SAMPLE QUESTION PAPER

BLUE PRINT

Time Allowed : 3 hours **Maximum Marks :** 70

S. No.	Chapter	Passage based/ MCQs/A & R (1 mark)	SA-I (2 marks)	SA-II (3 marks)	LA (5 marks)	Total
1.	The Solid State	2(2)	1(2)	–	–	**12(23)**
2.	Solutions	1(1)	–	1(3)	–	
3.	Electrochemistry	2(2)	–	1(3)	–	
4.	Chemical Kinetics	1(1)	–	–	1(5)	
5.	Surface Chemistry	–	2(4)	–	–	
6.	The *p*-Block Elements	1(4)	–	1(3)	–	**6(19)**
7.	The *d*- and *f*-Block Elements	–	1(2)	–	1(5)	
8.	Coordination Compounds	–	1(2)	1(3)	–	
9.	Haloalkanes and Haloarenes	1(4)	1(2)	–	–	**15(28)**
10.	Alcohols, Phenols and Ethers	3(3)	1(2)	–	–	
11.	Aldehydes, Ketones and Carboxylic Acids	2(2)	1(2)	–	1(5)	
12.	Amines	1(1)	–	1(3)	–	
13.	Biomolecules	2(2)	1(2)	–	–	
	Total	**16(22)**	**9(18)**	**5(15)**	**3(15)**	**33(70)**

Subject Code : **043**

CHEMISTRY

Time allowed : 3 hours ***Maximum marks : 70***

General Instructions : Read the following instructions carefully.

(a) There are 33 questions in this question paper. All questions are compulsory.

(b) Section A : Q. No. 1 to 16 are objective type questions. Q. No. 1 and 2 are passage based questions carrying 4 marks each while Q. No. 3 to 16 carry 1 mark each.

(c) Section B : Q. No. 17 to 25 are short answer questions and carry 2 marks each.

(d) Section C : Q. No. 26 to 30 are short answer questions and carry 3 marks each.

(e) Section D : Q. No. 31 to 33 are long answer questions carrying 5 marks each.

(f) There is no overall choice. However, internal choices have been provided.

(g) Use of calculators and log tables is not permitted.

SECTION - A (OBJECTIVE TYPE)

1. **Read the passage given below and answer the following questions :**

When non-metals and some metals in high oxidation states combine with O_2 acidic oxides are formed. They dissolve in water to form oxy-acids. The oxides are covalent in nature and form acids on reaction with water.

Oxides formed by reaction of oxygen with metal are either basic or amphoteric.

A few covalent oxides of non-metals do not react with either acids or bases or water *e.g.*, CO, NO, N_2O.

There are few classes of oxides like peroxide, superoxides, suboxides and mixed oxides.

The following questions are multiple choice questions. Choose the most appropriate answer.

(i) An oxide of a non-metal has the following properties :

(I) It acts both as a proton donor as well as proton acceptor.

(II) It reacts readily with bases and acids.

(III) It oxidises Fe at its boiling point.

The oxide is

(a) P_2O_5 (b) SiO_2 (c) H_2O (d) CO_2

(ii) Which of the following represent peroxide?

(a) N_2O (b) Na_2O_2 (c) KO_2 (d) K_2O

OR

Which of the following is basic oxide?

(a) Cl_2O_7 (b) Na_2O (c) OF_2 (d) Al_2O_3

(iii) Nature of oxide of Cl is

(a) acidic (b) basic (c) Amphoteric (d) none of these.

(iv) Oxide of a metal cannot be

(a) basic (b) acidic (c) amphoteric (d) both b and c.

2. **Read the passage given below and answer the following questions :**

Free radical halogenation is regioselective and replaces hydrogen atoms with the halogen atom in the order : allylic >3° > 2° > 1° methyl.

This order of reactivity can be predicted on the basis of radical's is intermediate stabilities, which follows the same order. Radical intermediates are analogous to carbocation in the sense that they are stabilised by the same interaction, namely resonance delocalisation and hyperconjugation with attached alkyl groups. Regioselectivity of halogenation is greater for bromination than for chlorination.

In these question (Q. No. i-iv), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(c) Assertion is correct statement but reason is wrong statement.
(d) Assertion is wrong statement but reason is correct statement.

(i) **Assertion :** Iodination of alkanes is carried out under reflux condition in the presence of reducing agent.

Reason : Iodination of alkanes takes place very slowly.

(ii) **Assertion :** The order of bond energy ΔH is methyl > 1° > 2° > 3°.

Reason : Energy required to break a C—H bond decreases as substitution on the carbon increases.

(iii) **Assertion :** Radical halogenation of F_2 is unselective, violent and dangerous.

Reason : Radical halogenation of I_2 is so slow to be used in organic synthesis.

OR

Assertion : On bromination of propane the product formed are:

$$\underset{\substack{|\\ \text{Br}\\ 75\%}}{CH_2}-CH_2-CH_3 \qquad CH_3-\underset{\substack{|\\ \text{Br}\\ 25\%}}{CH}-CH_3$$

Reason : Bromination is more selective than chlorination.

(iv) **Assertion :** Propene reacts with HI in presence of peroxide to give 1-iodopropane.

Reason : 2° free radical is more stable than 1° free radical.

Following questions (Q. No. 3-11) are multiple choice questions carrying 1 mark each:

3. The osmotic pressure of a solution can be increased by

(a) increasing the volume (b) increasing the number of solute molecules
(c) decreasing the temperature (d) removing semipermeable membrane.

4. Which of the following compounds has the strongest hydrogen bonding?

(a) Propan-1-ol (b) Propan-2-ol (c) Propane-1,2-diol (d) Propane-1,2,3-triol

5. Electrical conductance through metals is called metallic or electronic conductance and is due to the movement of electrons. The electronic conductance depends on

(a) the nature and structure of the metal
(b) the number of valence electrons per atom
(c) change in temperature
(d) all of these.

OR

Electrode potentials (E°_{red}) of four elements A, B, C and D are −1.36, − 0.32, 0, −1.26 V respectively. The decreasing reactivity order of these elements is

(a) *A*, *D*, *B* and *C* (b) *C*, *B*, *D* and *A* (c) *B*, *D*, *C* and *A* (d) *C*, *A*, *D* and *B*

6. Bond angle in alcohols is slightly less than the tetrahedral angle because of

(a) electronegativity of oxygen
(b) H-bonding
(c) repulsion between the unshared electron pairs of oxygen
(d) none of these.

7. Benzyl alcohol is obtained from benzaldehyde by

(a) Fittig reaction (b) Clemmensen's reduction
(c) Kolbe's reaction (d) Reduction with $LiAlH_4$.

OR

Acetic acid is obtained when

(a) methyl alcohol is oxidised with potassium permanganate
(b) calcium acetate is distilled in the presence of calcium formate
(c) acetaldehyde is oxidised with potassium dichromate and sulphuric acid
(d) glycerol is heated with sulphuric acid.

8. In fluorite structure (CaF_2),

(a) Ca^{2+} ions form *ccp* and F^- ions are present in all the tetrahedral voids
(b) Ca^{2+} ions form *ccp* and F^- ions are present in all the octahedral voids
(c) Ca^{2+} ions form *ccp* and F^- ions are present in all the octahedral voids and half of ions are present in tetrahedral voids
(d) none of these.

9. Aniline when acetylated, the product on nitration followed by alkaline hydrolysis gives

(a) acetanilide (b) *o*-nitroacetanilide (c) *p*-nitroaniline (d) *m*-nitroaniline.

OR

The compound, which does not react with CH_3COCl is

(a) RNH_2 (b) R_2NH (c) R_3N (d) all of these.

10. Nitrogen tetraoxide (N_2O_4) decomposes as :

$$N_2O_{4(g)} \longrightarrow 2NO_{2(g)}$$

If the pressure of N_2O_4 falls from 0.50 atm to 0.32 atm in 30 minutes, the rate of appearance of $NO_{2(g)}$ is

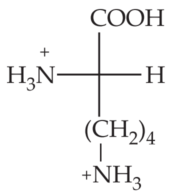
(a) 0.006 atm min^{-1} (b) 0.003 atm min^{-1} (c) 0.012 atm min^{-1} (d) 0.024 atm min^{-1}

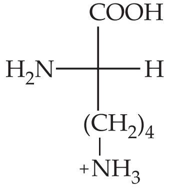
OR

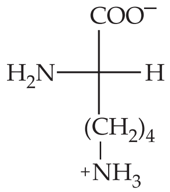
In the reaction, $2NO + Cl_2 \rightarrow 2NOCl$, it has been found that doubling the concentration of both the reactants increases the rate by a factor of eight but doubling the chlorine concentration alone only doubles the rate. Which of the following statements is incorrect?

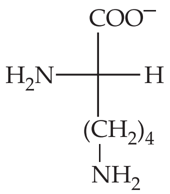
(a) The reaction is first order in Cl_2. (b) The reaction is second order in NO.
(c) The overall order of reaction is 2. (d) The overall order of reaction is 3.

11. Which of the following is the major species in a solution of lysine at pH = 3.5?

(a)

$H_3\overset{+}{N}-\underset{(CH_2)_4-\overset{+}{N}H_3}{\overset{COOH}{C}}-H$

(b)

$H_2N-\underset{(CH_2)_4-\overset{+}{N}H_3}{\overset{COOH}{C}}-H$

(c)

$H_2N-\underset{(CH_2)_4-\overset{+}{N}H_3}{\overset{COO^-}{C}}-H$

(d)

$H_2N-\underset{(CH_2)_4-NH_2}{\overset{COO^-}{C}}-H$

In the following questions (Q. No. 12 - 16), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(c) Assertion is correct statement but reason is wrong statement.
(d) Assertion is wrong statement but reason is correct statement.

12. **Assertion :** Alcohols react both as nucleophiles and electrophiles.
Reason : Alcohols react with active metals such as sodium, potassium and aluminium to yield corresponding alkoxides and hydrogen.

13. **Assertion :** Lithium has the lowest electrode potential.
Reason : Lithium ion is the strongest oxidising agent.

14. **Assertion :** Etard reaction helps to stop the oxidation of toluene at the aldehyde stage.
Reason : Chromyl chloride oxidises methyl group to a chromium complex, which on hydrolysis gives corresponding benzaldehyde.

OR

Assertion : Acetaldehyde can be prepared by addition of water to ethyne in the presence of H_2SO_4 and $HgSO_4$.
Reason : Higher alkynes give higher aldehydes.

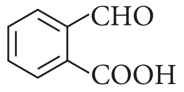
15. **Assertion :** *bcc* and *hcp* has same packing efficiency.
Reason : *bcc* arrangement has 2 while *hcp* arrangement has 4 atoms per unit cell.

16. **Assertion :** DNA molecules and RNA molecules are found only in the nucleus of a cell.
Reason : On heating, the enzymes lose their specific activity.

SECTION - B

The following questions, Q. No. 17-25 are short answer type and carry 2 marks each.

17. Complete the following reactions :

(i) 

$\xrightarrow{\text{NaCN/HCl}}$

(ii) $CH_3COCH_2COOC_2H_5 \xrightarrow[\text{(ii) } H^+]{\text{(i) } NaBH_4}$

18. Aluminium crystallises in a *fcc* structure. Atomic radius of the metal is 125 pm. What is the length of the side of the unit cell of the metal?

OR

(i) What type of non-stoichiometric point defect is responsible for the pink colour of LiCl?
(ii) What type of stoichiometric defect is shown by NaCl?

19. Describe what you understand by primary structure and secondary structure of proteins?

OR

(a) Amino acids show amphoteric behaviour. Why?
(b) Write one difference between α-helix and β-pleated structures of proteins.

20. When *tert*-butanol and *n*-butanol are separately treated with a few drops of dil. $KMnO_4$ in one case only, the purple colour disappears and a brown precipitate is formed. Which of the two alcohols gives the above reaction and what is the brown precipitate formed?

21. Write the differences between physisorption and chemisorption with respect to the following :

(i) Specificity (ii) Temperature dependence

(iii) Reversibility and (iv) Enthalpy change

22. Using valence bond theory, explain the geometry and magnetic behaviour of $[Co(NH_3)_6]^{3+}$.
(At. no. of Co = 27)

OR

Out of $[CoF_6]^{3-}$ and $[Co(C_2O_4)_3]^{3-}$, which one complex is

(i) diamagnetic

(ii) outer orbital complex

(Atomic no. of Co = 27)

23. Write the mechanism of the following reaction :

$CH_3CH_2OH \xrightarrow{HBr} CH_3CH_2Br + H_2O$

OR

Write the mechanism of the following S_N1 reaction:

$(CH_3)_3\,C—Br \xrightarrow{Aq.\ NaOH} (CH_3)_3\,C—OH + NaBr$

24. Define the following terms :

(i) Tyndall effect

(ii) Electrophoresis

25. (i) Of the ions Ag^+, Co^{2+} and Ti^{4+}, which one will be coloured in aqueous solution?
(Atomic nos : Ag = 47, Co = 27, Ti = 22).

(ii) If each one of the above ionic species is placed in a magnetic field how will it respond and why?

SECTION - C

Q. No. 26-30 are short answer type II carrying 3 mark each.

26. (a) Calculate the emf of the cell in which the following reaction takes place :

$Ni_{(s)} + 2Ag^+(0.002\ M) \longrightarrow Ni^{2+}(0.160\ M) + 2Ag_{(s)}$

(Given that $E^\circ_{cell} = 1.05$ V)

(b) When a bright silver object is placed in the solution of gold chloride, it acquires a golden tinge but nothing happens when it is placed in a solution of copper chloride. State reason for this behaviour of silver.

OR

When a certain conductance cell was filled with 0.1 M KCl, it has a resistance of 85 ohms at 25°C. When the same cell was filled with an aqueous solution of 0.052 M unknown electrolyte, the resistance was 96 ohms. Calculate the molar conductance of the electrolyte at this concentration.
[Specific conductance of 0.1 M KCl = 1.29×10^{-2} $ohm^{-1}\ cm^{-1}$]

27. How will you convert :

(i) Ethanoic acid into methanamine (ii) Ethanamine into methanamine

OR

Give reasons :

(i) Acetylation of aniline reduces its activation effect.

(ii) CH_3NH_2 is more basic than $C_6H_5NH_2$.

(iii) Although —NH_2 is *o*/*p* directing group, yet aniline on nitration gives a significant amount of *m*-nitroaniline.

28. (a) Complete the following reactions :

(i) $XeF_4 + SbF_5 \rightarrow$

(ii) $NaOH_{(aq.)}$ (hot and conc.) $+ Cl_{2(g)} \rightarrow$

(b) Explain why the oxidising power of oxoacids of chlorine follows the order :

$HClO_4 < HClO_3 < HClO_2 < HClO$

29. (i) What type of deviation is shown by a mixture of ethanol and acetone? Give reason.

(ii) Blood cells are isotonic with 0.9% sodium chloride solution. What happens if we place blood cells in a solution containing

(a) 1.2% sodium chloride solution?

(b) 0.4% sodium chloride solution?

30. Write the name, the structure and the magnetic behaviour of each one of the following complexes :

(i) $[Pt(NH_3)_2Cl(NO_2)]$ (ii) $[Co(NH_3)_4Cl_2]Cl$

(iii) $Ni(CO)_4$

(At. nos. Co = 27, Ni = 28, Pt = 78)

SECTION - D

Q. No. 31-33 are log answer type carrying 5 marks each.

31. (i) Explain the following observations :

(a) The metal-metal bonding is more frequent for the second and third series of transition elements than that for the first series.

(b) The higher oxidation states are usually exhibited by members in the middle of a series of transition elements.

(ii) Compare the nature of oxides of 3*d*-series of transition elements.

(iii) State reasons for the following :

(a) Transition metals and their many compounds act as a good catalyst.

(b) Among the lanthanoids, Ce(III) is easily oxidised to Ce(IV).

OR

The elements of 3*d* transition series are given as Sc Ti V Cr Mn Fe Co Ni Cu Zn

Answer the following :

(i) Write the element which shows maximum number of oxidation states. Given reason.

(ii) Which element has the highest melting point?

(iii) Which element shows only +3 oxidation state?

(iv) Which element is a strong oxidising agent in +3 oxidation state and why?

(v) Which element is not a transition element?

32. (i) Why cannot molecularity of any reaction be equal to zero?

(ii) Time required to decompose SO_2Cl_2 to half of its initial amount is 60 minutes. If the decomposition is a first order reaction then, calculate the rate constant of the reaction.

(iii) For the reaction, $2N_2O_{5(g)} \longrightarrow 4NO_{2(g)} + O_{2(g)}$, the rate of formation of $NO_{2(g)}$ is 2.8×10^{-3} M s^{-1}. Calculate the rate of disappearance of $N_2O_{5(g)}$.

OR

(a) The following initial rate data were obtained at 300 K for the reaction : $2A + B \rightarrow C + D$.

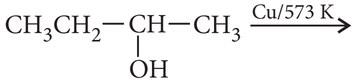
	[A]/mol L^{-1}	**[B]/mol L^{-1}**	**Rate/mol L^{-1} s^{-1}**
I.	0.2	0.1	6.0×10^{-2}
II.	0.4	0.1	2.4×10^{-1}
III.	0.2	0.2	1.2×10^{-1}

(i) Deduce the rate law.

(ii) If half-life of reaction is inversely proportional to initial concentration of the reactant, what is the order of the reaction?

(b) During nuclear explosion, one of the products is ^{90}Sr with half-life of 28.1 years. If 1 μg of ^{90}Sr was absorbed in the bones of a newly born baby instead of calcium, how much of it will remain after 10 years and 60 years if it is not lost metabolically?

33. (a) Write the final product(s) in each of the following reactions :

(i) 

$$CH_3CH_2-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3 \xrightarrow{Cu/573\ K}$$

(ii) $C_6H_5-OH \xrightarrow[\text{(ii) } H^+]{\text{(i) } CHCl_3 + \text{aq. NaOH}}$

(b) Which of the following can be nitrated more easily and why?

Benzoic acid or phenol.

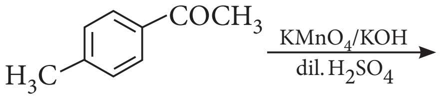
(c) How will you convert :

(i) Benzoyl chloride to benzaldehyde

(ii) Propanone to 2-propanol

OR

(a) Write the product of the following reactions :

(i) 

(ii) $2C_6H_5CHO + \text{conc. NaOH} \rightarrow$

(iii) $CH_3COOH \xrightarrow{Cl_2/\text{Red P}}$

(b) Arrange the following compounds in an increasing order of their property as indicated :

(i) Acetaldehyde, acetone, methyl-*tert*-butyl ketone (reactivity towards HCN)

(ii) $CH_3CH_2CH(Br)COOH$, $CH_3CH(Br)CH_2COOH$, $(CH_3)_2CHCOOH$ (acidic strength)

SOLUTIONS

1. (i) (c)

(ii) (b) OR (b)

(iii) (a) : Cl is a non-metal so its oxide would be acidic.

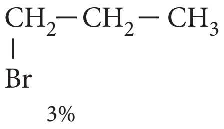
(iv) (b)

2. (i) (d): During iodination, HI is formed which is strong reducing agent and reduces alkyl iodide back to alkanes.

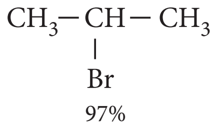
(ii) (a) **(iii) (b)**

OR

(d) : As bromination is more selective hence product formed are:

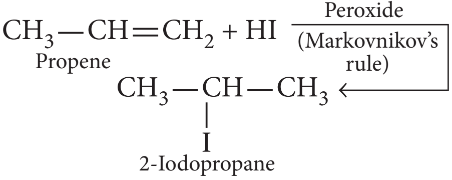

$\underset{\text{Br}}{\underset{|}{CH_2}}-CH_2-CH_3$

3%


$CH_3-\underset{\text{Br}}{\underset{|}{CH}}-CH_3$

97%

(iv) (d) : Peroxide effect is not observed in the case of HCl and HI. It is effective only in the case of HBr.


$\underset{\text{Propene}}{CH_3-CH=CH_2} + HI \xrightarrow[\text{(Markovnikov's rule)}]{\text{Peroxide}} \underset{\text{2-Iodopropane}}{CH_3-\underset{I}{\underset{|}{CH}}-CH_3}$

2° free radical is more stable than 1° free radical.

3. (b) : $\pi = \frac{n}{V}RT$

Hence, $\pi \propto n$

4. (d) : Order of strength of hydrogen bonding is: Propane–1, 2, 3-triol > propane–1, 2–diol > propan–1–o1 > propan–2–ol.

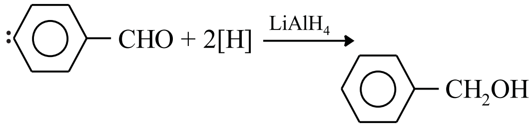
5. (d)

OR

(a) : Lower is the reduction potential, more easily a metal is oxidised and more is its reactivity.

6. (c) : The oxygen in alcohols is sp^3 hybridised but it has two lone pairs present on it and repulsion in lone pair-lone pair is greater than bond pair-bond pair repulsion. Thus, bond angle of alcohols decreases from tetrahedral angle.

7. (d) :

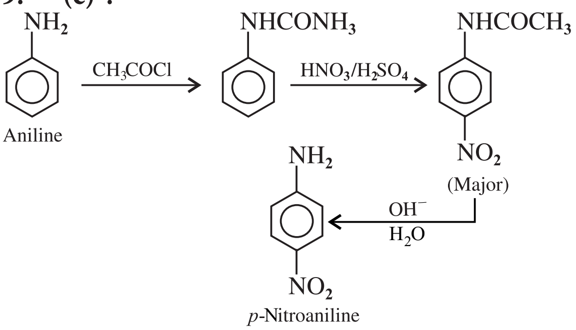


OR

(c) : $\underset{\text{Acetaldehyde}}{CH_3CHO} + [O] \xrightarrow{K_2Cr_2O_7 + H_2SO_4} \underset{\text{Acetic acid}}{CH_3COOH}$

8. (a) : In fluorite structure (CaF_2), Ca^{2+} form *ccp* while F^- ions are present in all available tetrahedral sites.

9. (c) :



(c) : R_3N is 3° amine, does not have replaceable hydrogen atoms.

10. (c) : Rate of disappearance of $N_2O_4 = \frac{\Delta[N_2O_4]}{\Delta t}$

$= \frac{0.50 - 0.32}{30} = 0.006 \text{ atm min}^{-1}$

Rate of appearance of NO_2 = Twice the rate of disappearance of $N_2O_4 = 2 \times 0.006 = 0.012 \text{ atm min}^{-1}$

OR

(c) : (i) $r = k[NO]^{\alpha}[Cl_2]^{\beta} = ka^{\alpha}b^{\beta}$

(ii) $8r = k(2a)^{\alpha}(2b)^{\beta}$

(iii) $2r = ka^{\alpha}(2b)^{\beta}$

Dividing (ii) by (iii), $4 = 2^{\alpha}$ or $\alpha = 2$

Dividing (iii) by (i), $2 = 2^{\beta}$ or $\beta = 1$

Overall order = 2 + 1 = 3

11. (a) : At low pH, cationic form dominates.

12. (b)

13. (c) : Lithium ion is the weakest oxidising agent while lithium metal is the most powerful reducing agent in an aqueous solution.

14. (a)

OR

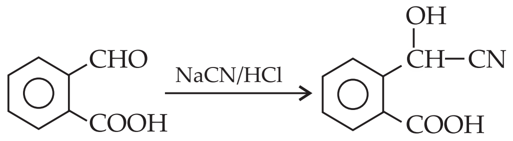
(c) : Acetaldehyde can be prepared by addition of water to ethyne in the presence of H_2SO_4 and $HgSO_4$. Higher alkynes give ketones on addition of water in presence of H_2SO_4.

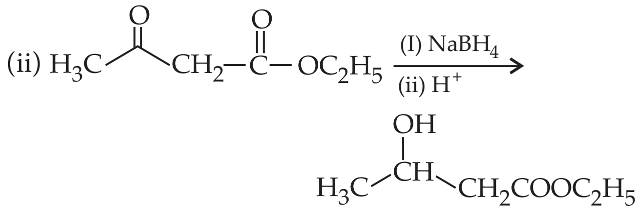
15. (d) : *bcc* has 68% and *hcp* has 74% packing efficiency.

16. **(d) :** In the cell, DNA molecules (*i.e.*, deoxyribose nucleic acid) are present predominantly in the nucleus, some DNA is also present in the mitochondria in Eukaryotes.

RNA molecules (*i.e.*, ribose nucleic acid) are present in cytoplasm of the eukaryotes and in nucleus in some prokaryotes and virus. Enzymes lose their specific activity on heating.

17. (i)





18. For *fcc* (or *ccp*), $a = 2\sqrt{2}r$

$= 2 \times 1.414 \times 125 \text{ pm} = 354 \text{ pm}$

OR

(i) Metal excess defect is responsible for pink colour of LiCl. It is also known as anion vacancy defect.

(ii) NaCl crystal shows Schottky defect.

19. **Primary structure :** The specific sequence in which the various amino acids present in a protein are linked to one another is called its primary structure. Any change in the primary structure creates a different protein.

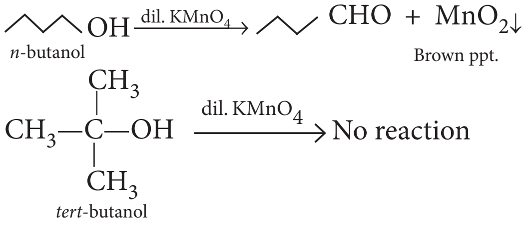
Secondary structure : The conformation of the polypeptide chain is known as secondary structure. The two types of secondary structure are α-helix and β-pleated sheet structure.

OR

(a) As amino acids have both acidic (carboxyl group) and basic groups (amino group) in the same molecule, they react with both acids and bases. Hence, they show amphoteric behaviour.

(b) In α-helix structure, intramolecular H-bonding takes place whereas in β-pleated structure, intermolecular H-bonding takes place.

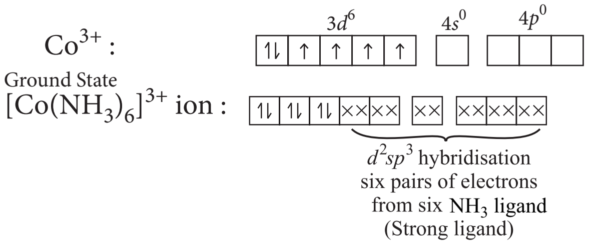
20.



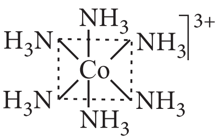
21.

S. No.	Criteria	Physisorption	Chemisorption
(i)	Specificity	It is not specific in nature.	It is highly specific in nature.
(ii)	Temperature dependence	It decreases with increase in temperature. Thus, low temperature is favourable for physisorption.	It increases with increase in temperature. Thus, high temperature is favourable for chemisorption.
(iii)	Reversibility	Reversible in nature.	Irreversible in nature.
(iv)	Enthalpy change	Low enthalpy of adsorption.	High enthalpy of adsorption.

22. Oxidation number of cobalt in $[Co(NH_3)_6]^{3+}$ is +3.

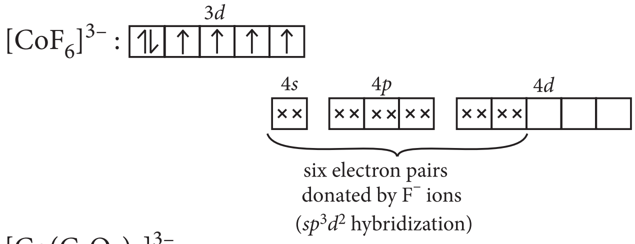


Hybridisation – d^2sp^3
Structure – Octahedral
(low spin)
Nature – Diamagnetic

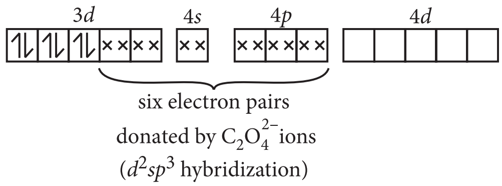


OR

Formation of $[CoF_6]^{3-}$ and $[Co(C_2O_4)_3]^{3-}$ can be represented as :

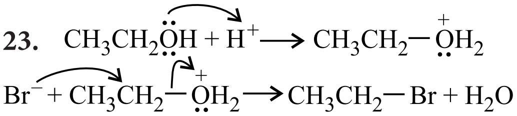


$[Co(C_2O_4)_3]^{3-}$:



(i) $[Co(C_2O_4)_3]^{3-}$ is diamagnetic as all electrons are paired.

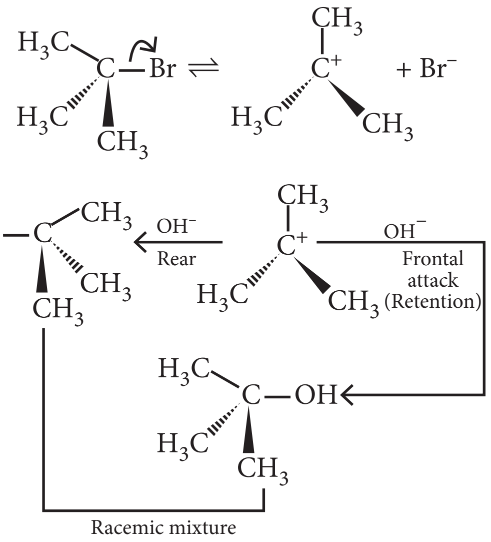
(ii) $[CoF_6]^{3-}$ is outer orbital complex as it undergoes sp^3d^2 hybridization using the outer 4*d*-orbital.

23. 

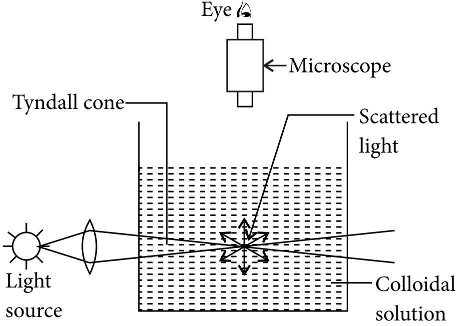
$$CH_3CH_2\ddot{O}H + H^+ \longrightarrow CH_3CH_2-\overset{+}{\ddot{O}}H_2$$

$$Br^- + CH_3CH_2-\overset{+}{\ddot{O}}H_2 \longrightarrow CH_3CH_2-Br + H_2O$$

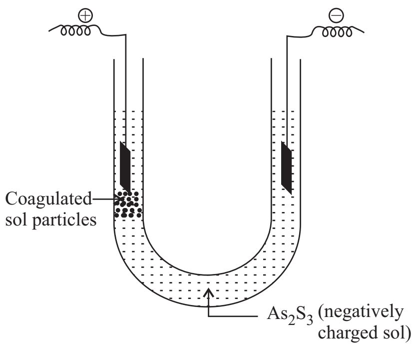
OR



24. (i) When a beam of light is passed through a colloidal solution and viewed perpendicular to the path of incident light, the path of beam is illuminated by a bluish light. This phenomenon is called Tyndall effect. This is due to the fact that colloidal particles scatter light in all the directions in space.



(ii) The movement of colloidal particles under an applied electric potential is called electrophoresis. Positively charged colloidal particles move towards the cathode, while negatively charged particles move towards the anode.



Electrophoresis

25. (i) Ag^+ ($4d^{10}5s^0$) and Ti^{4+} ($3d^04s^0$) have no unpaired d-electrons while Co^{2+} ($3d^74s^0$) has three unpaired electrons. Thus, Ag^+ and Ti^{4+} ions are colourless and Co^{2+} ion is coloured in aqueous solutions.

(ii) Co^{2+} ions will get attracted in a magnetic field while Ag^+ and Ti^{4+} ions will get repelled in the magnetic field *i.e.*, Co^{2+} ion is paramagnetic while Ag^+ and Ti^{4+} ions are diamagnetic in nature.

26. (a) $Ni_{(s)} + 2Ag^+_{(aq)} \longrightarrow Ni^{2+}_{(aq)} + 2Ag_{(s)}$

$$E_{cell} = E^\circ_{cell} - \frac{0.0591}{2}\log\frac{[Ni^{2+}]}{[Ag^+]^2}$$

$$= 1.05 - \frac{0.0591}{2}\log\frac{0.16}{(0.002)^2} = 1.05 - 0.1359 = 0.9141 \text{ V}$$

(b) The standard electrode potential, $E°$ for silver is 0.80 V and that of gold is 1.5 V, hence silver can replace gold from its solution. The replaced gold is deposited on silver object due to which golden tinge is obtained. On the other hand, $E°$ for Cu is 0.34 V which is lower than that of silver, thus silver cannot replace copper from its solution.

OR

For first solution,

$\kappa = 1.29 \times 10^{-2}\ \text{ohm}^{-1}\ \text{cm}^{-1}$

$$\kappa = \frac{1}{R} \times \text{Cell constant}$$

$$\Rightarrow \text{Cell constant} = \kappa \times R$$

$$= 1.29\ \text{S m}^{-1} \times 85\ \Omega = 109.65\ \text{m}^{-1}$$

For second solution,

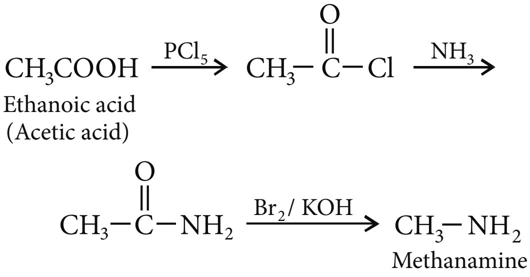
$$\kappa = \frac{1}{R} \times \text{Cell constant} = \frac{1}{96\ \Omega} \times 109.65\ \text{m}^{-1}$$

$$= 1.142\ \Omega^{-1}\text{m}^{-1}$$

$$\Lambda_m = \frac{\kappa \times 1000}{M} = \frac{1.142\ \Omega^{-1}\text{m}^{-1} \times 1000\ \text{cm}^3}{0.052}$$

$$\Lambda_m = \frac{1.142\ \Omega^{-1}\text{cm}^{-1} \times 10^{-2} \times 1000\ \text{cm}^3}{0.052\ \text{mol}}$$

$$= 219.61\ \text{S cm}^2\ \text{mol}^{-1}$$

27. (i) 

$$\underset{\substack{\text{Ethanoic acid}\\ \text{(Acetic acid)}}}{CH_3COOH} \xrightarrow{PCl_5} CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-Cl \xrightarrow{NH_3} CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-NH_2 \xrightarrow{Br_2/\ KOH} \underset{\text{Methanamine}}{CH_3-NH_2}$$

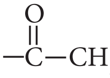
(ii)

$$\underset{\text{Ethanamine}}{CH_3-CH_2-NH_2} \xrightarrow[273\text{ - }278\text{ K}]{NaNO_2/HCl} CH_3-CH_2-OH$$

$$\xrightarrow{K_2Cr_2O_7/H^+} CH_3-COOH \xrightarrow{PCl_5} CH_3-COCl \xrightarrow{NH_3}$$

$$CH_3-CONH_2 \xrightarrow{Br_2/KOH} \underset{\text{Methanamine}}{CH_3-NH_2}$$

OR

(i) After acetylation of aniline, acetanilide is formed in which due to the presence of  $\overset{\overset{O}{\|}}{-C}-CH_3$ group having $-I$ effect, electron density on N-atom decreases and hence, activation effect of aniline gets reduced.

(ii) CH_3NH_2 is more basic than $C_6H_5NH_2$ because in aniline the lone pair of electrons on nitrogen are involved in resonance.

(iii) Nitration is carried out with conc. HNO_3 in the presence of conc. H_2SO_4. In the presence of these acids, the $-NH_2$ group of aniline gets protonated and is converted into $-\overset{+}{N}H_3$ group. This positively charged group acts as a strong electron withdrawing and *meta*-directing group. Hence, the incoming electrophile goes to *m*-position.

28. (a) (i) $XeF_4 + SbF_5 \rightarrow [XeF_3]^+ [SbF_6]^-$

(ii) $\underset{\text{(Hot and conc.)}}{6NaOH} + 3Cl_2 \rightarrow 5NaCl + NaClO_3 + 3H_2O$

(b) As the stability of the oxoanion increases, its tendency to decompose to give O_2 decreases and hence its oxidising power decreases. Since, the stability of the oxoanion decreases in the order :

$ClO_4^- > ClO_3^- > ClO_2^- > ClO^-$ therefore oxidising power of their oxoacids increases in the reverse order :

$HClO_4 < HClO_3 < HClO_2 < HClO$

29. (i) A mixture of ethanol and acetone shows positive deviation from Raoult's law. Pure ethanol possesses hydrogen bonding. Introduction of acetone between the molecules of ethanol results in breaking of some of these hydrogen bonds. Due to weakening of interactions, the solution shows positive deviation from Raoult's law.

(ii) (a) 1.2% sodium chloride solution is hypertonic with respect to 0.9% sodium chloride solution or blood cells thus, on placing blood cells in this solution exosmosis takes place that results in shrinking of cells.

(b) 0.4% sodium chloride solution is hypotonic with respect to 0.9% sodium chloride solution or blood cells thus, on placing blood cells in this solution endosmosis takes place that results in swelling of cells.

30. (i) $[Pt(NH_3)_2Cl(NO_2)]$:
Diamminechloridonitrito-N-platinum(II)
It is square planar and diamagnetic.

(ii) $[Co(NH_3)_4Cl_2]Cl$:
Tetraamminedichloridocobalt(III) chloride
It is octahedral and diamagnetic.

(iii) $Ni(CO)_4$: Tetracarbonylnickel(0)
It is tetrahedral and diamagnetic.

31. (i) (a) Nearly all the transition metals have the simple *hcp*, *ccp* or *bcc* lattice characteristics of true metals in which atoms are held together by strong metal-metal bonding. As we go down the group, electrons of elements of second and third series are available more easily as compared to first series hence, metal-metal bonding is more frequent in 4*d* and 5*d*-series of elements.

(b) The lesser number of oxidation states on the extreme ends of the series can be due to the presence of too few electrons or due to the presence of too many electrons and thus, fewer empty orbitals to share electrons with the ligands. In the middle of the series, *ns* and $(n-1)d$ electrons are involved hence, higher oxidation states are exhibited by them.

(ii) While moving along a period from Sc to Zn, basic nature decreases and acidic nature increases. Also, with increase in the oxidation state of a given transition series, the covalent character of its compound increases and thus, acidic character also increases.

(iii) (a) The transition metals and their compounds, are known for their catalytic activity. This activity is ascribed to their ability to adopt multiple oxidation states, ability to adsorb the reactant on its surface and to form complexes. Vanadium (V) oxide (in Contact Process), finely divided iron (in Haber's Process), and nickel (in catalytic hydrogenation) are some of the examples. Catalysis involves the formation of bonds between reactant molecules and atoms at the surface of the catalyst.

(b) Ce(III) has outer configuration $4f^1 5d^0 6s^0$. It easily loses an electron to acquire the configuration $4f^0$ and forms Ce(IV). In fact this is the only (+IV) lanthanoid which exists in solution.

OR

(i) Mn shows maximum no. of oxidation states from +2 to +7 because Mn has maximum number of unpaired electrons in 3*d* sub-shell.

(ii) Cr has maximum melting point, because it has 6 unpaired electrons in the valence shell, hence it has strong interatomic interaction.

(iii) Sc shows only +3 oxidation state because after losing 3 electrons, it has noble gas electronic configuration.

(iv) Mn is strong oxidising agent in +3 oxidation state because change of Mn^{3+} to Mn^{2+} give stable half filled (d^5) electronic configuration, $E°_{(Mn^{3+}/Mn^{2+})} = 1.5$ V.

(v) Zn has completely filled *d*-orbital so it is not a transition element.

32. (i) Molecularity is the number of molecules taking part in an elementary step. For a reaction at least one molecule is required hence, the minimum value of molecularity is one.

(ii) For a first order reaction,

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{60} = 1.155 \times 10^{-2}\ \text{min}^{-1}$$

or, $$k = \frac{0.693}{60 \times 60} = 1.925 \times 10^{-4}\ \text{s}^{-1}$$

(iii) Given, $\frac{d[NO_2]}{dt} = 2.8 \times 10^{-3}\ \text{M s}^{-1}$

According to rate law expression,

$$-\frac{1}{2}\frac{d[N_2O_5]}{dt} = \frac{1}{4}\frac{d[NO_2]}{dt} = \frac{d[O_2]}{dt}$$

$$\therefore \quad -\frac{d[N_2O_5]}{dt} = \frac{2}{4} \times 2.8 \times 10^{-3}$$

$$\frac{-d[N_2O_5]}{dt} = \frac{1}{2} \times 2.8 \times 10^{-3} = 1.4 \times 10^{-3}\ \text{M s}^{-1}$$

OR

(a) (i) Let the rate law for the given reaction be Rate = $k[A]^x[B]^y$

Then, $$\frac{r_{II}}{r_I} = \frac{2.4 \times 10^{-1}}{6.0 \times 10^{-2}} = \frac{k(0.4)^x \times (0.1)^y}{k(0.2)^x \times (0.1)^y}$$

$4 = 2^x \quad \Rightarrow \quad x = 2$

Again, $$\frac{r_{III}}{r_I} = \frac{1.2 \times 10^{-1}}{6.0 \times 10^{-2}} = \frac{k(0.2)^x \times (0.2)^y}{k(0.2)^x \times (0.1)^y}$$

or, $2 = 2^y \ \Rightarrow y = 1$

Hence, the rate law = $k[A]^2[B]^1$

(ii) If half life is inversely proportional to the initial concentration, then the order of the reaction is 2.

(b) Radioactive disintegration follows first order kinetics. Hence,

Decay constant of ^{90}Sr, $(\lambda) = \frac{0.693}{t_{1/2}} = \frac{0.693}{28.1}$

$$= 2.466 \times 10^{-2}\ \text{yr}^{-1}$$

To calculate the amount left after 10 years,

Given, $[R_0] = 1\ \mu g$, $t = 10$ years,

$\lambda = 2.466 \times 10^{-2}\ \text{yr}^{-1}$, $[R] = ?$

Using formula, $$\lambda = \frac{2.303}{t}\log\frac{[R_0]}{[R]}$$

or $$2.466 \times 10^{-2} = \frac{2.303}{10}\log\frac{1}{[R]}$$

or, $\log [R] = -0.1071$

or, $[R] = \text{Antilog}(-0.1071) = 0.7814\ \mu g$

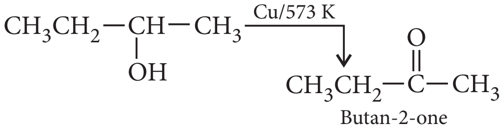
To calculate the amount left after 60 years, $t = 60$ years, $[R_0] = 1\ \mu g$, $[R] = ?$

or, $$2.466 \times 10^{-2} = \frac{2.303}{60}\log\frac{1}{[R]}$$

or, $\log [R] = -0.6425$

or, $[R] = \text{Antilog}(-0.6425) = 0.2278\ \mu g$

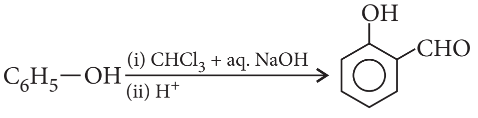
33. (a) (i)



$$CH_3CH_2-\underset{OH}{\underset{|}{CH}}-CH_3 \xrightarrow{Cu/573\ K} CH_3CH_2-\overset{O}{\overset{||}{C}}-CH_3$$

Butan-2-one

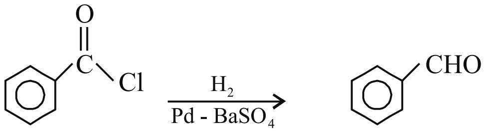
(ii)



Salicylaldehyde

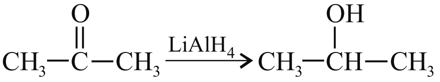
(b) Phenol gets easily nitrated than benzoic acid. Because carboxyl group is ring deactivating group whereas hydroxyl group is ring activating group.

(c) (i)



Benzoyl chloride Benzaldehyde

(ii)

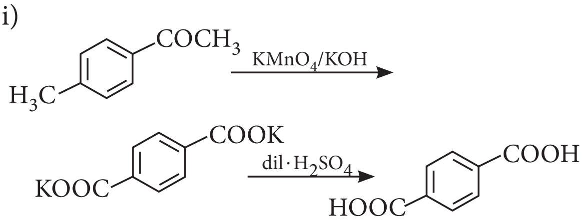


$$CH_3-\overset{O}{\overset{||}{C}}-CH_3 \xrightarrow{LiAlH_4} CH_3-\overset{OH}{\overset{|}{CH}}-CH_3$$

Propanone Propan-2-ol

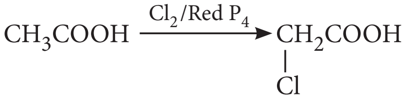
OR

(a) (i)



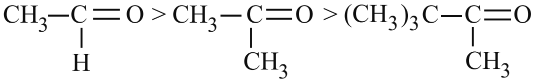
(ii) $2C_6H_5CHO + \text{conc. NaOH} \rightarrow C_6H_5COONa + C_6H_5CH_2OH$

(iii)



$$CH_3COOH \xrightarrow{Cl_2/\text{Red } P_4} \underset{Cl}{\underset{|}{CH_2}}COOH$$

(b) (i) Greater the number of alkyl groups attached to the carbonyl group, lower is the reactivity towards nucleophilic addition reactions.



$$CH_3-\underset{H}{\underset{|}{C}}=O > CH_3-\underset{CH_3}{\underset{|}{C}}=O > (CH_3)_3C-\underset{CH_3}{\underset{|}{C}}=O$$

Acetaldehyde Acetone Methyl-*tert*-butyl ketone

(ii) We know that +*I*-effect decreases while –*I*-effect increases the acid strength of carboxylic acids. The overall acid strength increases in the order :

$(CH_3)_2CHCOOH < CH_3CH(Br)CH_2COOH < CH_3CH_2CH(Br)COOH$

* * *