$
  - (D)  $V$
- Q37.** Which of the following gives an offensive smell with  $CHCl_3$  and  $KOH$ ?
- (A) Methylamine
  - (B) Dimethylamine



(C) Trimethylamine

(D) Aniline

**Q38.** The unit of molar conductivity is:

(A)  $S \text{ cm}^2 \text{ mol}^{-1}$

(B)  $S \text{ cm}^{-1}$

(C)  $\Omega \text{ cm}$

(D)  $S \text{ mol}^{-1}$

**Q39.** Which vitamin is water-soluble?

(A) Vitamin A

(B) Vitamin D

(C) Vitamin C

(D) Vitamin K

**Q40.** The reagent used for the detection of unsaturation in organic compounds is:

(A) Fehling's solution

(B) Bayer's reagent

(C) Lucas reagent

(D) Tollen's reagent

**Q41.** How many chiral carbons are present in 2, 3-dichlorobutane?

(A) 1

(B) 2

(C) 3

(D) 4

**Q42.** The boiling point of water is higher than  $H_2S$  because of:

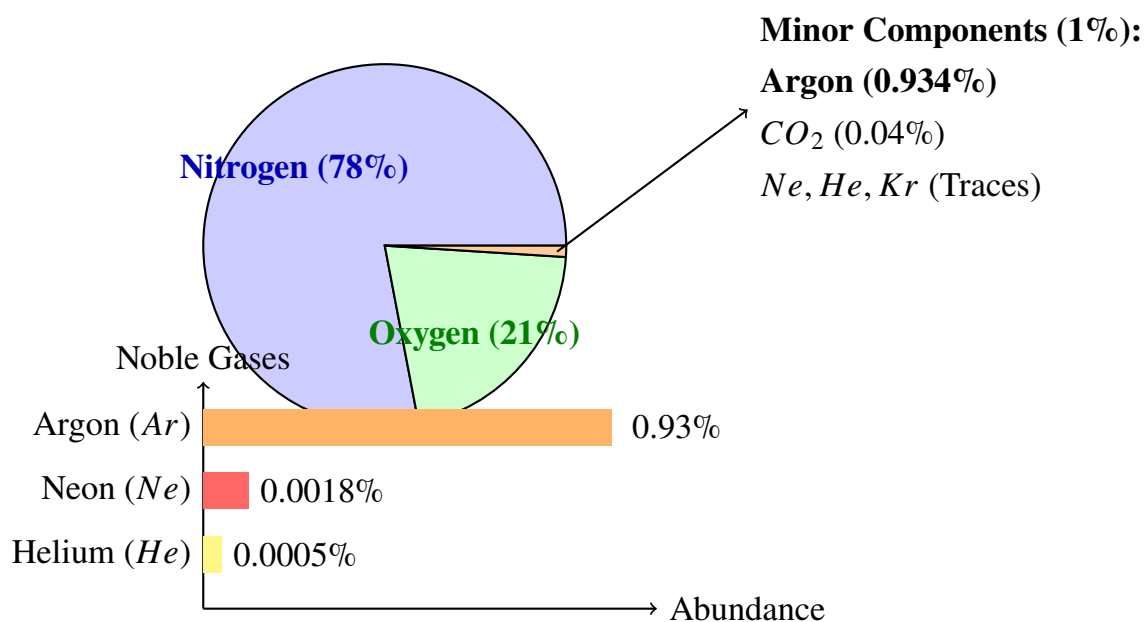


- (A) Hydrogen bonding
- (B) Van der Waals forces
- (C) Covalent bonding
- (D) Ionic bonding

**Q43.** The order of reactivity of alcohols towards Lucas reagent is:

- (A)  $1^\circ > 2^\circ > 3^\circ$
- (B)  $3^\circ > 2^\circ > 1^\circ$
- (C)  $2^\circ > 3^\circ > 1^\circ$
- (D)  $1^\circ > 3^\circ > 2^\circ$

**Q44.** Which is the most abundant noble gas in the atmosphere, as indicated by the fractional composition of dry air shown below?



- (A) *He*
- (B) *Ne*
- (C) *Ar*
- (D) *Kr*

**Q45.** The functional group present in an ester is:



- (A)  $-CHO$
- (B)  $-COOH$
- (C)  $-COOR$
- (D)  $-OH$

**Q46.** Calculate the mass of 0.5 moles of  $CO_2$  gas (Molar mass of  $CO_2 = 44$  g/mol):

- (A) 22 g
- (B) 44 g
- (C) 11 g
- (D) 88 g

**Q47.** The process of heating an ore below its melting point in the presence of excess air is:

- (A) Calcination
- (B) Roasting
- (C) Smelting
- (D) Refining

**Q48.** Which of the following is a polyamide?

- (A) Nylon-6, 6
- (B) Terylene
- (C) Buna-N
- (D) PVC

**Q49.** The bond angle in  $CH_4$  is:

- (A)  $90^\circ$
- (B)  $104.5^\circ$
- (C)  $109.5^\circ$



(D)  $120^\circ$

**Q50.** The cost of 1 kg of sugar is ₹ 45. If a chemist prepares a solution using sugar worth ₹ 9, what mass of sugar was used?

(A) 200 g

(B) 100 g

(C) 50 g

(D) 250 g



## Detailed Solutions

Q1.

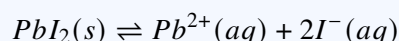
## Solution

**Concept:**

Solubility product constant ( $K_{sp}$ ) is the equilibrium constant for a solid substance dissolving in an aqueous solution. For a salt that dissociates into ions, the  $K_{sp}$  expression is derived from the stoichiometry of the dissolution reaction.

**Solution:**

1. The dissociation of  $PbI_2$  in water is represented as:



2. Let  $S$  be the molar solubility of  $PbI_2$ . 3. Based on stoichiometry:  $[Pb^{2+}] = S$   $[I^{-}] = 2S$  4. The solubility product expression is:

$$K_{sp} = [Pb^{2+}][I^{-}]^2$$

5. Substitute the concentrations:

$$K_{sp} = (S)(2S)^2 = S \times 4S^2 = 4S^3$$

**Final Answer:** The relationship is  $K_{sp} = 4S^3$ .

**Answer: (B)**

Q2.

## Solution

**Concept:**

The boiling point of alkanes depends on intermolecular Van der Waals forces. These forces increase with molecular weight (surface area) and decrease with branching. Branching makes the molecule more spherical, reducing the surface area in contact with other molecules.

**Solution:**

1.  $n$ -Pentane, 2-Methylbutane, and 2,2-Dimethylpropane are isomers with the formula  $C_5H_{12}$ . 2.  $n$ -Butane has fewer carbon atoms ( $C_4H_{10}$ ), so it has the lowest boiling point among the options. 3. Among the  $C_5$  isomers,  $n$ -Pentane is a straight-chain molecule with the maximum surface area. 4. 2-Methylbutane has one branch, and 2,2-Dimethylpropane has two branches. 5. Therefore,  $n$ -Pentane has the strongest intermolecular attractions and the highest boiling point.

**Final Answer:**  $n$ -Pentane has the highest boiling point.

**Answer: (A)**



Q3.

### Solution

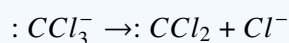
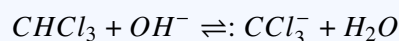
#### Concept:

Reimer-Tiemann Reaction mechanism and reactive intermediates.

#### Solution:

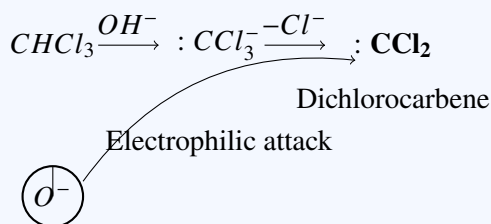
Step 1: The reaction of phenol with  $CHCl_3$  and aqueous  $NaOH$  is the Reimer-Tiemann reaction. The first step involves the deprotonation of chloroform by the base ( $OH^-$ ).

Step 2: Elimination of a chloride ion from the trichloromethanide ion ( $:CCl_3^-$ ) generates a neutral, divalent carbon species called **\*\*dichlorocarbene\*\*** ( $:CCl_2$ ).



Step 3: Dichlorocarbene acts as an electrophile because the carbon atom has only six electrons in its valence shell. It attacks the electron-rich phenoxide ion.

Step 4: While "carbene" is a general class, the specific intermediate formed in this reaction is dichlorocarbene.



#### Final Answer:

(D) Dichlorocarbene

Answer: (D)



Q4.

**Solution****Concept:**

The coordination number is the total number of coordinate bonds formed between the central metal ion and the ligands. The oxidation state is the formal charge on the central metal.

**Solution:**

1. In  $K_3[Cr(C_2O_4)_3]$ , the complex ion is  $[Cr(C_2O_4)_3]^{3-}$ . 2. The oxalate ion ( $C_2O_4^{2-}$ ) is a bidentate ligand, meaning it forms two coordinate bonds with the metal. 3. Since there are three oxalate ligands, the total number of coordinate bonds is  $3 \times 2 = 6$ . Thus, the Coordination Number is 6. 4. Let  $x$  be the oxidation state of  $Cr$ . 5. The sum of charges must equal the net charge of the ion:

$$x + 3(-2) = -3$$

$$x - 6 = -3$$

$$x = +3$$

**Final Answer:** The coordination number is 6 and the oxidation state is +3.

**Answer: (C)**

Q5.

**Solution****Concept:**

A molecule is non-polar if its individual bond dipoles cancel out due to a symmetrical molecular geometry. Polar bonds exist when there is an electronegativity difference between bonded atoms.

**Solution:**

1.  $H_2O$  has a bent shape, so bond dipoles do not cancel (Polar). 2.  $NH_3$  has a trigonal pyramidal shape, resulting in a net dipole (Polar). 3.  $SO_2$  has a bent shape due to a lone pair on Sulfur (Polar). 4.  $BF_3$  has a trigonal planar geometry. The Fluorine atoms are arranged at  $120^\circ$  angles around the Boron atom. 5. The three  $B - F$  bond dipoles are equal in magnitude and their vector sum is zero, making the molecule non-polar.

**Final Answer:**  $BF_3$  is a non-polar molecule.

**Answer: (C)**



Q6.

**Solution****Concept:**

The number of atoms per unit cell (rank of the unit cell,  $Z$ ) is determined by the positions of the atoms and the fraction of each atom that belongs to a single unit cell. Atoms at corners are shared by 8 cells, atoms on faces by 2, and atoms in the center belong entirely to one cell.

**Solution:**

1. **Simple Cubic (SC):** Atoms are present only at the 8 corners. Each corner atom contributes  $1/8$  to the cell.

$$Z = 8 \times \frac{1}{8} = 1$$

2. **Body-Centered Cubic (BCC):** Atoms are at the 8 corners plus 1 atom at the body center.

$$Z = \left(8 \times \frac{1}{8}\right) + 1 = 1 + 1 = 2$$

3. **Face-Centered Cubic (FCC):** Atoms are at the 8 corners plus atoms at the centers of the 6 faces.

$$Z = \left(8 \times \frac{1}{8}\right) + \left(6 \times \frac{1}{2}\right) = 1 + 3 = 4$$

**Final Answer:** The number of atoms are 1, 2, 4 respectively.

**Answer: (A)**

Q7.

**Solution****Concept:**

According to IUPAC nomenclature for alkanes: 1. Identify the longest continuous carbon chain. 2. Number the chain from the end that gives the lowest locants to the substituents. 3. Alphabetize the names of the substituents (e.g., 'c' in chloro comes before 'm' in methyl).

**Solution:**

1. The structure is  $(CH_3)_2CH-CH(Cl)-CH_3$ . 2. The longest chain has 4 carbon atoms, making it a "butane" derivative. 3. Let's number the chain: - From left to right:  $C_1$  is  $CH_3$ ,  $C_2$  has a methyl,  $C_3$  has a chloro. Locants: (2, 3). - From right to left:  $C_1$  is  $CH_3$ ,  $C_2$  has a chloro,  $C_3$  has a methyl. Locants: (2, 3). 4. Since the locant set is the same, we give the lower number to the substituent that comes first alphabetically. Chloro (C) comes before Methyl (M). 5. Therefore, Chloro gets position 2 and Methyl gets position 3.

**Final Answer:** The IUPAC name is 2-Chloro-3-methylbutane.

**Answer: (A)**



Q8.

**Solution****Concept:**

Ionization Enthalpy is the energy required to remove an electron from a gaseous atom. It generally increases across a period (left to right) and decreases down a group (top to bottom). Exceptions occur due to stable electronic configurations (half-filled or fully-filled subshells).

**Solution:**

1. Nitrogen (*N*) and Oxygen (*O*) are in Period 2. Phosphorus (*P*) and Sulfur (*S*) are in Period 3. 2. Period 3 elements have larger atomic radii than Period 2 elements, so they generally have lower ionization enthalpies. We compare *P* and *S*. 3. Electronic configurations: - *P* ( $Z = 15$ ) :  $[Ne]3s^23p^3$  (Half-filled *p*-subshell, very stable) - *S* ( $Z = 16$ ) :  $[Ne]3s^23p^4$  (One electron more than half-filled) 4. Because *P* has a stable half-filled configuration, it is harder to remove an electron from *P* than from *S*. 5. Therefore, Sulfur (*S*) has the lowest first ionization enthalpy among the choices.

**Final Answer:** *S* has the lowest first ionization enthalpy.

**Answer: (D)**

Q9.

**Solution****Concept:**

Named reactions in organic chemistry often involve specific transformations. Amides can be converted to amines through various methods, but the reduction of the carbon chain length is a specific characteristic of one particular degradation reaction.

**Solution:**

1. **Hofmann Bromamide Degradation:** An amide ( $R - CONH_2$ ) reacts with Bromine ( $Br_2$ ) and aqueous/ethanolic  $KOH/NaOH$  to produce a primary amine ( $R - NH_2$ ). 2. The key feature is the loss of the carbonyl carbon as a carbonate ion, resulting in an amine with one less carbon than the starting amide. 3. **Gabriel Phthalimide Synthesis** is used for primary amines but does not shorten the chain. 4. **Reimer-Tiemann** and **Friedel-Crafts** are related to aromatic substitution, not amide conversion.

**Final Answer:** The reaction is Hofmann bromamide degradation.

**Answer: (B)**



Q10.

**Solution****Concept:**

The oxidation state of an element in a compound is calculated by assigning standard values to other elements (usually  $H = +1$  and  $O = -2$ ) and ensuring the sum of all oxidation states equals the total charge of the molecule.

**Solution:**

1. The molecular formula for orthophosphorous acid is  $H_3PO_3$ . 2. Let the oxidation state of Phosphorus ( $P$ ) be  $x$ . 3. Oxidation state of Hydrogen ( $H$ ) is  $+1$ . 4. Oxidation state of Oxygen ( $O$ ) is  $-2$ . 5. Sum of oxidation states in  $H_3PO_3$ :

$$3(+1) + x + 3(-2) = 0$$

$$3 + x - 6 = 0$$

$$x - 3 = 0$$

$$x = +3$$

**Final Answer:** The oxidation state of Phosphorus is  $+3$ .

**Answer: (B)**

Q11.

**Solution****Concept:**

The basicity of amines in aqueous solution is determined by three factors: the inductive effect ( $+I$ ) of alkyl groups, solvation (hydration) effect, and steric hindrance. The  $+I$  effect increases electron density on Nitrogen, while solvation stabilizes the substituted ammonium cation through hydrogen bonding with water.

**Solution:**

1. In the gas phase, the order of basicity is  $3^\circ > 2^\circ > 1^\circ > NH_3$  due to the  $+I$  effect. 2. In aqueous solution, the solvation effect is strongest for the smaller  $1^\circ$  cation and weakest for the  $3^\circ$  cation. 3. Steric hindrance also increases as more alkyl groups are added. 4. For methyl-substituted amines, the combination of these factors results in the following order:



5. Dimethylamine ( $(CH_3)_2NH$ ) is the strongest base because it has a balance of inductive effect and solvation stabilization.

**Final Answer:**  $(CH_3)_2NH$  is the strongest base.

**Answer: (C)**



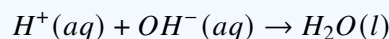
Q12.

**Solution****Concept:**

Enthalpy of neutralization is the heat evolved when one equivalent of an acid is neutralized by one equivalent of a base. For strong acids and strong bases, they are completely dissociated in aqueous solution, and the reaction is essentially the formation of water from  $H^+$  and  $OH^-$  ions.

**Solution:**

1. The net ionic equation for the neutralization of a strong acid (like  $HCl$ ) and a strong base (like  $NaOH$ ) is:



2. Since the reaction is the same for any strong acid-base pair, the energy released is a constant value. 3. This value is measured to be approximately  $-57.1$  kJ/mol (or  $-13.7$  kcal/mol). 4. The negative sign indicates that the process is exothermic (heat is released).

**Final Answer:** The enthalpy of neutralization is approximately  $-57.1$  kJ/mol.

Answer: (A)

Q13.

**Solution****Concept:**

Carboxylic acids ( $R - COOH$ ) are difficult to reduce. Strong reducing agents are required to convert the carboxyl group directly into a primary alcohol ( $R - CH_2OH$ ).

**Solution:**

1. Lithium Aluminum Hydride ( $LiAlH_4$ ) is a powerful reducing agent that can reduce carboxylic acids, esters, and amides to alcohols and amines. 2. Sodium Borohydride ( $NaBH_4$ ) is a milder reducing agent and is generally unable to reduce carboxylic acids or esters; it only reduces aldehydes and ketones. 3. Catalytic hydrogenation ( $H_2/Ni$ ) usually requires high temperature and pressure to reduce acids, making  $LiAlH_4$  the standard laboratory reagent. 4. Red phosphorus and  $HI$  ( $P/HI$ ) is a very strong reducing agent that would reduce the acid all the way to an alkane.

**Final Answer:** The reagent used is  $LiAlH_4$ .

Answer: (A)



Q14.

**Solution****Concept:**

Point defects in crystals are classified into Stoichiometric and Non-stoichiometric defects. Frenkel defect occurs when an ion (usually the smaller cation) is displaced from its lattice site to an interstitial site, creating a vacancy at the original site.

**Solution:**

1. Frenkel defect is common in ionic solids where there is a large difference in the size of the cation and anion. 2. Alkali metal halides like  $NaCl$ ,  $KCl$ , and  $CsCl$  typically show Schottky defect because the ions are of similar sizes. 3. Silver halides, specifically  $AgBr$ , are unique because they exhibit both Schottky and Frenkel defects. 4. In  $AgBr$ , the  $Ag^+$  ion is small enough to fit into interstitial spaces, leading to the Frenkel defect.

**Final Answer:**  $AgBr$  exhibits Frenkel defect.

**Answer: (D)**

Q15.

**Solution****Concept:**

Osmotic pressure ( $\pi$ ) is a colligative property of a solution. It is defined by the Van't Hoff equation:

$$\pi = CRT$$

where  $C$  is molarity,  $R$  is the gas constant, and  $T$  is the absolute temperature.

**Solution:**

1. From the formula  $\pi = CRT$ , it is evident that osmotic pressure is directly proportional to both concentration ( $C$ ) and absolute temperature ( $T$ ). 2. Increasing the temperature ( $T$ ) will lead to an increase in  $\pi$ . 3. Decreasing the concentration ( $C$ ) by adding more solvent or increasing volume would decrease the osmotic pressure. 4. Therefore, the most direct way to increase osmotic pressure among the given options is to increase the temperature.

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

**Answer: (A)**



Q16.

**Solution****Concept:**

Polymers are classified based on their source as natural, semi-synthetic, or synthetic. Natural polymers are found in nature, primarily in plants and animals, and are usually composed of units like amino acids, nucleotides, or isoprene.

**Solution:**

1. **Nylon and Terylene** are completely synthetic polymers (polyamides and polyesters, respectively) created in laboratories. 2. **Bakelite** is a synthetic thermosetting polymer made from phenol and formaldehyde. 3. **Cis-polyisoprene** is the chemical name for Natural Rubber. It is obtained from the latex of rubber trees. 4. It consists of thousands of isoprene units (2-methyl-1,3-butadiene) linked together in a cis-configuration, which gives rubber its elastic properties.

**Final Answer:** Cis-polyisoprene is a natural polymer.

**Answer:** (C)

Q17.

**Solution****Concept:**

The overall order of a chemical reaction is the sum of the exponents of the concentration terms in the rate law expression.

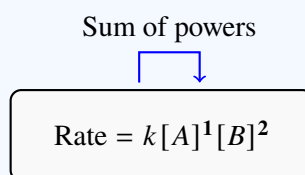
**Solution:**

Step 1: Identify the rate law given in the problem:  $Rate = k[A]^1[B]^2$ .

Step 2: The order with respect to reactant A is  $m = 1$ , and the order with respect to reactant B is  $n = 2$ .

Step 3: Calculate the overall order ( $n_{total}$ ) by summing the individual orders:  $n_{total} = m + n = 1 + 2 = 3$ .

Step 4: Therefore, the reaction is a third-order reaction.



$$1 + 2 = 3$$

(Overall Order)

**Final Answer:**

3

**Answer:** (C)



Q18.

**Solution****Concept:**

Alcohols are weakly acidic in nature. They react with active metals like Sodium (*Na*), Potassium (*K*), and Magnesium (*Mg*) to release a specific gas and form the corresponding metal alkoxide.

**Solution:**

1. When Ethanol ( $C_2H_5OH$ ) reacts with Sodium metal (*Na*), the O-H bond breaks. 2. The reaction is represented as:



3. The products are Sodium ethoxide and Hydrogen gas. 4. This reaction is often used as a test for the presence of the hydroxyl group in alcohols.

**Final Answer:** Hydrogen ( $H_2$ ) gas is evolved.

**Answer: (B)**

Q19.

**Solution****Concept:**

The stability of carbocations is determined by the inductive effect and hyperconjugation. Alkyl groups are electron-releasing (+*I* effect) and provide stability by dispersing the positive charge on the carbon atom.

**Solution:**

1.  $CH_3^+$  (Methyl carbocation) has no alkyl groups to stabilize it. 2.  $CH_3CH_2^+$  (Ethyl carbocation) is a  $1^\circ$  carbocation with one alkyl group. 3.  $(CH_3)_2CH^+$  (Isopropyl carbocation) is a  $2^\circ$  carbocation with two alkyl groups. 4.  $(CH_3)_3C^+$  (Tert-butyl carbocation) is a  $3^\circ$  carbocation with three alkyl groups. 5. In  $(CH_3)_3C^+$ , the positive charge is most efficiently dispersed by three +*I* groups and 9 alpha-hydrogens (hyperconjugation). 6. Stability order:  $3^\circ > 2^\circ > 1^\circ > \text{Methyl}$ .

**Final Answer:**  $(CH_3)_3C^+$  is the most stable carbocation.

**Answer: (A)**



Q20.

**Solution****Concept:**

A transition element is defined as an element whose atom has a partially filled  $d$ -subshell, or which can give rise to cations with an incomplete  $d$ -subshell. These elements are located in groups 3-12 of the periodic table.

**Solution:**

1.  $Fe$  (Iron) and  $Sc$  (Scandium) have incomplete  $d$ -shells in their atomic or common ionic states. 2.  $Cu$  (Copper) has a full  $d$ -shell ( $3d^{10}$ ) in its atomic state, but in its common +2 oxidation state ( $Cu^{2+}$ ), it has a  $3d^9$  configuration (incomplete), so it is a transition element. 3.  $Zn$  (Zinc) has an electronic configuration of  $[Ar]3d^{10}4s^2$ . In its only common oxidation state,  $Zn^{2+}$ , the configuration is  $[Ar]3d^{10}$ . 4. Since  $Zn$  has a completely filled  $d$ -subshell in both its atomic and ionic states, it is technically not considered a transition element, though it is a  $d$ -block element.

**Final Answer:**  $Zn$  is not considered a transition element.

Answer: (C)

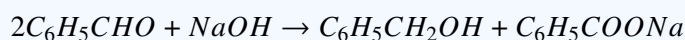
Q21.

**Solution****Concept:**

The Cannizzaro reaction is a chemical reaction that involves the base-induced disproportionation of an aldehyde that lacks a hydrogen atom in the  $\alpha$  position ( $\alpha$ -hydrogen). In this redox process, one molecule of aldehyde is reduced to an alcohol, while another is oxidized to a carboxylic acid salt.

**Solution:**

1. Benzaldehyde ( $C_6H_5CHO$ ) lacks an  $\alpha$ -hydrogen atom because the carbon adjacent to the carbonyl group is part of the benzene ring and has no hydrogens. 2. When treated with concentrated  $NaOH$ , it undergoes the Cannizzaro reaction. 3. Oxidation Step: One molecule of benzaldehyde is oxidized to Benzoic acid, which in the presence of  $NaOH$  exists as Sodium benzoate ( $C_6H_5COONa$ ). 4. Reduction Step: Another molecule of benzaldehyde is reduced to Benzyl alcohol ( $C_6H_5CH_2OH$ ). 5. The balanced equation is:



**Final Answer:** The products are Benzyl alcohol and Sodium benzoate.

Answer: (A)



Q22.

**Solution****Concept:**

Carbohydrates like glucose and fructose can be distinguished using specific chemical tests that exploit their different functional groups. *d*-glucose is an aldohexose (contains an aldehyde group), while *d*-fructose is a ketohexose (contains a ketone group).

**Solution:**

1. Both glucose and fructose give positive Molisch tests (general for carbohydrates), Tollen's tests (fructose reduces it due to tautomerization in base), and form the same osazone. 2. Bromine water ( $Br_2/H_2O$ ) is a mild oxidizing agent. 3. It oxidizes the aldehyde group of glucose to a carboxyl group, forming Gluconic acid, and the reddish-brown color of bromine is decolorized. 4. Fructose, containing a ketone group, does not react with bromine water under mild conditions. 5. Therefore, bromine water is used to distinguish between an aldose and a ketose.

**Final Answer:** Bromine water test is used to distinguish them.

**Answer:** (C)

Q23.

**Solution****Concept:**

The magnetic properties of transition metal ions are related to the number of unpaired electrons ( $n$ ). The spin-only magnetic moment ( $\mu$ ) is calculated using the formula:

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

where BM stands for Bohr Magneton.

**Solution:**

1. Atomic number of *Ni* is 28. Its ground state configuration is  $[Ar]3d^84s^2$ . 2. For  $Ni^{2+}$ , two electrons are removed from the 4s orbital, giving the configuration:  $[Ar]3d^8$ . 3. In the  $3d^8$  configuration, according to Hund's Rule, the 8 electrons are distributed in 5 orbitals as follows: 3 orbitals are fully filled (pairs) and 2 orbitals are half-filled (unpaired). 4. Number of unpaired electrons ( $n$ ) = 2. 5. Calculation:

$$\mu = \sqrt{2(2+2)} = \sqrt{2 \times 4} = \sqrt{8}$$

6. Since  $\sqrt{9} = 3$ ,  $\sqrt{8}$  is approximately 2.83 BM.

**Final Answer:** The magnetic moment is approximately 2.83 BM.

**Answer:** (B)



Q24.

**Solution****Concept:**

The acidity of a compound depends on the stability of its conjugate base (the anion formed after losing a proton). Greater stability of the anion via resonance or inductive effects leads to higher acidity of the parent compound.

**Solution:**

1. Ethanol ( $C_2H_5OH$ ) and Water ( $H_2O$ ) are very weak acids. Ethanol is even weaker than water due to the +I effect of the ethyl group. 2. Acetone ( $CH_3COCH_3$ ) is only weakly acidic at the  $\alpha$ -hydrogens. 3. Phenol ( $C_6H_5OH$ ) is significantly more acidic than alcohols and water. 4. When phenol loses a proton, it forms the Phenoxide ion ( $C_6H_5O^-$ ). 5. The negative charge on oxygen is delocalized over the ortho and para positions of the benzene ring through resonance, which greatly stabilizes the anion.

**Final Answer:** Phenol is the most acidic compound among the choices.

**Answer:** (C)

Q25.

**Solution****Concept:**

The structure of oxoacids of phosphorus can be determined by following certain rules: Phosphorus is always bonded to at least one Oxygen via a double bond ( $P = O$ ) and at least one Hydroxyl group ( $P - OH$ ).

**Solution:**

1. The molecular formula for orthophosphoric acid is  $H_3PO_4$ . 2. In  $H_3PO_4$ , Phosphorus is the central atom. 3. It forms one double bond with Oxygen ( $P = O$ ). 4. The remaining three Oxygen atoms are bonded to the three Hydrogen atoms to form three Hydroxyl groups ( $P - OH$ ). 5. Therefore, the molecule is tribasic, containing 3  $P - OH$  bonds.

**Final Answer:** There are 3  $P - OH$  bonds.

**Answer:** (C)



Q26.

**Solution****Concept:**

An ideal solution is a solution that obeys Raoult's Law over the entire range of concentration. This typically occurs when the intermolecular forces between the components ( $A - A$  and  $B - B$ ) are nearly identical to the forces between the unlike molecules ( $A - B$ ). Such substances usually have similar chemical structures and polarities.

**Solution:**

1. **Benzene and Toluene:** Both are non-polar hydrocarbons with very similar structures (toluene is just methylbenzene). Their sizes and intermolecular Van der Waals forces are nearly identical. Thus, they form an almost ideal solution. 2. **Ethanol and Water:** Show large positive deviation from Raoult's Law due to differences in hydrogen bonding. 3. **Chloroform and Acetone:** Show negative deviation because of the formation of a new hydrogen bond between the two components. 4. **Phenol and Aniline:** Show negative deviation due to strong intermolecular hydrogen bonding between the phenolic  $-OH$  and the aniline  $-NH_2$  group.

**Final Answer:** Benzene and Toluene form an ideal solution.

**Answer: (A)**

Q27.

**Solution****Concept:**

The Valence Shell Electron Pair Repulsion (VSEPR) theory predicts the geometry of molecules based on the repulsion between electron pairs (both bonding and lone pairs) surrounding a central atom. The order of repulsion is: Lone Pair-Lone Pair > Lone Pair-Bond Pair > Bond Pair-Bond Pair.

**Solution:**

1. In  $NH_3$ , the central Nitrogen atom has 5 valence electrons. 2. It forms 3 sigma bonds with 3 Hydrogen atoms, using 3 electrons. 3. The remaining 2 electrons form 1 lone pair. 4. The steric number is 4 (3 bond pairs + 1 lone pair), which corresponds to a tetrahedral electron geometry. 5. However, the presence of the lone pair pushes the  $N - H$  bonds closer together. The molecular shape (looking only at the atoms) is trigonal pyramidal.

**Final Answer:** The shape of  $NH_3$  is Pyramidal.

**Answer: (C)**



Q28.

**Solution****Concept:**

Electron gain enthalpy ( $\Delta_{eg}H$ ) is the energy change when an electron is added to a neutral gaseous atom. Generally, it becomes more negative across a period. For halogens, one would expect Fluorine to have the highest (most negative) value, but there is a well-known anomaly.

**Solution:**

1. Fluorine ( $F$ ) is a very small atom. When an electron is added to its compact  $2p$  subshell, it experiences significant inter-electronic repulsion from the electrons already present. 2. Chlorine ( $Cl$ ) has a larger  $3p$  subshell, which can accommodate the incoming electron more easily with less repulsion. 3. As a result, more energy is released when an electron is added to Chlorine than to Fluorine. 4. The experimental order of negative electron gain enthalpy is:  $Cl > F > Br > I$ .

**Final Answer:** Chlorine ( $Cl$ ) has the highest electron gain enthalpy.

**Answer: (B)**

Q29.

**Solution****Concept:**

The Hall-Héroult process is used for the extraction of Aluminum from purified alumina ( $Al_2O_3$ ). Pure alumina has an extremely high melting point (over  $2000^\circ C$ ) and is a poor conductor of electricity, making electrolysis difficult and expensive.

**Solution:**

1. Cryolite ( $Na_3AlF_6$ ) is mixed with alumina during electrolysis. 2. It serves two primary functions: - It acts as a solvent and lowers the melting point of the mixture to about  $950^\circ C$ . - It increases the electrical conductivity of the electrolyte. 3. Fluorspar ( $CaF_2$ ) is also often added to further improve conductivity and fluidity.

**Final Answer:** Cryolite is added to decrease the melting point and increase conductivity.

**Answer: (C)**



Q30.

**Solution****Concept:**

For a first-order reaction, the half-life ( $t_{1/2}$ ) is the time taken for the concentration to reduce to half of its initial value. The relationship between the rate constant ( $k$ ) and half-life is:

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

**Solution:**

1. The initial concentration is 0.1 M. After 10 minutes, the concentration is 0.05 M. 2. Since 0.05 is exactly half of 0.1, the time taken (10 minutes) is the half-life ( $t_{1/2}$ ). 3. Substitute  $t_{1/2} = 10$  min into the formula:

$$k = \frac{0.693}{10}$$

$$k = 0.0693 \text{ min}^{-1}$$

**Final Answer:** The rate constant is  $0.0693 \text{ min}^{-1}$ .

**Answer: (A)**

Q31.

**Solution****Concept:**

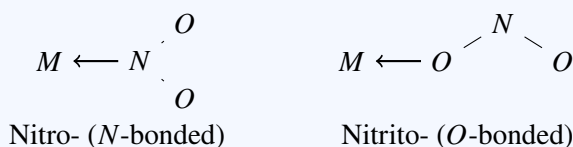
Ambidentate ligands are monodentate ligands that contain more than one donor atom and can coordinate to a central metal atom through either of the two different atoms.

**Solution:**

Step 1: Analyze the given options for donor sites: \*  $H_2O$  and  $NH_3$ : Only one type of donor atom (Oxygen and Nitrogen respectively). \*  $C_2O_4^{2-}$  (Oxalate): A didentate ligand that coordinates through two Oxygen atoms simultaneously. \*  $NO_2^-$  (Nitrite): Contains two different potential donor atoms—Nitrogen and Oxygen.

Step 2: The nitrite ion can link to the metal ( $M$ ) in two ways: 1. Through Nitrogen ( $M \leftarrow NO_2$ ): called the nitro- ligand. 2. Through Oxygen ( $M \leftarrow ONO$ ): called the nitrito- ligand.

Step 3: Because  $NO_2^-$  can coordinate via two different atoms (though only one at a time), it is classified as an ambidentate ligand.



**Final Answer:**

**(B)  $NO_2^-$**

**Answer: (B)**



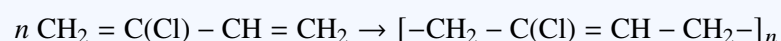
Q32.

**Solution****Concept:**

Polymers are formed by the repeated linkage of smaller units called monomers. Neoprene, also known as polychloroprene, is a synthetic rubber-like polymer known for its chemical stability and flexibility over a wide temperature range.

**Solution:**

1. Isoprene (2-methyl-1,3-butadiene) is the monomer for natural rubber. 2. Acrylonitrile is the monomer for Orlon (PAN). 3. Styrene is the monomer for Polystyrene. 4. Chloroprene (2-chloro-1,3-butadiene) is the monomer for Neoprene. 5. The polymerization of chloroprene occurs via free radical mechanism to yield Neoprene:



**Final Answer:** The monomer of Neoprene is Chloroprene.

**Answer: (B)**

Q33.

**Solution****Concept:**

Greenhouse gases are atmospheric gases that absorb and emit radiant energy within the thermal infrared range, causing the greenhouse effect. The primary greenhouse gases in Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone.

**Solution:**

1.  $N_2$  (Nitrogen),  $O_2$  (Oxygen), and  $Ar$  (Argon) make up the bulk of the atmosphere but do not absorb infrared radiation significantly; therefore, they are not greenhouse gases. 2.  $CH_4$  (Methane) is a potent greenhouse gas, significantly more effective at trapping heat than  $CO_2$  on a per-molecule basis. 3. Sources of methane include wetlands, agricultural activities (like rice paddies and livestock), and fossil fuel extraction.

**Final Answer:**  $CH_4$  is a greenhouse gas.

**Answer: (C)**



Q34.

**Solution****Concept:**

The relationship between the standard Gibbs free energy change ( $\Delta G^\circ$ ) and the standard electromotive force ( $E^\circ_{cell}$ ) of an electrochemical cell is given by the formula:

$$\Delta G^\circ = -nFE^\circ_{cell}$$

where  $n$  is the number of moles of electrons transferred,  $F$  is Faraday's constant, and  $E^\circ_{cell}$  is the standard cell potential.

**Solution:**

1. Identify the cell reaction:  $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$ . 2. The number of electrons transferred ( $n$ ) is 2 (since  $Zn \rightarrow Zn^{2+} + 2e^-$ ). 3. Given values:  $n = 2$ ,  $F = 96500 \text{ C/mol}$ ,  $E^\circ_{cell} = 1.10 \text{ V}$ . 4. Calculate  $\Delta G^\circ$ :

$$\Delta G^\circ = -(2) \times (96500) \times (1.10)$$

$$\Delta G^\circ = -212300 \text{ Joules} = -212.3 \text{ kJ}$$

5. The negative sign indicates that the reaction is spontaneous under standard conditions.

**Final Answer:**  $\Delta G^\circ$  is  $-212.3 \text{ kJ}$ .

**Answer: (A)**

Q35.

**Solution****Concept:**

Nucleophilic substitution bimolecular (SN2) reaction occurs in a single step where the nucleophile attacks the carbon atom from the side opposite to the leaving group (backside attack). This simultaneous bond-breaking and bond-making leads to a specific stereochemical outcome.

**Solution:**

1. In an SN2 reaction, the nucleophile approaches the central carbon atom  $180^\circ$  away from the leaving group. 2. As the transition state is formed, the other three groups attached to the carbon "flip" over to the other side, similar to an umbrella blowing inside out in a strong wind. 3. This process results in the product having a spatial arrangement of groups that is the exact opposite of the starting material. 4. This phenomenon is known as Walden Inversion or simply inversion of configuration.

**Final Answer:** The configuration of the product is inverted.

**Answer: (B)**



Q36.

**Solution****Concept:**

The electronic configuration of transition elements follows the Aufbau principle, but there are notable exceptions in the 3d series due to the extra stability associated with half-filled ( $d^5$ ) and fully-filled ( $d^{10}$ ) subshells. In these cases, an electron from the 4s orbital shifts to the 3d orbital.

**Solution:**

1. According to the Aufbau principle, the expected configuration for Chromium ( $Z = 24$ ) would be  $[Ar]3d^44s^2$ . 2. However, a  $d^5$  configuration is more stable because of its symmetrical distribution of electrons and high exchange energy. 3. Therefore, one electron from the 4s orbital jumps to the 3d orbital to achieve the half-filled state. 4. The actual electronic configuration of Chromium ( $Cr$ ) is  $[Ar]3d^54s^1$ . 5. Manganese ( $Mn, Z = 25$ ) has the configuration  $[Ar]3d^54s^2$ .

**Final Answer:** The element is  $Cr$  (Chromium).

**Answer: (B)**

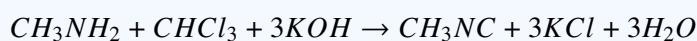
Q37.

**Solution****Concept:**

The Carbylamine reaction (also known as the isocyanide test) is a chemical test for the detection of primary amines. When a primary amine is heated with chloroform and alcoholic potassium hydroxide, it forms an isocyanide (carbylamine), which possesses an extremely foul and offensive odor.

**Solution:**

1. Secondary ( $2^\circ$ ) and tertiary ( $3^\circ$ ) amines do not give this reaction. 2. Dimethylamine is a  $2^\circ$  amine and Trimethylamine is a  $3^\circ$  amine; hence they do not react. 3. Both Methylamine and Aniline are primary ( $1^\circ$ ) amines. Methylamine is aliphatic, and Aniline is aromatic. 4. Both (A) and (D) would technically give a positive result. However, in standard textbook context for "offensive smell with  $CHCl_3$  and  $KOH$ ", primary aliphatic amines like Methylamine are the classic examples cited for this test. 5. The reaction for Methylamine is:



6.  $CH_3NC$  is Methyl isocyanide, the source of the smell.

**Final Answer:** Methylamine gives an offensive smell.

**Answer: (A)**



Q38.

**Solution****Concept:**

Molar conductivity ( $\Lambda_m$ ) 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 ( $\kappa$ ) by the formula:

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

**Solution:**

1. The unit of conductivity ( $\kappa$ ) is  $S \text{ cm}^{-1}$  (where  $S$  is Siemens). 2. The unit of molarity ( $M$ ) in this context is  $\text{mol cm}^{-3}$  (when using the 1000 factor). 3. Therefore, the units for molar conductivity are:

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

4. In SI units, it is expressed as  $S \text{ m}^2 \text{ mol}^{-1}$ .

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

**Answer: (A)**

Q39.

**Solution****Concept:**

Vitamins are classified into two groups based on their solubility: fat-soluble vitamins and water-soluble vitamins. Fat-soluble vitamins are stored in the liver and fatty tissues, while water-soluble vitamins are not stored in the body and must be supplied regularly in the diet.

**Solution:**

1. **\*\*Fat-soluble vitamins:\*\*** Vitamin A, Vitamin D, Vitamin E, and Vitamin K (Remembered by the acronym ADEK). 2. **\*\*Water-soluble vitamins:\*\*** Vitamin B-complex group and Vitamin C. 3. Vitamin C (ascorbic acid) is easily dissolved in water and is excreted in urine if taken in excess. 4. It is essential for the repair of tissues and the enzymatic production of certain neurotransmitters.

**Final Answer:** Vitamin C is water-soluble.

**Answer: (C)**



Q40.

### Solution

#### Concept:

Tests for unsaturation in organic compounds involve reagents that react with carbon-carbon double bonds ( $C = C$ ) or triple bonds ( $C \equiv C$ ).

#### Solution:

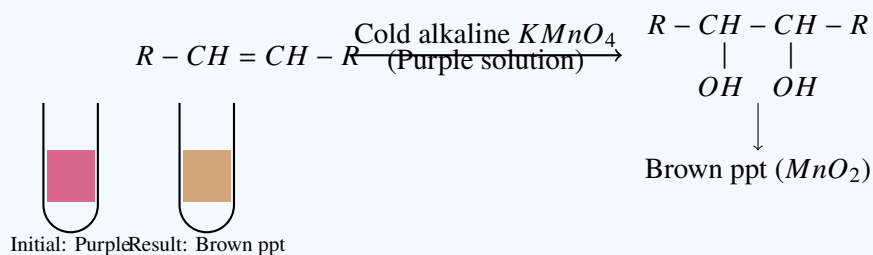
Step 1: **Baeyer's reagent** is a cold, dilute, alkaline solution of potassium permanganate ( $KMnO_4$ ). It is a standard reagent used to detect unsaturation.

Step 2: When an alkene or alkyne is added to Baeyer's reagent, the deep purple color of the  $MnO_4^-$  ion disappears, and a dark brown precipitate of manganese dioxide ( $MnO_2$ ) is formed.

Step 3: This occurs because the  $KMnO_4$  oxidizes the unsaturated bond to form a vicinal diol (glycol). Saturated compounds (alkanes) do not react with it under these conditions.



Step 4: Other options like Fehling's and Tollen's reagents are used to detect aldehydes, while Lucas reagent is used to distinguish between different types of alcohols.



#### Final Answer:

(B) Baeyer's reagent

Answer: (B)



Q41.

**Solution****Concept:**

A chiral carbon (or asymmetric carbon) is a carbon atom that is bonded to four different types of atoms or groups of atoms. The presence of a chiral center allows for the existence of optical isomers.

**Solution:**

1. The structure of 2, 3-dichlorobutane is  $CH_3 - CH(Cl) - CH(Cl) - CH_3$ . 2. Let's examine the second carbon (C2): - It is bonded to a hydrogen atom ( $-H$ ). - It is bonded to a chlorine atom ( $-Cl$ ). - It is bonded to a methyl group ( $-CH_3$ ). - It is bonded to a  $-CH(Cl)CH_3$  group. 3. Since all four groups are different, C2 is a chiral center. 4. Similarly, examine the third carbon (C3): - It is bonded to  $-H$ ,  $-Cl$ ,  $-CH_3$ , and a  $-CH(Cl)CH_3$  group. 5. C3 is also bonded to four different groups, making it a second chiral center. 6. Therefore, the molecule contains exactly two chiral carbons.

**Final Answer:** There are 2 chiral carbons.

**Answer: (B)**

Q42.

**Solution****Concept:**

Hydrogen bonding is a special type of dipole-dipole attraction between a hydrogen atom bonded to a strongly electronegative atom (like  $N$ ,  $O$ , or  $F$ ) and another electronegative atom. It significantly increases the boiling point of a substance.

**Solution:**

1. In Water ( $H_2O$ ), oxygen is highly electronegative and has two lone pairs. This allows each water molecule to form strong intermolecular hydrogen bonds with neighboring molecules. 2. In Hydrogen sulfide ( $H_2S$ ), sulfur is much less electronegative than oxygen. Consequently,  $H_2S$  molecules are held together only by weaker Van der Waals forces (dipole-dipole). 3. Breaking hydrogen bonds requires significantly more energy than breaking Van der Waals forces. 4. This extra energy requirement manifests as a much higher boiling point for water ( $100^\circ C$ ) compared to  $H_2S$  ( $-60^\circ C$ ), even though  $H_2S$  has a higher molecular weight.

**Final Answer:** The boiling point is higher because of hydrogen bonding.

**Answer: (A)**



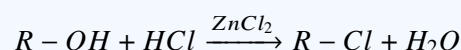
Q43.

**Solution****Concept:**

Lucas reagent is a mixture of concentrated  $HCl$  and anhydrous  $ZnCl_2$ . It is used to distinguish between primary, secondary, and tertiary alcohols based on the rate at which they form alkyl chlorides, which appear as turbidity in the solution.

**Solution:**

1. The reaction proceeds via a carbocation intermediate:



2. The stability of the carbocation determines the speed of the reaction. Tertiary ( $3^\circ$ ) carbocations are the most stable, followed by secondary ( $2^\circ$ ), and then primary ( $1^\circ$ ). 3. Tertiary alcohols react almost instantaneously, producing turbidity immediately. 4. Secondary alcohols react within 5 to 10 minutes. 5. Primary alcohols do not react at room temperature and only produce turbidity upon heating. 6. Therefore, the reactivity order is  $3^\circ > 2^\circ > 1^\circ$ .

**Final Answer:** The order of reactivity is  $3^\circ > 2^\circ > 1^\circ$ .

**Answer: (B)**

Q44.

**Solution****Concept:**

Noble gases (Group 18 elements) are present in the Earth's atmosphere in very small quantities. They are chemically inert under normal conditions due to their stable electronic configurations.

**Solution:**

1. The Earth's atmosphere is composed of approximately 78% Nitrogen and 21% Oxygen. 2. The remaining 1% consists mostly of noble gases and carbon dioxide. 3. Among the noble gases, Argon ( $Ar$ ) is by far the most abundant, making up about 0.93% of the atmosphere by volume. 4. Argon is produced in the Earth's crust by the radioactive decay of Potassium-40 ( $^{40}K$ ). 5. Other noble gases like Helium, Neon, and Krypton are present in trace amounts (parts per million).

**Final Answer:** Argon ( $Ar$ ) is the most abundant noble gas.

**Answer: (C)**



Q45.

**Solution****Concept:**

Functional groups are specific groups of atoms within molecules that are responsible for the characteristic chemical reactions of those molecules. Esters are organic compounds derived from carboxylic acids.

**Solution:**

1.  $-OH$  is the hydroxyl group, characteristic of alcohols and phenols. 2.  $-CHO$  is the aldehyde group. 3.  $-COOH$  is the carboxylic acid group (carboxyl group). 4.  $-COOR$  is the ester functional group, where an alkyl or aryl group ( $R$ ) replaces the hydrogen of a carboxyl group. 5. Esters are typically formed by the reaction of a carboxylic acid and an alcohol (esterification) and often have pleasant, fruity smells.

**Final Answer:** The functional group in an ester is  $-COOR$ .

**Answer:** (C)

Q46.

**Solution****Concept:**

The mole concept relates the mass of a substance to the number of particles or moles present. The mass of a substance can be calculated by multiplying the number of moles by the molar mass of that substance.

$$\text{Mass} = \text{Number of moles} \times \text{Molar mass}$$

**Solution:**

1. The substance given is Carbon dioxide ( $CO_2$ ). 2. The molar mass of  $CO_2$  is calculated as:

$$\text{Molar mass} = (1 \times \text{Atomic mass of C}) + (2 \times \text{Atomic mass of O})$$

$$\text{Molar mass} = (1 \times 12) + (2 \times 16) = 12 + 32 = 44 \text{ g/mol}$$

3. The number of moles given is 0.5 mol. 4. Calculate the mass:

$$\text{Mass} = 0.5 \text{ mol} \times 44 \text{ g/mol} = 22 \text{ g}$$

**Final Answer:** The mass of 0.5 moles of  $CO_2$  is 22 g.

**Answer:** (A)



Q47.

**Solution****Concept:**

Metallurgy involves various processes to extract pure metals from their ores. For sulfide ores, a specific thermal treatment is used to convert the sulfide into an oxide, which is easier to reduce.

**Solution:**

1. **Roasting** is the process of heating the ore (usually sulfide ores like  $ZnS$  or  $PbS$ ) to a high temperature below its melting point in the presence of a regular supply of air. 2. This process converts metal sulfides into metal oxides and removes volatile impurities like arsenic or antimony. 3. **Calcination** is a similar heating process but is done in the absence or limited supply of air, typically for carbonate or hydrated oxide ores. 4. **Smelting** involves reduction of the ore with a reducing agent (like coke) at high temperatures.

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

**Answer: (B)**

Q48.

**Solution****Concept:**

Polyamides are a category of polymers that contain repeating amide linkages ( $-CO - NH-$ ) in their backbone. They are typically formed by the condensation polymerization of a diamine and a dicarboxylic acid, or by the polymerization of amino acids.

**Solution:**

1. **Terylene** is a polyester, containing ester linkages. 2. **Buna-N** is a synthetic rubber (copolymer of butadiene and acrylonitrile). 3. **PVC** (Polyvinyl chloride) is an addition polymer. 4. **Nylon-6,6** is prepared by the condensation of adipic acid and hexamethylenediamine. 5. During the reaction, the carboxylic acid group and the amine group react to form an amide bond, releasing a water molecule. This makes it a classic example of a polyamide.

**Final Answer:** Nylon-6,6 is a polyamide.

**Answer: (A)**



Q49.

**Solution****Concept:**

The bond angle in a molecule is determined by the hybridization of the central atom. In a perfectly symmetrical molecule with  $sp^3$  hybridization and no lone pairs, the geometry is tetrahedral.

**Solution:**

1. In Methane ( $CH_4$ ), the central Carbon atom is  $sp^3$  hybridized. 2. It has 4 valence electrons, all of which are used to form 4 sigma bonds with 4 Hydrogen atoms. 3. Since there are no lone pairs on the Carbon atom, the bond pairs repel each other equally to minimize repulsion. 4. This results in a regular tetrahedral geometry where all  $H - C - H$  bond angles are exactly  $109.5^\circ$  (or more precisely  $109^\circ 28'$ ).

**Final Answer:** The bond angle is  $109.5^\circ$ .

**Answer: (C)**

Q50.

**Solution****Concept:**

This is a simple arithmetic problem related to the concept of unit cost. The total cost is the product of the quantity used and the price per unit.

$$\text{Total Cost} = \text{Quantity} \times \text{Unit Price}$$

**Solution:**

1. Given the cost of sugar is ₹ 45 for 1 kg (1000 g). 2. The chemist uses sugar worth ₹ 9. 3. We need to find the mass ( $m$ ) used:

$$m = \frac{\text{Cost of sugar used}}{\text{Cost per kg}} \times 1000 \text{ g}$$

4. Substitute the values:

$$m = \frac{9}{45} \times 1000 \text{ g}$$

5. Simplify the fraction:

$$m = \frac{1}{5} \times 1000 \text{ g} = 200 \text{ g}$$

**Final Answer:** The mass of sugar used was 200 g.

**Answer: (A)**



## Answer Key

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

