SET-I

1. Write the formula of an oxo-anion of manganese (Mn) in which it shows the oxidation state equal to its group number.

2. Write IUPAC name of the following compound:
   \((\text{CH}_3\text{CH}_2)_2\text{NCH}_3\)

3. For a reaction \(R \rightarrow P\), half-life \((t_{1/2})\) is observed to be independent of the initial concentration of reactants. What is the order of reaction?

4. Write the structure of 1-bromo-4-chlorobut-2-ene.

5. Write one similarity between physisorption and chemisorption.

6. Complete the following reactions:
   (a) \(\text{NH}_3 + 3\text{Cl}_2\text{(excess)} \rightarrow \)
   (b) \(\text{XeF}_6 + 2\text{H}_2\text{O} \rightarrow \)
   \(\) or
   \(\)
   What happens when
   (a) \((\text{NH}_4)_2\text{Cr}_2\text{O}_7\) is heated?
   (b) \(\text{H}_3\text{PO}_3\) is heated?
   Write the equations.

7. Define the following terms:
   (a) Colligative properties
   (b) Molality \((m)\)

8. Draw the structures of the following:
   (a) \(\text{H}_3\text{S}_2\text{O}_7\)
   (b) \(\text{XeF}_6\)

9. Calculate the degree of dissociation \((\alpha)\) of acetic acid if its molar conductivity \((\lambda_m)\) is 39.05 S cm\(^2\)mol\(^{-1}\).
   Given: \(\lambda^\circ(\text{H}^+) = 349.6\) S cm\(^2\)mol\(^{-1}\) and \(\lambda^\circ(\text{CH}_3\text{COO}^-) = 40.9\) S cm\(^2\)mol\(^{-1}\)

10. Write the equations involved in the following reactions:
    (a) Wolff-Kishner reduction.
    (b) Etard reaction.

11. A 10% solution (by mass) of sucrose in water has freezing point of 269.15 K. Calculate the freezing point of 10% glucose in water, if freezing point of pure water is 273.15 K.
    Given: Molar mass of sucrose = 342 g mol\(^{-1}\) and Molar mass of glucose = 180 g mol\(^{-1}\)
12. (a) Calculate the mass of Ag deposited at cathode when a current of 2A was passed through a solution of AgNO$_3$ for 15 min. (Given : Molar mass of Ag = 108 g mol$^{-1}$, 1F = 96500 C mol$^{-1}$).

(b) Define fuel cell.

13. (a) What type of isomerism is shown by the complex $\text{[Co(NH}_3)_6\text{][Cr(CN)_6]}$?

(b) Why a solution of $\text{[Ni(H}_2\text{O)}_6\text{]}^{2+}$ is green while a solution of $\text{[Ni(CN)}_4\text{]}^{2-}$ is colourless?

(c) Write the IUPAC name of the following complex : $\text{[Co(NH}_3)_3\text{(CO)}_3\text{]Cl}$

14. Write one difference in each of the following:

(a) Lyophobic sol and lyophilic sol.

(b) Solution and colloid.

(c) Homogeneous catalysis and heterogeneous catalysis.

15. Following data are obtained for the reaction:

$$\text{N}_2\text{O}_5 \rightarrow 2\text{NO}_2 + \frac{1}{2}\text{O}_2$$

<table>
<thead>
<tr>
<th>t/s</th>
<th>$[\text{N}_2\text{O}_5]$ mol L$^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$1.6 \times 10^{-2}$</td>
</tr>
<tr>
<td>300</td>
<td>$0.8 \times 10^{-2}$</td>
</tr>
<tr>
<td>600</td>
<td>$0.4 \times 10^{-2}$</td>
</tr>
</tbody>
</table>

(a) Show that it follows first order reaction.

(b) Calculate the half-life.

(Given: log 2 = 0.3010, log 4 = 0.6021)

16. Following compounds are given to you:

2-bromopentane, 2-bromo-2-methylbutane, 1-bromopentane

(a) Write the compound which is most reactive towards $\text{SnCl}_2$ reaction.

(b) Write the compound which is optically active.

(c) Write the compound which is most reactive towards $\beta$-elimination reaction.

17. (a) Write the principle of method used for the refining of germanium.

(b) Out of PbS and PbCO$_3$ (ores of lead), which one is concentrated by froth flotation process preferably?

(c) What is the significance of leaching in the extraction of aluminiun?

18. Write structures of compounds $A$, $B$ and $C$ in each of the following reactions:

(a) $\text{C}_6\text{H}_5\text{Br} \xrightarrow{\text{Mg/dry ether}} A \xrightarrow{\text{CO}_2(g)} B \xrightarrow{\text{PCl}_5} C$

(b) $\text{CH}_3\text{CN} \xrightarrow{\text{SnCl}_2/\text{HCl}} A \xrightarrow{\text{dil.NaOH}} B \xrightarrow{\Delta} C$

Or

Do the following conversions in not more than two steps:

(a) Benzoic acid to benzaldehyde.

(b) Ethyl benzene to benzoic acid.

(c) Propanone to propene.

19. Write the structures of the monomers used for getting the following polymers:

(a) Dacron.

(b) Melamine-formaldehyde polymer.

(c) Buna-N.

20. Define the following:

(a) Anionic detergents.

(b) Broad spectrum antibiotics.

(c) Antiseptic.

21. Give reasons:

(a) Thermal stability decreases from $\text{H}_2\text{O}$ to $\text{H}_2\text{Te}$.

(b) Fluoride ion has higher hydration enthalpy than chloride ion.

(c) Nitrogen does not form pentahalide.

22. Give reasons:

(a) Acetylation of aniline reduces its activation effect.

(b) $\text{CH}_3\text{NH}_2$ is more basic than $\text{C}_6\text{H}_5\text{NH}_2$.

(c) Although $\text{NH}_2$ is o/p-directing group, yet aniline on nitrination gives a significant amount of m-nitroaniline.

23. After watching a programme on TV about the presence of carcinogens (cancer causing agents), potassium bromate and potassium iodate in bread and other bakery products, Ritu a class XII student decided to aware others about the adverse effects of these carcinogens in foods. She consulted the school principal and requested him to instruct canteen contractor to stop selling sandwiches, pizza, burgers and other bakery products to the students. Principal took an immediate action and instructed the canteen contractor to replace the bakery products with some proteins and vitamins rich food like fruits, salads, sprouts etc. The decision was welcomed by the parents and students.
After reading the above passage, answer the following questions:

(a) What are the values (at least two) displayed by Ritu?
(b) Which polysaccharide component of carbohydrates is commonly present in bread?
(c) Write the two types of secondary structure of proteins.
(d) Give two example of water soluble vitamins.

24. (a) Account for the following
(i) Transition metals form large number of complex compounds.
(ii) The lowest oxide of transition metal is basic whereas the highest oxide is amphoteric or acidic.
(iii) $E^\circ$ value for the Mn$^{3+}$/Mn$^{2+}$ couple is highly positive (+1.57V) as compare to Cr$^{3+}$/Cr$^{2+}$.

(b) Write one similarity and one difference between the chemistry of lanthanoid and actinoid elements.

Or

(a) (i) How is the variability in oxidation states of transition metals different from that of the $p$-block elements?
(ii) Out of Cu$^+$ and Cu$^{2+}$, which ion is unstable in aqueous solution and why?
(iii) Orange colour of Cr$_2$O$_7^{2-}$ ion changes to yellow when treated with an alkali. Why?

(b) Chemistry of actinoids is complicated as compared to lanthanoids. Give two reasons.

25. (a) An element has atomic mass 93 g mol$^{-1}$ and density 11.5 g cm$^{-3}$. If the edge length of its unit cell is 300 pm, identify the type of unit cell.

(b) Write any two differences between amorphous solids and crystalline solids.

Or

(a) Calculate the number of unit cells in 8.1 g of aluminium if it crystallises in a fcc structure.

(Atomic mass of Al = 27 g mol$^{-1}$)

(b) Give reasons:
(i) In stoichiometric defects, NaCl exhibits Schottky defect and not Frenkel defect.
(ii) Silicon on doping with phosphorus forms $n$-type semiconductor.
(iii) Ferrimagnetic substances show better magnetism than antiferromagnetic substances.

26. (a) Write the products(s) in the following reactions:
(i) CH$_2$CH$_2$OH $\xrightarrow{(\text{H}_2\text{O})}$ COOH

Or

(b) Give simple chemical tests to distinguish between the following pairs of compounds:
(i) Ethanol and phenol.
(ii) Propanol and 2-methylpropan-2-ol.

Or

(a) Write the formula of reagents used in the following reactions:
(i) Bromination of phenol to 2, 4, 6-tribromophenol.
(ii) Hydroboration of propene and then oxidation to propanol.

(b) Arrange the following compounds in the increasing order of the property indicated:
(i) $p$-nitrophenol, ethanol, phenol (acidic character).
(ii) Propanol, propane, propanal (boiling point).

(c) Write the mechanism (using curved arrow notation) of the following reaction:

CH$_3$–CH$_2$–OH $\xrightarrow{\text{CH}_3\text{CH}_2\text{OH}}$ CH$_3$–CH$_2$–O–CH$_3$ + H$_2$O

ANSWERS

1. The formula of an oxo-anion of manganese (Mn) in which it shows the oxidation state equal to its group number is MnO$_4^-$.

Here, oxidation state of Mn is +7 which is same as is its group number.

2. Given compound is H$_3$CH$_2$C–N–CH$_2$CH$_3$

IUPAC name –N-ethyl, N-methylethanamine.

3. For a reaction $R \rightarrow P$, half-life ($t_{1/2}$) is observed to be independent of the initial concentration of reactants. Thus, it follows first order reaction.
4. The structure of 1-bromo-4-chlorobut-2-ene is 
\[ \text{H}_2\text{C}—\text{CH} \equiv \text{CH}—\text{CH}_2 \]

5. Both physisorption and chemisorption depends on the surface area and increases with an increase in surface area of the adsorbent.

6. (a) \( \text{NH}_3 + 3\text{Cl}_2(\text{excess}) \rightarrow \text{NCl}_3 + 3\text{HCl} \) 
(b) \( \text{XeF}_6 + 2\text{H}_2\text{O} \rightarrow \text{XeOF}_2 + 4\text{HF} \)

Or
(a) When \( (\text{NH}_3)_2\text{Cr}_2\text{O}_7 \) is heated, it gives nitrogen gas \( (\text{N}_2) \) and chromium oxide \( (\text{Cr}_2\text{O}_3) \).
(b) On heating, \( \text{H}_2\text{PO}_3 \) undergoes disproportionation to form \( \text{H}_3\text{PO}_4 \) and \( \text{PH}_3 \) (phosphine).

7. (a) **Colligative Properties** The properties of solutions which depend only on the number of solute particles, irrespective of their nature relative to the total number of particles present in the solution. There are four important colligative properties.
   I. Relative lowering of vapour pressure
   II. Elevation of boiling point
   III. Depression of freezing point
   IV. Osmosis and osmotic pressure

(b) **Molality** \( (m) \) It is defined as the number of moles of the solute per kilogram of the solvent.

\[
\text{Molality} = \frac{\text{Moles of solute}}{\text{Mass of solvent in kg}}
\]

E.g. 1.00 mol kg\(^{-1}\) (or 1.00 m) solution of KCl means that 1 mole (74.5 g) of KCl is dissolved in 1 kg of water.

8. Structures
   (a) \( \text{H}_2\text{SO}_4 \)
   (b) \( \text{XeF}_6 \)

9. To find out the degree of dissociation of acetic acid, we first need to calculate \( \Delta m \) \((\text{CH}_2\text{COOH})\) with the help of kohlrausch law. According to the questions

Given, \( \Delta m = 39.05 \text{ cm}^2 \text{ mol}^{-1} \)
\( \lambda^\circ (\text{H}^+) = 349.6 \text{ cm}^2 \text{ mol}^{-1} \)
\( \lambda^\circ (\text{CH}_3\text{COO}^-) = 40.9 \text{ cm}^2 \text{ mol}^{-1} \)
\( \lambda^\circ (\text{CH}_3\text{COO}) = \lambda^\circ (\text{H}^+) + \lambda^\circ (\text{CH}_3\text{COO}^-) = 349.6 \text{ cm}^2 \text{ mol}^{-1} + 40.9 \text{ cm}^2 \text{ mol}^{-1} = 390.5 \text{ cm}^2 \text{ mol}^{-1} \)
\( \alpha = \frac{\Delta m}{390.5 \text{ cm}^2 \text{ mol}^{-1}} = \frac{39.05}{390.5} \text{ cm}^2 \text{ mol}^{-1} \)
\( \Rightarrow \alpha = 0.1 \)

10. (a) **Wolff-Kishner Reduction**

   Carbonyl group are easily reduce by hydrazine followed by heating with strong base like alkali to \( \text{CH}_2 \)

\[
\text{C} ≡ \text{O} \xrightarrow{\text{NH}_2\text{NH}_2\text{H}_2\text{O}} \text{C} ≡ \text{N}—\text{NH}_2 \xrightarrow{\text{KOH} \text{ Ethanolic glycol}} \text{CH}_2 + \text{N}_2
\]

(b) **Etard Reaction**

Toluene reacts with chronyl chloride in presence of CS\(_2\) followed by hydrolysis produces benzaldehyde.

11. First, calculate the molality of sucrose, using
\[ m = \frac{W_{\text{solute}} \times 1000}{M_{\text{solute}} \times W_{\text{solvent}}} \]

then, calculate the cryoscopic constant \( (K_f) \) by using depression is freezing point, \( \Delta T_f = K_f m \). Finally calculate the \( \Delta T_f \) of glucose solution followed by freezing point of glucose solution \( T_f = 273.15 - \Delta T_f \).

**For sucrose solution,**

\[
\text{Molality of sucrose solution} = \frac{W_2 \times 1000}{M_2 \times W_1}
\]

Given, \( W_2 = 10 \text{ g}, W_1 = 90 \text{ g}, M_2 = 342 \text{ g mol}^{-1} \)
\[ \text{Molality}(m) = \frac{10 \times 1000}{90} = 0.324 \text{ mol kg}^{-1} \]
\[ \Delta T_f \text{ for sucrose solution} = 273.15K - 269.15K = 4K \]
\[ \Delta T_f = k_f m \]
\[ k_f = \frac{4}{0.324} \text{ K kg mol}^{-1} \]

**For glucose solution,**

\[
W_2 = 10 \text{ g}, W_1 = 90 \text{ g}, M_2 = 180 \text{ g mol}^{-1}
\]
\[ \text{Molality}(m) = \frac{10 \times 1000}{90} = 0.617 \text{ mol kg}^{-1} \]
\[ \Delta T_f = k_f m \]
\[ \Delta T_f = \frac{4}{0.324} \times 0.617 = 7.617 \]

Hence, freezing point of glucose solution
\[ = 273.15 K - 7.617K = 265.53K \]

12. (a) To find out the mass of Ag deposited at cathode, we first need to find the quantity of electricity passed \( (Q) \) using faraday’s law. The value of \( Q \) helps in determining the mass of 108 g of Ag.

Given, current \( (I) = 2\text{ A} \)

\[ \text{time} (t) = 15 \text{ min} \]

Quantity of electricity passed will be
\[ Q = It = 2 \times 15 \times 60 = 1800 \text{ C} \]

Electrolysis of AgNO\(_3\)
\[ \text{Ag}^+ + e^- \rightarrow \text{Ag(s)} \]
(Atomic mass of Ag = 108 g mol\(^{-1}\))

As, 108 g of Ag has 96500 C.
13. (a) The type of isomerism exhibited by the
[Co(NH)₆]³⁺ |Cr(CN)₆]⁻ is coordination isomerism. Here, both the positive and negative ions are complex ions. Isomerism may be caused by the interchange of ligands between the anion and cation. The two isomers are
[Co(NH)₆]³⁺ |Cr(CN)₆]⁻ and [Cr(NH)₆]³⁺ |Co(CN)₆]⁻.
(b) Electronic configuration of Ni [Ar]³⁺ ¹⁸ ¹⁹ ²⁰
Ni-atom = 3d⁶ 4s²
Oxidation state of Ni is +2 in both [Ni(H₂O)₆]²⁺ and [Ni(CN)₄]²⁻.

[NI]²⁺ = 3d⁶ 4s² 4p⁰
In case of [NI(H₂O)₆]²⁺, H₂O is a weak field ligand so pairing of electrons in 3d-orbital does not occur. These unpaired electrons get excited from a lower energy d-orbital to a higher energy d-orbital. Due to d-d transition, [NI(H₂O)₆]²⁺ possess green colour, whereas CN⁻ is a strong field ligand so pairing occurs and a solution of [NI(CN)₄]²⁻ is colourless.

(c) The IUPAC name of the complex [Co(NH)₆](CO)₃ Cl is pentaaminocarbonatocobalt(III) chloride.

14. (a) Lyophilic sol The colloidal solution in which the particles of the dispersed phase have a great affinity for the dispersion medium is called lyophilic sol. e.g. gum, gelatin, starch etc.

Lyophobic sol The colloidal solution in which there is no affinity between particles of the dispersed phase and the dispersion medium is called lyophobic sol. Lyophobic sols need stabilising agents for their preservation.

(b) Solution It contains small solute particles dispersed throughout the solvent. The particle size is less than 1 nm.
Colloid It contain particles of intermediate size. It is a heterogeneous solution. The particles of colloid have diameters between 1 to 1000 nm.

(c) Homogeneous catalysis It is the phenomenon in which reactants and catalyst are present in the same phase.
Heterogeneous catalysis It is the phenomenon in which reactants and catalyst are present in the same phase.

2SO₂(g) + O₂(g) → 2SO₃(g)

15. When time and rate of a reaction is given then can use hit and trial method to find out the order of reaction by substituting the values in different integrated equation.

Using data, to find out the rate constant.

\[ \dfrac{[N₂O₅]}{[N₂O₅]} = \dfrac{1.6 \times 10^{-2}}{0.8 \times 10^{-2}} \]

Using hit and trial method,
For first order reaction, \( k = \dfrac{2.303}{t} \log \dfrac{[N₂O₅]}{[N₂O₅]} \)
Here, \( t = 300 \) s, \( [N₂O₅]₀ = 1.6 \times 10^{-2} \text{ mol L}^{-1} \) and \( [N₂O₅] = 0.8 \times 10^{-2} \text{ mol L}^{-1} \)
\( k = \dfrac{2.303}{300} \log \dfrac{1.6 \times 10^{-2}}{0.8 \times 10^{-2}} \text{ mol L}^{-1} \cdot \text{s}^{-1} \)
\( k = 2.31 \times 10^{-3} \text{ s}^{-1} \)

16. (a) S₈₂ reactions involve the formation of transition state. Higher the steric hinderance, lesser the stability of transition state and lower is their reactivity towards S₈₂.

CH₃CH₂CH₂CH₃CH₂CH₃ > CH₃ CH₂CH₂CH₃
1-bromopentane (²¹) 2-bromopentane (²²)
Br
> CH₃ C₂H₄ CH₃
2-bromo-2-methylbutane (²³)

(b) Among the given compounds, 2-bromopentane is optically active due to presence of chiral carbon (⁺)
(c) 2-bromo-2-methylbutane is most reactive towards $\beta$-elimination reaction because in this case more substituted alkene is the major product.

\[
\begin{align*}
\text{CH}_3 & \xrightarrow{\text{Br}} \text{CH}_3 \\
\text{CH}_3\text{CH}_2\text{CH}_3 & \xrightarrow{\text{Br, Hi}} \text{CH}_3\text{CH}_2\text{CH}==\text{CH}_3
\end{align*}
\]

17. (a) Refining of germanium is done by **zone-refining method**. This method is based on the principle that the impurities are more soluble in the melt than in the solid state of the metal. In this method, a circular mobile heater is fixed at one end of a rod of the impure metal. The molten zone moves along with the heater which is moved forward. As the heater moves forward, the pure metal crystallises out of the melt and the impurities pass on into the adjacent molten zone. The process is repeated several times and the heater is moved in the same direction. At one end, impurities get concentrated. This end is cut off.

(b) Out of PbS and PbCO$_3$, PbS is concentrated by froth floatation process. It is generally used for removing gangue from sulphide ores. This method is used for the extraction of those metals in which the ore particles are preferentially wetted by oil and gangue by water. In this process, a rotating paddle agitates the mixture and draws air in it. As a result, froth is formed which carries the mineral particles. The froth is light and is skimmed off. It is then dried for recovery of the ore particles.

(c) The principal ore of aluminum is bauxite, usually contains SiO$_2$ iron oxides and titanium oxide (TiO$_2$) as impurities. In leaching of alumina, concentration is carried out by digesting the powdered ore with a concentrated solution of NaOH at 473-523 K and 35-36 bar pressure. This way, Al$_2$O$_3$ is leached out as sodium aluminate leaving impurity behind Al$_2$O$_3$(s) + 2NaOH(aq) + 3H$_2$O(β) $\rightarrow$ 2Na[Al(OH)$_3$]F(aq)

18. (a)

\[
\begin{align*}
\text{COOH} & \quad \text{(A)} \\
\text{Cl} & \quad \text{(B)} \\
\text{Cl} & \quad \text{(C)}
\end{align*}
\]

(b) CH$_3$CN $\xrightarrow{\text{HCl}}$ CH$_3$CHO $\xrightarrow{\text{dil. NaOH}}$ CH$_3$CH$_2$OH $\xrightarrow{\text{H}_2\text{SO}_4}$ CH$_3$CH$_2$CH$_2$CHO

Or

(a) **Benzoic acid to benzaldehyde**

\[
\begin{align*}
\text{COOH} & \quad \text{(A)} \\
\text{Cl} & \quad \text{(B)} \\
\text{CHO} & \quad \text{(C)}
\end{align*}
\]

(b) **Ethyl benzene to benzoic acid**

\[
\begin{align*}
\text{COOH} & \quad \text{(A)} \\
\text{Cl} & \quad \text{(B)} \\
\text{H}_2 & \quad \text{Pd/BaSO}_4 \\
\text{CHO} & \quad \text{Palladium reduction}
\end{align*}
\]

(c) **Propanone to propene**

\[
\begin{align*}
\text{CH}_3 & \xrightarrow{\text{NaBH}_4} \text{CH}_3\text{CH}_2\text{OH} \\
\text{CH}_3\text{CH}_2\text{OH} & \xrightarrow{\text{conc. H}_2\text{SO}_4} \text{CH}_2\text{CH}==\text{CH}_3
\end{align*}
\]
19.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Polymer</th>
<th>Monomer</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Dacron</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>Melamine-formaldehyde polymer</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>Buna-N</td>
<td></td>
</tr>
</tbody>
</table>

20. (a) **Anionic detergents** These are sodium salts of sulphonated long chain alcohols or hydrocarbons. Alkyl hydrogen sulphates formed by treating long chain alcohols with conc.\( \text{H}_2\text{SO}_4 \) are neutralised with alkali to form anionic detergents. Similarly, alkyl benzene sulphonates are obtained by neutralising alkyl benzene sulphonic acids with alkali. e.g. \( \text{CH}_2(\text{CH}_3)_{10}\text{CH}_2\text{OH} \xrightarrow{\text{H}_2\text{SO}_4} \text{CH}_3(\text{CH}_3)_{10}\text{CH}_2\text{OSO}_3^- \xrightarrow{\text{NaOH(aq)}} \text{CH}_3(\text{CH}_3)_{10}\text{CH}_2\text{OSO}_3^- \text{Na}^+ \) \( \text{Sodium lauryl sulphate (Anionic detergent)} \)

(b) **Broad spectrum antibiotics** Antibiotics which kill or inhibit a wide range of gram-positive and gram-negative bacteria are called broad spectrum antibiotics. e.g. ampicillin and amoxycillin.

(c) **Antiseptics** These are the chemicals which kill or prevent the growth of microorganism but are not harmful to the living human tissues. e.g. furacine and soframycin. These are applied to wounds, cuts, ulcers and diseased skin surfaces. while all the elements of this group have vacant d-orbitals that helps then in making pentahalides such as \( \text{PCl}_5 \).

21. (a) The thermal stability of hydrides decreases on moving down the group. This is due to the decrease in the bond dissociation enthalpy \( (H-E) \) of hydrides on moving down the group where \( E = \text{O, S, Se, Te} \).

(b) Hydration enthalpy is a measure of energy released when attractions are set-up between positive or negative ions and water molecules. These attractions are stronger when the ion is smaller. As we know that \( \text{F}^- \) ion is smaller than \( \text{Cl}^- \) ion. So, \( \text{F}^- \) ion possess higher hydration enthalpy than \( \text{Cl}^- \) ion.

(c) Nitrogen does not form pentahalide due to the absence of d-orbitals. While all the elements of this group have vacant d-orbitals that helps them in making pentahalides such as \( \text{PCl}_5 \).

22. (a) Due to electron withdrawing effect of the acetyl group, the lone pair of electrons on N-atom is attracted by the \( \text{C} \equiv \text{O} \) group. As a result, lone pair of electrons on N-atom is not exclusively available for donation to the benzene ring and hence, activating effect of the \( \text{NH}_2 \) group is reduced.

(b) In aniline \( (\text{C}_6\text{H}_5\text{NH}_2) \), the electron pair on nitrogen atom is involved in conjugation with ring and is less available for protonation than that in methylamine \( (\text{CH}_3\text{NH}_2) \). Therefore, aniline is less basic than methylamine.

(c) Nitration is usually carried out with a mixture of conc. \( \text{HNO}_3 \) and conc. \( \text{H}_2\text{SO}_4 \). So in the presence of these acids, aniline gets protonated to form anilinium ion. Therefore, the reaction mixture consists of aniline and anilinium ion. \( \text{NH}_2 \) group in aniline is \( \sigma \), \( p \)-directing and activating, whereas the \( \text{NH}_3 \) group in anilinium is \( m \)-directing and deactivating. Now, nitration of aniline mainly gives \( p \)-nitroaniline due to steric hindrance at \( \sigma \)-position and the nitration of anilinium ion gives \( m \)-nitroaniline.
23. (a) Awareness regarding the adverse consequences of junk food and also showed concern towards the health of her school mates.
(b) Starch is commonly present in bread.
(c) The two types of secondary structures of proteins are α-helix and β-pleated sheet structure.
(d) Vitamin B and vitamin C are water soluble vitamins.

24. (a) (i) Due to the comparatively smaller size of the metal ions, their high ionic charges and the availability of vacant d-orbitals for bond formation, transition metals form a large number of complex compounds.
(ii) As oxidation number (or oxidation state) of an element increases ionic character decreases. In general, the oxides in lower oxidation states of metals are basic and in their higher oxidation state, the oxides are amphoteric.

(iii) Lanthanoids have less tendency towards complex formation while actinoids have greater tendency towards complex formation.

(iv) When orange solution containing CrO$_3^-$ is treated with an alkali, a yellow solution of CrO$_4^{2-}$ (Chromate ion) is obtained.

(b) Chemistry of actinoid is complicated as compared to the lanthanoids. The two reasons are:
(i) 5f-orbital present in actinoids is more exposed to the outer environment while 4f-orbital present in lanthanoids are deeply buried.
(ii) Lanthanoids show limited number of oxidation states as $+2$, $+3$ and $+4$ (out of which $+3$ is most common). This is due to the large energy gap between 4f and 5d subshells. The dominant oxidation state of actinoids is also $+3$ but they show a number of other oxidation states also like uranium ($Z = 92$) and plutonium ($Z = 94$) show $+3$, $+4$, $+5$ and $+6$. Neptunium shows $+3$, $+4$, $+5$ and $+7$. This is due to some energy difference between 5f, 6d and 7s subshells.

25. (a) To find out the type of unit cell, we put the given values in the formula.

Many, $M = 93$ g mol$^{-1}$, $d = 11.5$ g cm$^{-1}$

$a = 300$ pm $= 300 \times 10^{-10}$ cm,

$N_A = 6.023 \times 10^{23}$ mol$^{-1}$

Density $d = \frac{Z \times M}{a^3 \times N_A}$

\[ \therefore Z = \frac{d \times a^3 \times N_A}{M} = \frac{(11.5 \text{ g cm}^{-3}) \times (300 \times 10^{-10} \text{ cm})^3}{(6.023 \times 10^{23} \text{ mol}^{-1})} = 2 \frac{93 \text{ g mol}^{-1}}{2} \]

\[ \therefore Z = 2, \text{ it is body centred cubic unit (BCC).} \]

(b) Crystallographic solids
(i) They have definite characteristic geometrical shape
(ii) They have long range order

Amorphous solids
(i) They have irregular shape
(ii) They have short range order

Or

(a) 1 mole of aluminium (Al) $= 27$ g $= 6.02 \times 10^{23}$ atoms

Number of atoms present in 1 g of Al = $\frac{6.02 \times 10^{23}}{27}$

Number of atoms in 8.1 g of Al = $\frac{6.02 \times 10^{23} \times 81}{27}$ = $4.52 \times 10^{22}$

Face-centred cubic (fcc) unit cell contains 4 atoms

\[ \therefore \text{Number of units cells} = \frac{6.02 \times 10^{23} \times 81}{27 \times 4} = 4.52 \times 10^{22} \]

(b) (i) In NaCl, the cation (Na$^+$) and anion (Cl$^-$) are of almost similar sizes. The defect shown by these cations and anions is Schottky defect. Whereas Frenkel defect is generally found in ionic crystals where anion is much larger in size than that the cation.

(ii) Silicon belongs to group-14 and phosphorus belongs to group-15. On doping, there will be a free electron. Hence, it is $n$-type semiconductor.
(iii) In the presence of magnetic field, ferrimagnetic substances get oriented in the direction of the magnetic field. While in antiferromagnetic substance, domains are oppositely oriented and cancel out each other. Hence, ferrimagnetic substances show better magnetism than antiferromagnetic substances.

26. (a) (i)

(ii) CH CH

CH

O CH CH

3

2-ethoxy propane

→

HI

CH C

H

CH

I+ CH CH OH

3

3

3 2

ethanol

(ii) CH — CH — O — CH2 — CH3 → H+ 2-iodopropane

(iii) CH3 — CH ≡ CH — CH3 → PCC

But-2-en-1-ol

(b) (i) Ethanol and phenol

Iodoform test is used to distinguish ethanol and phenol. Ethanol reacts with NaOH solution containing iodine. On heating, it gives a yellow precipitate of iodoform while phenol does not react.

NaOH + I2 → NaI + NaOI + H2O

CH3CH2OH + 3NaI →

CH3I + R — C — ONa

Iodoform

[increasing order of acidic character]

(ii) Propanol and 2-methylpropan-2-ol

Propanol is 1° alcohol while 2-methylpropan-2-ol is 2° alcohol. Victor-Meyer’s test is used to distinguish both of them. In this test, first the given alcohol is treated with P/I2 and then with AgNO3 and HNO3. The final product obtained gives different colour with NaOH. By identifying the colour produced, the alcohols are identified.

Primary alcohols give blood red colour

RCH2OH → RCH2I → AgNO3 → RCH2NO2

[increasing order of boiling point]

(c) In given reaction, alcohol acts as nucleophilic and attacks on carbocation (CH3—CH2—OH) to form (CH3—CH2—O—CH2CH3). It is the intermediate step, involved in the preparation of ethers.

Secondary alcohols give blue colour

\[
\begin{align*}
R'\text{CHOH} & \xrightarrow{\text{P}} R'\text{CH—I} \quad \xrightarrow{\text{AgNO}_3} R_2\text{CHNO}_2 \\
\text{2° alcohol} & \quad \text{2° alcohol} \\
\text{O—N—OH} & \quad \text{R}_2\text{C—NO}_2 \quad \text{R}_2\text{C—NO}_2 \\
\text{NaOH} & \quad \text{N—O} \\
& \quad \text{Blue colour}
\end{align*}
\]

Or

(a) (i) Bromine in presence of water can carry out bromination of phenol to 2, 4, 6-tribromophenol.

(ii) Diborane (BH3)2 reacts with propene to give tripropylboranes as addition product which on oxidation with alkaline H2O2 give alcohols.

(iii) CH2 = CH — CH2 + H2O2 → B(OH)3 + 3CH2 = CH — OH

(b) (i) Electron withdrawing group such as NO2 increases the acidic character while electron releasing group such as CH3 decreases the acidic character.

CH3CH2OH < CH3 = CH — CH2 < CH3CH2CHO < CH3CH2OH

(Propane) (Propanal) (Propanol)

[increasing order of boiling point]
2. Write the structure of 2, 4-dinitrochlorobenzene.

4. Write IUPAC name of the following compound:
   \[ \text{CH}_3\text{NHCH(CH}_3\text{)}_2 \]

5. Write the formula of an oxo-anion of chromium (Cr) in which it shows the oxidation state equal to its group number.

7. Draw the structures of the following:
   (a) \[ \text{H}_3\text{PO}_2 \]
   (b) \[ \text{XeF}_4 \]

8. Define the following
   (a) Ideal solution
   (b) Molarity (\(M\))

9. Complete the following reactions:
   (a) \[ \text{Cl}_2 + \text{H}_2\text{O} \rightarrow \]
   (b) \[ \text{XeF}_6 + 3\text{H}_2\text{O} \rightarrow \]

Or What happens when
(a) conc\(\cdot\)\(\text{H}_2\text{SO}_4\) is added to \(\text{Cu}\)?
(b) \(\text{SO}_3\) is passed through water?

Write the equations.

10. Write the reactions involved in the following:
    (a) Hell-Volhard Zelinsky reaction
    (b) Decarboxylation reaction

13. Write the principles of the following methods:
    (a) Vapour phase refining
    (b) Zone refining
    (c) Chromatography

15. Define the following
    (a) Cationic detergents
    (b) Narrow spectrum antibiotics
    (c) Disinfectants

19. Write the structures of the monomers used for getting the following polymers:
    (a) Neoprene
    (b) Melamine-formaldehyde polymer
    (c) Buna-S

ANSWERS

2. The structure of 2,4-dinitrochlorobenzene is

   \[
   \begin{array}{c}
   \text{Cl} \\
   \mid \\
   \text{NO}_2 \\
   \mid \\
   \text{Cl} \\
   \end{array}
   \]

4. The IUPAC name for \(\text{CH}_3\text{NHCH(CH}_3\text{)}_2\) is N-methylpropan-2-amine.

5. An oxo-anion of chromium (Cr) in which it shows the oxidation state equal to its group number is \(\text{Cr}_7\text{O}_{22}^7\). Here, oxidation number of Cr is +6 which is equal to its group number.

7. Structures
   (a) \[ \text{H}_3\text{PO}_2 \]
   (b) \[ \text{XeF}_4 \]

8. (a) **Ideal solution** The solutions which obey Raoult’s law over the entire range of concentration are known as ideal solutions. The important properties of these solutions are:

   (i) The enthalpy of mixing of the pure components to form the solution is zero, i.e. \(\Delta_{\text{mix}}H = 0\)
   (ii) The volume of mixing is also zero, i.e. \(\Delta_{\text{mix}}V = 0\)

(b) **Molarity** (\(M\)) Molarity is defined as the number of moles of solute dissolved in one litre or one cubic decimetre of the solution.

\[
\text{Molarity} = \frac{\text{Moles of solute}}{\text{Volume of solution in litre}}
\]

   e.g. 0.25 mol L\(^{-1}\) (or 0.25 M) solution of NaOH means that 0.25 mole of NaOH has been dissolved in one litre (or one cubic decimetre).

9. (a) \[ \text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HCl} + \text{HOCl} \]
   (b) \[ \text{XeF}_6 + 3\text{H}_2\text{O} \rightarrow \text{XeO}_3 + 6\text{HF} \]

Or
(a) When conc\(\cdot\)\(\text{H}_2\text{SO}_4\) is added to \(\text{Cu}\), then \(\text{CuSO}_4\) and \(\text{SO}_2\) is formed. In this reaction, hot conc\(\cdot\)\(\text{H}_2\text{SO}_4\) acts as a moderately strong oxidising agent. Here, metal is oxidised by conc\(\cdot\)\(\text{H}_2\text{SO}_4\) and itself it is reduced to \(\text{SO}_2\).

\[
\text{Cu} + 2\text{H}_2\text{SO}_4 \text{(conc.)} \rightarrow \text{CuSO}_4 + \text{SO}_2 + 2\text{H}_2\text{O}
\]

(b) \(\text{SO}_3\) reacts vigorously with water, evolving a large amount of heat and forming \(\text{H}_2\text{SO}_4\).

\[
\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4
\]
10. (a) Hell-Volhard-Zelinsky reaction
Carboxylic acids having α-hydrogen are halogenated at the α-position. On treatment with chlorine or bromine in the presence of small amount of red phosphorus it give α-halocarboxylic acids. The reaction is known as Hell-Volhard-Zelinsky reaction.

\[ R \xrightarrow{X_2/\text{Red phosphorus}} CH_2COOH \xrightarrow{\text{H}_2\text{O}} R'CH-\text{COOH}\]

(where, \( X = \text{Cl, Br} \))

(b) Decarboxylation reaction
Decarboxylation is a chemical reaction that take place in carboxylic acid via the release of carbon dioxide (\( \text{CO}_2 \)). It is an example of the cleavage of a carbon-carbon single bond.

(i) Using sodalime
\[ R \xrightarrow{\text{NaOH and CaO}} \text{Na}_2\text{CO}_3 \]

(ii) Electrolytic decarboxylation (Kolbe electrolysis)
\[ 2\text{RCOO}^-\text{Na}^+ + 2\text{H}_2\text{O} \xrightarrow{\text{Electrolysis}} 2\text{R}^* + 2\text{CO}_2 + \text{H}_2 + 2\text{NaOH}\]

At anode
\[ 2\text{RCOO}^-\text{Na}^+ \xrightarrow{\text{Alkane}} 2\text{R}^* + 2\text{CO}_2 + \text{H}_2 + 2\text{NaOH}\]

Decarboxylation of silver salts of carboxylic acids in presence of bromine (Hunsdiecker reaction).
\[ \text{CH}_3\text{COOH} \xrightarrow{\text{AgNO}_3/\text{Br}_2/\text{CCl}_4} \text{CH}_3\text{COO}^-\text{Ag}^+ \xrightarrow{\text{CH}_3\text{Br} + \text{AgBr} + \text{CO}_2}\]

13. (a) Principle of vapour phase refining This method is based on the principle that metal is converted into its volatile compound and collected elsewhere. Then, it is decomposed to give pure metal. The two requirements are.

(i) The metal should form a volatile compound with an available reagent.

(ii) The volatile compound should be easily decomposable, so that recovery is easy.

(b) Principle of zone-refining This method is based on the principle that the impurities are more soluble in the molten state than in the solid state of the metal.

(c) Principle of chromatography This method is based on the principle of selective adsorption of different components in a mixture on an adsorbent. The mixture is put in a liquid or gaseous medium which is moved through the absorbent. Different components are adsorbed at different levels on the column.

15. (a) Cationic detergents These are quarternary ammonium salts of amines with acetates, chlorides or bromides as anions. The cationic part possesses a long hydrocarbon chain with a positive charge on nitrogen atom. Hence, these are called cationic detergents. Cation part of these cationic detergents is involved in cleansing action, e.g. cetyltrimethyl ammonium bromide used in hair conditioners.

(b) Narrow spectrum antibiotics Antibiotics that are effective mainly against gram positive or gram-negative bacteria are called narrow spectrum antibiotics, e.g. Penicillin-G.

(c) Disinfectants These are the chemicals which kills the microorganism and are applied to inanimate objects like floors, drainage system. The same substances can act as an antiseptic as well as disinfectant by varying the concentration, e.g. 0.2% solution of phenol is an antiseptic while its 1% solution is disinfectant.
1. What is the effect of catalyst on:
   (a) Gibbs energy ($\Delta G$)?
   (b) Activation energy of a reaction?

4. Write the structure of 3-bromo-2-methylprop-1-ene.

5. Write IUPAC name of the following compound:
   \((\text{CH}_3)_2\text{N}–\text{CH}_2\text{CH}_3\)

6. Write the reactions involved in the following reactions:
   (a) Clemmensen reduction
   (b) Cannizzaro reaction

7. Draw the structures of the following:
   (a) $\text{H}_3\text{P}_2\text{O}_7$
   (b) $\text{XeOF}_4$

8. Define the following terms:
   (a) Abnormal molar mass
   (b) van't Hoff factor (i)

10. Complete the following chemical:
    (a) \(\text{F}_2 + 2\text{Cl}^- \rightarrow \) (b) \(2\text{XeF}_2 + 2\text{H}_2\text{O} \rightarrow \)
     \(\text{Or}\)

    What happens when
    (a) $\text{HCl}$ is added to $\text{MnO}_2$?

   (b) $\text{PCl}_5$ is heated?

   Write the equations involved.

13. Define the following
    (a) Limited spectrum antibiotics
    (b) Tranquilisers

14. Write the structures of the monomers used for getting the following polymers.
    (a) Nylon-6
    (b) Melamine-formaldehyde polymer
    (c) Teflon

19. Write one difference between each of the following:
    (a) Multimolecular colloid and macromolecular colloid
    (b) Sol and gel
    (c) O/W emulsion and W/O emulsion

20. (a) What type of isomerism is shown by the complex $[\text{Co(en)}_3\text{Cl}_3]^-$?
    (b) Write the hybridisation and magnetic character of $[\text{Co(C}_2\text{O}_4)_3]^{3-}$.

    (Atomic number of Co = 27)
    (c) Write IUPAC name of the following complex $[\text{Cr(NH}_3)_3\text{Cl}_3]$. 

### SET-III (Only Uncommon Questions from Set I & II)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Polymer</th>
<th>Monomer</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Neoprene</td>
<td><img src="image" alt="Neoprene Structure" /></td>
<td><img src="image" alt="Chloroprene" /></td>
</tr>
<tr>
<td>(ii) Melamine formaldehyde polymer</td>
<td><img src="image" alt="Melamine Structure" /></td>
<td><img src="image" alt="Formaldehyde" /></td>
</tr>
<tr>
<td>(iii) Buna-S</td>
<td><img src="image" alt="Buna-S Structure" /></td>
<td><img src="image" alt="Styrene" /></td>
</tr>
</tbody>
</table>
ANSWERS

1. (a) Presence of catalyst does not affect Gibbs energy (G).
   (b) Presence of catalyst decreases the activation energy of a reaction by providing an alternate pathway or reaction mechanism.

4. The structure of 3-bromo-2-methyl prop-1-ene is $\text{BrCH}_2\text{C} = \text{CH}_2\text{CH}_3$.

5. Given compound, $\text{H}_2\text{C} - \text{N} - \text{CH}_2\text{CH}_3$

   IUPAC name : $\text{N, N-dimethyl ethanamine}$.

6. (a) **Clemmensen reduction** It involves reduction of carbonyl group of an aldehyde or ketone to methylene group to form a hydrocarbon. Clemmensen reduction is carried out in presence of Zn amalgam and conc. HCl.

   e.g. $\text{C} = \text{O} + 4 \{\text{H}\} \xrightarrow{\text{Zn-Hg/ conc. HCl}} \text{CH}_2 + \text{H}_2\text{O}$

   Hydrocarbon

   It is widely used for the reduction of aldehydes and ketones which are sensitive to alkalis.

   (b) **Cannizzaro reaction** Aldehydes which do not have $\alpha$-H atoms undergo Cannizzaro reaction on treatment with conc. alkali. In this reaction, one molecule of aldehyde is reduced to alcohol while another molecule is oxidised to salt of carboxylic acid.

   ![Cannizzaro Reaction Diagram]

7. **Structures**

   (a) $\text{H}_2\text{P}_2\text{O}_7$

   Pyrophosphoric acid

   (b) $\text{XeOF}_4$

   Square planar

8. (a) **Abnormal molar mass** Molar masses that are either lower or higher than the expected or normal values are called abnormal molar masses, e.g. all the molecules of ethanoic acid associate in benzene, then $\Delta T_b$ or $\Delta T_f$ for ethanoic acid will be half of the normal value.

   (b) **van’t Hoff factor** ($i$) It is defined as the ratio of the experimental value of the colligative property to the calculated value of the colligative property.

   $$i = \frac{\text{Normal molar mass}}{\text{Observeed molar mass}} = \frac{\text{Observeed colligative property}}{\text{Calculated colligative property}}$$

10. (a) $\text{F}_2 + 2\text{Cl}^- \rightarrow 2\text{F}^- + \text{Cl}_2$

(b) $2\text{XeF}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{Xe} + 4\text{HF} + \text{O}_2$

   (a) When HCl is added to MnO$_2$, then MnCl$_2$ and Cl$_2$ is formed. Here, HCl act as a reducing agent. Since, it reduces MnO$_2$ by taking oxygen atoms from it.

   $$\text{MnO}_2 + 4\text{HCl} \rightarrow \text{MnCl}_2 + \text{Cl}_2 + 2\text{H}_2\text{O}$$

   (b) When PCl$_3$ is heated, it sublimes and decomposes on strong heating.

   $$\text{PCl}_3 \xrightarrow{\text{Heat}} \text{PCl}_5 + \text{Cl}_2$$
13. (a) **Limited spectrum antibiotics** Antibiotics that are effective mainly against gram positive or gram negative bacteria are called narrow spectrum antibiotics. If it kills a single microorganism, then these are known as limited spectrum antibiotics.

(b) **Tranquilisers** These are the classes of chemical compounds used for the treatment of stress and mild or severe mental diseases. These form an essential component of sleeping pills. There are various types of tranquilisers which function by different mechanisms. They relieve anxiety, stress, irritability or excitement by inducing a sense of well-being. Noradrenaline is one of the neurotransmitters that plays a role in mood changes. If the level of noradrenaline is low for some reason, then signal-sending activity becomes low and the person suffers from depression.

14.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Polymer</th>
<th>Monomer</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td><strong>Nylon-6</strong></td>
<td><img src="" alt="Nylon-6" /></td>
</tr>
<tr>
<td>(b)</td>
<td><strong>Melamine-formaldehyde polymer</strong></td>
<td><img src="" alt="Melamine-formaldehyde" /></td>
</tr>
<tr>
<td>(c)</td>
<td><strong>Teflon</strong></td>
<td><img src="" alt="Teflon" /></td>
</tr>
</tbody>
</table>

19. (a) **Multimolecular colloids** In this type of colloids, colloidal particles are aggregates of atoms or small molecules with molecular size less than 1 nm. e.g. sulphur solution consists of particles containing a thousand or more of $S_8$ sulphur molecules.

**Macromolecular colloids** Particles in suitable solvents form solutions in which the size of the macromolecules may be in the colloidal range. Such systems are called macromolecular colloids.

(b) **Sol** The colloidal system in which dispersed phase is solid and dispersion medium is liquid, e.g. paints, cell fluids.

**Gel** The colloidal system in which dispersed phase is liquid and dispersion medium is solid, e.g. Jellies, butter and cheese.

(c) **O/W emulsion and W/O emulsion**

(i) **Oil dispersed in water type** This is an emulsion in which oil act as dispersed phase and water acts as dispersion medium, e.g. milk, vanishing cream.

(ii) **Water dispersed in oil type** This is an emulsion in which water acts as dispersed phase and oil as dispersion medium, e.g. butter and cream.

20. (a) Optical isomerism is shown by the complex $[\text{Co(en)}_3]^{3+}$. (b) In $[\text{Co(C}_2\text{O}_4)_{3}]^{3-}$, cobalt is in $+3$ oxidation state $\text{Co} = [\text{Ar}] 3d^6 4s^2$

$$\text{Co}^{3+} = 3d^6$$

$$[\text{Co(C}_2\text{O}_4)_{3}]^{3-} = 3d^6 4s^2 4p$$

$$d^2sp^3$$-hybridisation

Magnetic character = Diamagnetic (all electrons are paired)

(c) IUPAC name of the complex $[\text{Cr(NH}_3)_3\text{Cl}_3]$ Triamminetriclorochromium (III).