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	1(1)	–	1(3)	–	**9(23)**
2.	Solutions	–	2(4)	–	–	
3.	Electrochemistry	–	1(2)	–	1(5)	
4.	Chemical Kinetics	1(4)	–	–	–	
5.	Surface Chemistry	1(1)	–	1(3)	–	
6.	The *p*-Block Elements	1(1)	–	–	1(5)	**8(19)**
7.	The *d*- and *f*-Block Elements	–	1(2)	2(6)	–	
8.	Coordination Compounds	1(1)	2(4)	–	–	
9.	Haloalkanes and Haloarenes	4(4)	1(2)	–	–	**16(28)**
10.	Alcohols, Phenols and Ethers	1(1)	1(2)	–	–	
11.	Aldehydes, Ketones and Carboxylic Acids	1(1)	–	–	–	
12.	Amines	2(5)	–	–	1(5)	
13.	Biomolecules	3(3)	1(2)	1(3)	–	
	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.

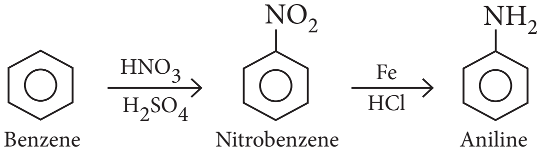
(f) There is no overall choice. However, internal choices have been provided.

(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 :**

Amines can be synthesized by various processes. But for industrial preparation one has to emphasise on the economics of the process. The reduction of nitro compounds is definitely a reasonable and a practicable method for preparing primary amines.



The reduction of nitro compounds to amines may be accomplished by metal-acid combinations, by catalytic reduction and in specific cases other reducing agents may be used. Aniline is also prepared industrially by ammination of chlorobenzene with ammonia in presence of a copper oxide catalyst and at high temperature and pressure. Some other methods of preparation of amines are Hofman degradation of primary amides, Gabriel phthalimide reaction etc.

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

(i) Alkanamide, which on Hofmann's reaction gives 1-phenyl ethylamine, is

(a) 2-phenylpropanamide (b) 3-phenylpropanamide

(c) 2-phenylethanamide (d) N-phenylethanamide.

(ii) Which of the following reactions will not give a primary amine?

(a) $CH_3CONH_2 \xrightarrow{Br_2/KOH}$ (b) $CH_3CN \xrightarrow{LiAlH_4}$

(c) $CH_3NC \xrightarrow{LiAlH_4}$ (d) $CH_3CONH_2 \xrightarrow{LiAlH_4}$

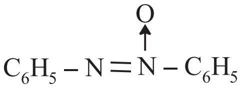
OR

In the reduction of nitrobenzene, which of the following is the intermediate?

(a) $C_6H_5-N=O$

(b) $C_6H_5NH-NHC_6H_5$

(c) $C_6H_5-N=N-C_6H_5$

(d) 
$C_6H_5-N=\overset{\overset{O}{\uparrow}}{N}-C_6H_5$

(iii) Which of the following gives primary amine on reduction?

(a) $CH_3CH_2NO_2$

(b) $CH_3CH_2-O-N=O$

(c) $C_6H_5N=NC_6H_5$

(d) CH_3CH_2NC

(iv) The reaction by which a primary amine is formed from a primary amide is called

(a) Hofmann bromamide reaction

(b) Gabriel phthalimide reaction

(c) Carbylamine reaction

(d) Liebermann nitrosoamine reaction.

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

Rate of a chemical reaction is defined as the rate at which reactants are used up or equivalently the rate at which products are formed. For well known Haber's process

$$N_2 + 3H_2 \longrightarrow 2NH_3$$

$$\text{Rate} = \frac{-d[N_2]}{dt} = -\frac{1}{3}\frac{d[H_2]}{dt} = \frac{1}{2}\frac{d[NH_3]}{dt}$$

Reaction rate depends on the concentrations of the chemical species present in the reaction mixture.

Unimolecular reaction $A \rightarrow B$; rate $= \dfrac{-d[A]}{dt} = k[A]$

Bimolecular reaction $A + B \rightarrow P$; rate $= \dfrac{-d[A]}{dt} = k[A][B]$

or $A + A \rightarrow P$; rate $= \dfrac{-dA}{dt} = k[A]^2$

A unimolecular elementary reaction therefore has an overall order of one, while a bimolecular reaction has an order of one with respect to each reactant, and an overall order of two.

Many complex reactions also follow simple rate laws.

In these questions (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 : The kinetics of the reaction : $mA + nB + pC \rightarrow m'X + n'Y + p'Z$ obeys the rate expression as $\dfrac{dx}{dt} = k[A]^m[B]^n$

Reason : The rate of reaction does not depend upon the concentration of C.

(ii) Assertion : In rate law, unlike in the expression for equilibrium constants, the exponents for concentrations do not necessarily match the stoichiometric coefficients.

Reason : It is the mechanism and not the balanced chemical equation for the overall change that governs the reaction rate.

(iii) Assertion : The overall order of the reaction is the sum of the exponents of all the reactants in the rate expression.

Reason : There are many higher order reactions.

OR

Assertion : Two different reactions can never have same rate of reaction.

Reason : Rate of reaction always depends only on frequency of collision and Arrhenius factor.

(iv) **Assertion :** Rate of reaction doubles when concentration of reactant is doubled if it is a first order reaction.

Reason : Rate constant also doubles.

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

3. Adsorption is an exothermic process, because during adsorption

(a) surface energy increases
(b) surface energy decreases
(c) surface energy remains same
(d) residual forces of attraction increase.

4. Name of the synthetic radioactive element of group 16 having atomic number 116 is

(a) Livermorium
(b) Tennessine
(c) Livernorium
(d) Moscovium.

5. Treatment of ammonia with excess of ethyl chloride will yield

(a) diethyl amine
(b) ethane
(c) tetraethylammonium chloride
(d) methyl amine.

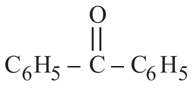
OR

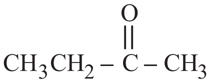
Which of the following is the expected product when *neo*-pentyl chloride reacts with anhydrous aluminium chloride at 415 K?

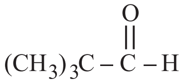
(a) Neopentyl alcohol
(b) 2-Chloro-2-methylbutane
(c) 2-Chloro-2-methylpropane
(d) 2-Chloro-3-methylbutane

6. Which of the following gives aldol condensation reaction?

(a) C_6H_5OH

(b)

$C_6H_5-\overset{\overset{O}{\|}}{C}-C_6H_5$

(c)

$CH_3CH_2-\overset{\overset{O}{\|}}{C}-CH_3$

(d)

$(CH_3)_3C-\overset{\overset{O}{\|}}{C}-H$

7. Which of the following is correct?

(a) S_N1 reaction involves transition state and completed in polar protic solvents.
(b) S_N2 reaction is stereospecific.
(c) Walden inversion is S_N1 reaction.
(d) None of these

8. Which one of the following forms a molecular solid when solidified?

(a) Silicon carbide
(b) Calcium fluoride
(c) Rock salt
(d) Methane

OR

The number of atoms present in unit cell of a monatomic substance of simple cubic lattice is

(a) 6
(b) 3
(c) 2
(d) 1

9. $CH_3CH_2Cl \xrightarrow{NaCN} X \xrightarrow{Ni/H_2} Y \xrightarrow{\text{Acetic anhydride}} Z$

Z in the above reaction sequence is

(a) $CH_3CH_2CH_2NHCOCH_3$
(b) $CH_3CH_2CH_2NH_2$
(c) $CH_3CH_2CH_2CONHCH_3$
(d) $CH_3CH_2CH_2CONHCOCH_3$

10. Which of the statements about "Denaturation" given below are correct?

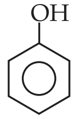
(1) Denaturation of proteins causes loss of secondary and tertiary structures of the protein.
(2) Denaturation leads to the conversion of double strand of DNA into single strand.

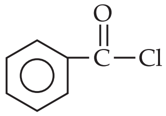
(3) Denaturation affects primary structure which gets distorted.
(a) (2) and (3) (b) (1) and (3) (c) (1) and (2) (d) (1), (2) and (3)

OR

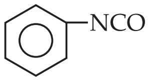
Fructose reduces Tollens' reagent due to
(a) asymmetric carbons
(b) primary alcoholic group
(c) secondary alcoholic group
(d) enolisation of fructose followed by conversion to aldehyde by base.

11. Aniline reacts with phosgene to form

(a) 

(b) 

(c) 

(d) 

OR

Which of the following statements is not correct?
(a) Aliphatic amines are stronger bases than ammonia.
(b) Aromatic amines are stronger bases than ammonia.
(c) The alkyl group in alkyl ammonium ion stabilizes the ion more relative to the amine.
(d) The aryl group in aryl ammonium ion stabilizes the ion less relative to the amine.

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 :** In Zeise's salt coordination number of Pt is five.
Reason : Ethene is a monodentate ligand.

13. **Assertion :** Chlorobenzene is more reactive than benzene towards the electrophilic substitution reaction.
Reason : Halogen atom is *o*, *p*- directing.

14. **Assertion :** Aryl sulphonic acid gives phenol on reacting with NaOH at high temperature.
Reason : This reaction is electrophilic substitution reaction.

15. **Assertion :** Nucleotides are phosphate esters of nucleosides.
Reason : The various nucleotides in nucleic acids are linked either through purine or pyrimidine bases.

16. **Assertion :** Oxidation of glucose by Br_2-water gives saccharic acid.
Reason : Br_2-water oxidises only —CHO and not —OH group.

OR

Assertion : Fructose is a reducing sugar.

Reason : It has a ketonic group.

SECTION - B

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

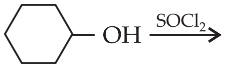
17. Write the IUPAC nomenclature of the following complex along with hybridisation and structure.
$K_2[Cr(NO)(NH_3)(CN)_4]$, $\mu = 1.73$ BM

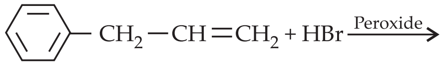
18. (a) Complete the following reaction : $CH_3—CH_2—CH{=}CH_2 + HCl \rightarrow$

(b) Draw the structure of the compound whose IUPAC name is 4-chloropentan-2-one.

OR

Draw the structure of major monohalo product in each of the following reactions :

(i) 

(ii) 

19. The measured resistance of a conductance cell containing 7.5×10^{-3} M solution of KCl at 25°C was 1005 ohm. Calculate

(a) Specific conductance

(b) Molar conductance of the solution (cell constant = $1.25\ cm^{-1}$).

20. State Henry's law. Why is air diluted with helium in the tanks used by scuba divers?

OR

What type of azeotropic mixture will be formed by a solution of acetone and chloroform? Justify on the basis of strength of intermolecular interactions that develop in the solution.

21. Compare the magnetic behaviour of the complex entities $[Fe(CN)_6]^{4-}$ and $[Fe(H_2O)_6]^{3+}$.

22. Write the mechanism of the following reaction :

$CH_3CH_2OH \xrightarrow{HBr} CH_3CH_2Br + H_2O$

OR

How are the following conversions carried out?

(i) Propene to propane-2-ol

(ii) Benzyl chloride to Benzyl alcohol

23. (a) Name the bases that are common in both DNA and RNA.

(b) Despite having an aldehyde group glucose does not give 2,4 - DNP test and addition of $NaHSO_3$. Why?

24. List any four factors on which the colligative properties of a solution depend.

25. To what extent do the electronic configurations decide the stability of oxidation states in the first series of transition elements? Illustrate your answer with examples.

SECTION - C

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

26. Account for the following :

(i) Zirconium and hafnium exhibit almost similar properties.

(ii) Zinc salts are white while copper II salts are coloured [At. nos. Zn = 30, Cu = 29].

(iii) Europium (II) is more stable than cerium (II).

27. Explain the following observations :

(a) Sun looks red at the time of sunset.

(b) Rate of physical adsorption decreases with rise in temperature.

(c) Physical adsorption is multilayered while chemical adsorption is monolayered.

OR

What is the difference between multimolecular and macromolecular colloids? Give one example of each type. How are associated colloids different from these two types of colloids ?

28. Differentiate between the following :

(i) Amylose and Amylopectin

(ii) Peptide linkage and Glycosidic linkage

(iii) Fibrous proteins and Globular proteins.

29. Give reasons :

(i) *d*-block elements exhibit more oxidation states than *f*-block elements.

(ii) The enthalpies of atomization of the transition metals are high.

(iii) The variation in oxidation states of transition metals is of different type from that of the non-transition metals.

30. (i) Examine the given defective crystal.

A^+ B^- A^+ B^- A^+
B^- ○ B^- A^+ B^-
A^+ B^- A^+ ○ A^+
B^- A^+ B^- A^+ B^-

Answer the following questions :

(a) What type of stoichiometric defect is shown by the crystal?

(b) How is the density of the crystal affected by this defect?

(ii) Analysis shows that FeO has a non-stoichiometric composition with formula $Fe_{0.95}O$. Give reason.

OR

(i) Silver crystallises in face centred cubic unit cell. Each side of this unit cell has a length of 400 pm. Calculate the radius of the silver atom. (Assume the atom just touch each other on the diagonal across the face of the unit cell, that is each face atom is touching the four corner atoms).

(ii) Why is Frenkel defect not found in pure alkali metal halides?

SECTION - D

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

31. (a) Complete the following reactions :

(i) $C_6H_5NH_2 + C_6H_5CHO \xrightarrow{H^+}$ (ii) $C_6H_5NH_2 + Br_{2(aq)} \rightarrow$

(b) State reasons for the following :

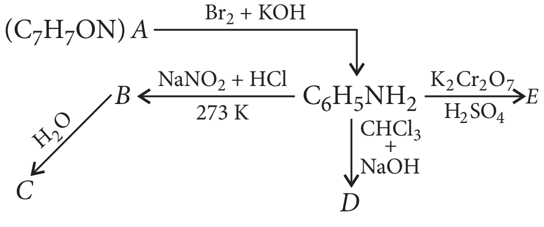
(i) pK_b value for aniline is more than that for ethylamine.

(ii) Ethylamine is soluble in water whereas aniline is not soluble in water.

(iii) Primary amines have higher boiling points than tertiary amines.

OR

An aromatic compound '*A*' of molecular formula C_7H_7ON undergoes a series of reactions as shown below. Write the structures of *A*, *B*, *C*, *D* and *E* in the following reactions :



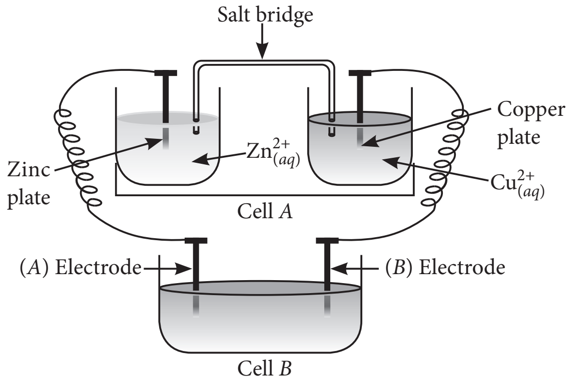
32. (i) Two half-reactions of an electrochemical cell are given below :

$MnO^-_{4(aq)} + 8H^+_{(aq)} + 5e^- \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$, $E° = +1.51V$

$Sn^{2+}_{(aq)} \rightarrow Sn^{4+}_{(aq)} + 2e^-$, $E° = +0.15$ V

Construct the redox equation from the standard potential of the cell and predict if the reaction is reactant favoured or product favoured.

(ii) Consider the figure and answer the following questions :



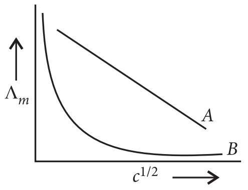
(a) Cell '*A*' has $E_{cell} = 2$ V and cell '*B*' has $E_{cell} = 1.1$ V, which of the two cells '*A*' or '*B*' will act as an electrolytic cell? Which electrode reactions will occur in this cell?

(b) If cell '*A*' has $E_{cell} = 0.5$ V and cell '*B*' has $E_{cell} = 1.1$ V then what will be the reactions at anode and cathode?

OR

(i) A cell is prepared by dipping copper rod in 1 M copper sulphate solution and zinc rod in 1 M zinc sulphate solution. The standard reduction potential of copper and zinc are 0.34 V and –0.76 V respectively. (i) What will be the cell reactions? Calculate the emf of the cell.

(ii) In the plot of molar conductivity (Λ_m) *vs* square root of concentration ($c^{1/2}$), following curves are obtained for two electrolytes *A* and *B*



Answer the following :

(a) Predict the nature of electrolytes *A* and *B*.

(b) What happens on extrapolation of Λ_m to concentration approaching zero for electrolytes *A* and *B*?

33. (i) Give the formula and describe the structure of a noble gas species which is isostructural with :

(a) ICl_4^- (b) BrO_3^-

(ii) What happens when Cl_2 reacts with hot concentrated solution of sodium hydroxide? Is this reaction a disproportionation reaction?

OR

(i) Account for the following :

(a) Bond dissociation energy of F_2 is less than that of Cl_2.

(b) Bleaching of flowers by chlorine is permanent while that by sulphur dioxide is temporary.

(ii) Among the hydrides of group 16.

(a) Which is a strong reducing agent?

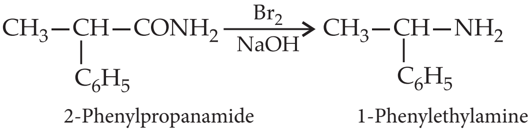
(b) Which has maximum bond angle?

(c) Which is most thermally stable?

Give suitable reason in each.

SOLUTIONS

1. (i) (a) :



$$CH_3-\underset{\underset{C_6H_5}{|}}{CH}-CONH_2 \xrightarrow[NaOH]{Br_2} CH_3-\underset{\underset{C_6H_5}{|}}{CH}-NH_2$$

2-Phenylpropanamide 1-Phenylethylamine

(ii) (c) : $CH_3CONH_2 \xrightarrow{Br_2/KOH} \underset{\text{Primary amine}}{CH_3NH_2}$

$CH_3CN \xrightarrow{LiAlH_4} \underset{\text{Primary amine}}{CH_3CH_2NH_2}$

$CH_3NC \xrightarrow{LiAlH_4} \underset{\text{Secondary amine}}{CH_3NHCH_3}$

$CH_3CONH_2 \xrightarrow{LiAlH_4} \underset{\text{Primary amine}}{CH_3CH_2NH_2}$

OR

(a) : In the reduction of nitrobenzene, nitrosobenzene ($C_6H_5-N=O$) and phenyl hydroxylamines (C_6H_5-NHOH) are obtained as intermediate depending upon the pH of reaction medium.

(iii) (a) : Nitro compounds on reduction yield primary amines.

$CH_3CH_2NO_2 \xrightarrow[6[H]]{LiAlH_4} CH_3CH_2-NH_2 + 2H_2O$

(iv) (a) : Preparation of primary amine from primary amide is called Hofmann bromamide reaction.

2. (i) (a) : Rate expression $\frac{dx}{dt} = k[A]^m[B]^n$ shows that the total order of reactions is $m + n + 0 = m + n$ as the rate of reaction is independent of concentration of C, *i.e*, the order with respect to C is zero. This is the reason that C does not figure in the rate expression.

(ii) (a)

(iii) (c) : Reactions of higher order are rare because chances for larger number of molecules to come simultaneously for collision are less.

OR

(d) : Two different reactions can have same rate of reaction. Rate of reaction depends upon many factors like nature and concentration of reactants, temperature, catalyst, energy factors, orientation factor, etc.

(iv) (c) : For first order reaction,

$\text{Rate}_1 = k[A_1]$

According to question,

$[A_2] = [2A_1]$

$\therefore \quad \text{Rate}_2 = k[2A_1]$

$\Rightarrow \quad \text{Rate}_2 = 2\ \text{Rate}_1$

For a given reaction, rate constant is constant and independent of the concentration of reactant.

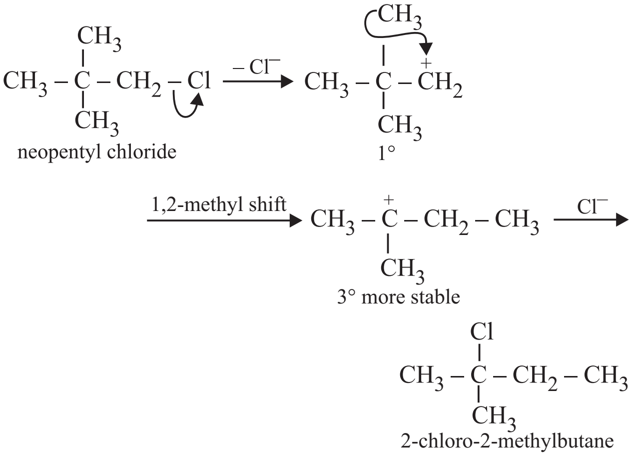
3. (b) : During adsorption, there is always a decrease in residual forces of the surface, *i.e.*, there is decrease in surface energy which appears as heat, therefore adsorption is an exothermic process.

4. (a)

5. (c) : $\underset{\text{(excess)}}{C_2H_5Cl + NH_3} \longrightarrow \underset{\text{Tetraethylammonium chloride}}{(C_2H_5)_4N^+Cl^-}$

OR

(b) : Neopentyl chloride rearranges to 2- chloro- 2-methylbutane.



6. (c) : Carbonyl compounds containing α-hydrogen atom give aldol condensation.

7. (b) : S_N1 reaction involves carbocation as the intermediate. Walden inversion is S_N2 reaction.

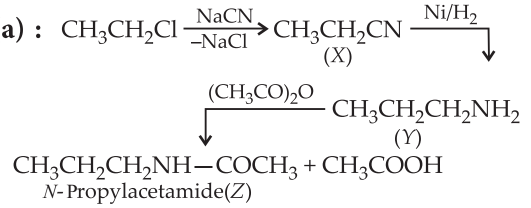
8. (d)

OR

(d) : The number of atoms present in unit cell of a monatomic substance of simple cubic lattice

$= 8$ corner atoms $\times \frac{1}{8}$ atom per unit cell $= 1$ atom

9. (a) :



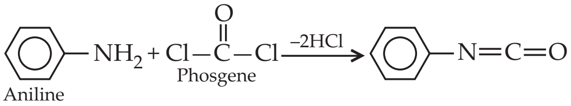
$$CH_3CH_2Cl \xrightarrow[-NaCl]{NaCN} \underset{(X)}{CH_3CH_2CN} \xrightarrow{Ni/H_2} \underset{(Y)}{CH_3CH_2CH_2NH_2} \xrightarrow{(CH_3CO)_2O} \underset{N\text{-Propylacetamide}(Z)}{CH_3CH_2CH_2NH-COCH_3} + CH_3COOH$$

10. (c) : Denaturation does not change the primary structure of protein.

OR

(d) : Under alkaline conditions of the reagent, fructose gets converted into a mixture of glucose and mannose both of which contain the –CHO group and hence reduces Tollens' reagent to give silver mirror test.

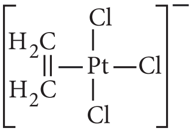
11. (d) :



OR

(b)

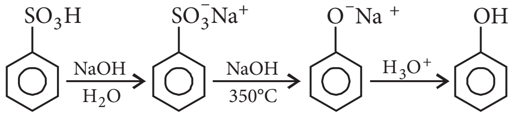
12. (d) : Zeise's salt :



Coordination no. of Pt is 4.

13. (d) : Chlorobenzene is less reactive than benzene towards the electrophilic substitution reactions due to –*I*-effect.

14. (c) :



This is nucleophilic aromatic substitution reaction and occurs *via* the addition-elimination mechanism with SO_3^{2-} as the leaving group.

15. (c) : The various nucleotides in nucleic acids are linked through phosphate ester groups.

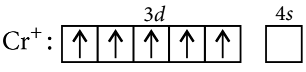
16. (d) : Oxidation of glucose by Br_2-water gives gluconic acid.

OR

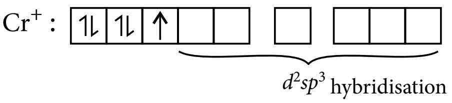
(b)

17. $\mu = \sqrt{n(n+2)} = 1.73$ which gives $n = 1$

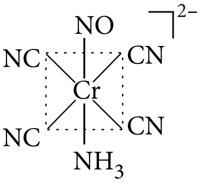
This means that chromium ion has one unpaired electron, *i.e.*, it is present as Cr^+ or Cr (I). This implies that NO is present as nitrosonium ion. Hence, the name will be potassium amminetetracyanidonitrosonium chromate(I).



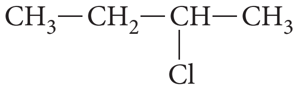
In the complex, as there is only one unpaired electron and coordination number is 6,



it will undergo d^2sp^3 hybridisation to give octahedral geometry.



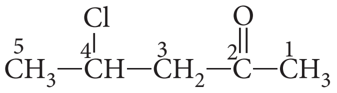
18. (a) $CH_3-CH_2-CH=CH_2 + HCl \rightarrow$



$CH_3-CH_2-\underset{\underset{Cl}{|}}{CH}-CH_3$

2- chlorobutane

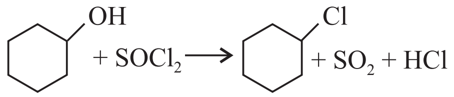
(b) The structure of 4-chloropentan-2-one is



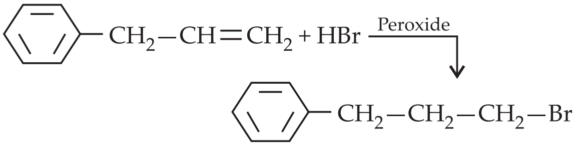
$\overset{5}{C}H_3-\overset{\overset{Cl}{|}}{\underset{4}{C}}H-\overset{3}{C}H_2-\overset{\overset{O}{||}}{\underset{2}{C}}-\overset{1}{C}H_3$

OR

(i)



(ii)



19. (a) Specific conductance = Cell constant/*R*

$\kappa = \frac{1.25}{1005} = 0.001243\ ohm^{-1}\ cm^{-1}$

(b) Molar conductance $= \frac{\kappa \times 1000}{M}$

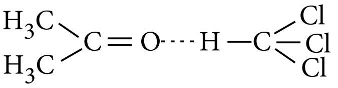
$= \frac{0.001243 \times 1000}{7.5 \times 10^{-3}} = 165.73\ ohm^{-1}\ cm^2\ mol^{-1}$

20. Henry's law states that, the partial pressure of the gas in vapour phase (*p*) is proportional to the mole fraction of the gas (*x*) in the solution.

$p = K_H \cdot x$ where, K_H = Henry's law constant. Different gases have different K_H values at the same temperature. To minimise the painful effects of decompression sickness in deep sea divers, oxygen diluted with less soluble helium gas is used as breathing gas

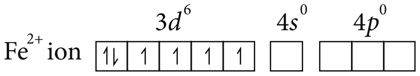
OR

Mixture of chloroform and acetone shows negative deviation from Raoult's law, thus it forms maximum boiling azeotrope. This is because chloroform molecule is able to form hydrogen bond with acetone molecule as shown :



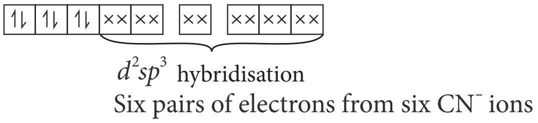
This decreases the escaping tendency of molecules for each component and consequently the vapour pressure decreases resulting in negative deviation from Raoult's law.

21. (i) $[Fe(CN)_6]^{4-}$ ion :



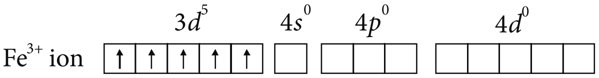
Fe^{2+} ion hybridised (under the influence of strong field ligand).

$[Fe(CN)_6]^{4-}$ ion formation :



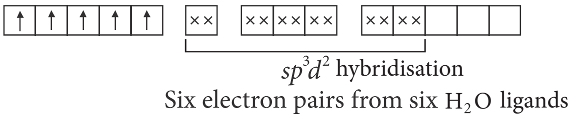
Since the complex ion does not contain any unpaired electron, so it is diamagnetic.

(ii) $[Fe(H_2O)_6]^{3+}$ ion :



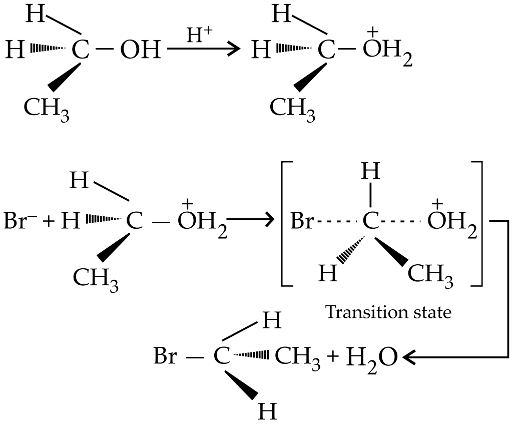
Fe^{3+} ion is hybridised (under the influence of weak field ligand)

$[Fe(H_2O)_6]^{3+}$ ion formation :



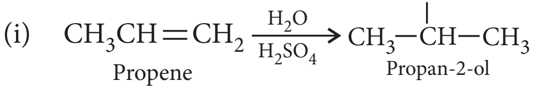
As the complex ion contains five unpaired electrons, it is highly paramagnetic in nature.

22. The reaction proceeds through nucleophilic substitution bimolecular (S_N2) mechanism, as shown below :



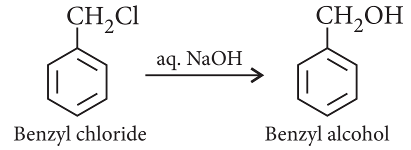
Inversion of configuration takes place during the reaction.

OR



(i) $$\underset{\text{Propene}}{CH_3CH{=}CH_2} \xrightarrow[H_2SO_4]{H_2O} \underset{\text{Propan-2-ol}}{CH_3{-}\overset{\overset{\large OH}{|}}{C}H{-}CH_3}$$

(ii)



23. (a) Adenine, guanine and cytosine are the bases common in DNA and RNA both.

(b) Glucose does not have open structure and hence, it does not have a free –CHO group. Actually –CHO group combines with C_5–OH to form hemiacetal.

24. (i) Number of particles of solute

(ii) Association or dissociation of solute

(iii) Concentration of solute

(iv) Temperature

25. In the first series of the transition elements electronic configurations decide the stability of oxidation state.

Example : Sc^{3+} has stable electronic configuration (vacant *d*-orbital), therefore Sc^{3+} is more stable than Sc^+.

Fe^{3+} is more stable than Fe^{2+} due to half filled *d*-orbitals. Mn^{2+} is more stable than Mn^{3+} due to half filled *d*-orbitals. V^{5+} is more stable (due to vacant *d*-orbital) than V^{3+}.

26. (i) Due to lanthanoid contraction the elements of 4*d* and 5*d*-series have similar atomic radii *e.g.*, Zr = 160 pm and Hf = 159 pm. Thus Zr and Hf have almost identical properties.

(ii) Zn^{2+} ion has completely filled *d*-subshell and no *d-d* transition is possible. So zinc salts are white. Configuration of Cu^{2+} is [Ar] $3d^9$. It has partially filled *d*-subshell and hence it is coloured due to *d-d* transition.

(iii) Europium (II) has electronic configuration $[Xe]4f^7 5d^0$ while cerium (II) has electronic configuration [Xe] $4f^1\ 5d^1$. In Eu^{2+}, 4*f* subshell is half filled and 5*d*-subshell is empty. Since, half filled and completely filled electronic configurations are more stable, therefore Eu^{2+} ions is more stable than Ce^{2+} .

27. (a) At the time of sunset, the sun is at horizon. The light emitted by the sun has to travel a relatively longer distance through the atmosphere. As a result, blue part of light is scattered away by the particulate in the atmosphere causing red part to be visible.

(b) Gas (adsorbate) + Solid (adsorbent)

$$\underset{\text{Evaporation}}{\overset{\text{Condensation}}{\rightleftharpoons}} \text{Gas adsorbed on solid + Heat}$$

Physical adsorption is an exothermic process. According to Le-Chatelier's principle, at equilibrium as the temperature is increased, the equilibrium shifts in the backward direction, *i.e.*, adsorption decreases.

(c) Physical adsorption involves van der Waals' forces, so any number of layers may be formed one over the other on the surface of the adsorbent. Chemical adsorption takes place as a result of the reaction between adsorbent and adsorbate. When the surface of adsorbent is covered with one layer, no further reaction can take place.

OR

S. No.	Multimolecular Colloids	Macromolecular colloids
1.	When a large number of small molecules or atoms (diameter < 1 nm) of a substance combine together in a dispersion medium to form aggregates, having size in the colloidal range, the colloidal solutions thus, formed are known as multimolecular colloids.	When substances which possess very high molecular masses are dispersed in suitable dispersion medium, the colloidal solutions thus, formed are called macromolecular colloids.
2.	*e.g.*, gold sol, sulphur sol, etc.	*e.g.*, cellulose, starch, etc.

Associated colloids : The substances which at low concentration, behave as normal strong electrolytes but at higher concentration exhibit colloidal behaviour due to the formation of aggregated particles, are known as associated colloids.

28. (i) Amylose is a linear condensation polymer of α-*D*-glucose in which C_1 of one glucose unit is attached to C_4 of the other through α-glycosidic linkage while amylopectin is a highly branched polymer in which C_1 of terminal glucose unit in each chain is further linked to C_6 of some other glucose unit in the next chain through C_1-C_6 α-glycosidic linkage.

(ii) Peptide linkage is an amide linkage formed between – COOH group of one α-amino acid and $-NH_2$ group of the other amino acid by loss of a molecule of water whereas a linkage between two monosaccharides units through oxygen atom is called glycosidic linkage.

(iii) Characteristic differences between globular and fibrous proteins can be given as :

S. No.	Globular proteins	Fibrous proteins
1.	These are cross-linked proteins and are condensation product of acidic and basic amino acids.	These are linear condensation polymer.
2.	These are soluble in water, mineral acids and bases.	These are insoluble in water but soluble in strong acids and bases.
3.	These proteins have three dimensional folded structure. These are stabilised by internal hydrogen bonding, *e.g.*, egg albumin, enzymes.	These are linear polymers held together by intermolecular hydrogen bonds, *e.g.*, hair, silk.

29. (i) All transition elements except the first and the last member in each series show a large number of variable oxidation states. This is because difference of energy in the $(n - 1)d$ and ns orbitals is very little.

Hence, electrons from both the energy levels can be used for bond formation.

(ii) As transition metals have a large number of unpaired electrons in the *d*-orbitals of their atoms they have strong interatomic attraction or metallic bonds. Hence, they have high enthalpy of atomization.

(iii) The variability in oxidation states of transition metals is due to the incomplete filling of *d*-orbitals. Their oxidation states differ from each other by unity. For example, Fe^{3+} and Fe^{2+}, Cu^{2+} and Cu^+, etc.

In case of non transition elements the oxidation states normally differ by units of two. For example, Pb^{2+} and Pb^{4+}, Sn^{2+} and Sn^{4+}, etc. It arises due to expansion of octet and inert pair effect.

30. (i) (a) Schottky defect

(b) Density of the crystal decreases.

(ii) In FeO crystal some of the Fe^{2+} ions are replaced by Fe^{3+} ions. Three Fe^{2+} ions are replaced by two Fe^{3+} ions to maintain electrical neutrality. Eventually there will be less amount of metal ($Fe_{0.95}O$) as compared to stoichiometric proportion (FeO).

OR

(i) $a = 400$ pm

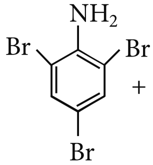
For *fcc*, $r = \frac{a}{2\sqrt{2}}$

$$\therefore \quad r = \frac{400}{2\sqrt{2}} = \frac{400}{2\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} = \frac{400\sqrt{2}}{4} = 100\sqrt{2}$$

$\Rightarrow \quad r = 100 \times 1.414 = 141.4$ pm

(ii) Frenkel defect is not found in alkali metal halides because alkali metal ions have large size which cannot fit into interstitial sites.

31. (a) (i) $C_6H_5NH_2 + C_6H_5CHO \xrightarrow{H^+} \underset{\text{Benzalaniline}}{C_6H_5N{=}CHC_6H_5} + H_2O$

(ii) $C_6H_5NH_2 + 3Br_{2(aq)} \longrightarrow$  $+ 3HBr$

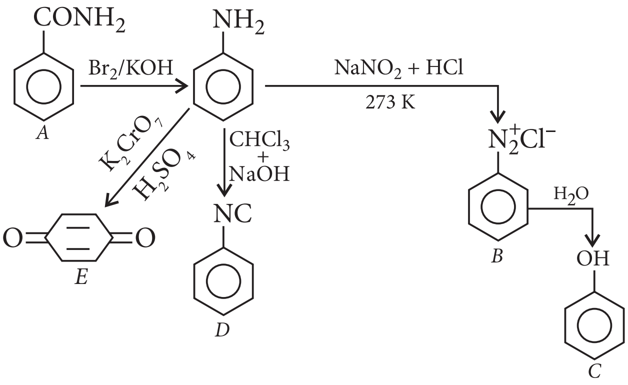
2, 4, 6–Tribromoaniline

(b) (i) In aniline, the lone pair of electrons on N-atom are delocalised over benzene ring due to resonance. As a result, electron density on the nitrogen atom decreases. In contrast, in methylamine, +*I*-effect of $-CH_3$ group increases electron density on the nitrogen atom. Therefore, aniline is a weaker base than methylamine, hence its pK_b value is more than that for methylamine.

(ii) Ethylamine is soluble in water due to formation of intermolecular hydrogen bonds with water molecules. However, in aniline due to large hydrophobic aryl group the extent of hydrogen bonding decreases considerably and hence, aniline is insoluble in water.

(iii) Due to the presence of two H-atoms, primary amines undergo extensive intermolecular hydrogen bonding. Due to the absence of N–H bond, 3°-amines do not undergo H-bonding. As a result, primary amines have higher boiling points than tertiary amines.

OR



32. (i) At anode : $Sn^{2+}_{(aq)} \longrightarrow Sn^{4+}_{(aq)} + 2e^-] \times 5$

At cathode : $MnO^-_{4(aq)} + 8H^+_{(aq)} + 5e^- \longrightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}] \times 2$

Net cell reaction :

$$2MnO^-_{4(aq)} + 5Sn^{2+}_{(aq)} + 16H^+_{(aq)} \longrightarrow 2Mn^{2+}_{(aq)} + 5Sn^{4+}_{(aq)} + 8H_2O_{(l)}$$

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode} = 1.51\ V - 0.15\ V = 1.36\ V$

Since, cell potential is positive therefore the reaction is spontaneous *i.e.*, product favoured.

(ii) (a) Cell *B* will act as electrolytic cell as it has lower emf.

The electrode reactions will be

$Zn^{2+} + 2e^- \rightarrow Zn$ (Cathode)

$Cu \rightarrow Cu^{2+} + 2e^-$ (Anode)

(b) With the values of emf, cell *B* will act as galvanic cell due to higher emf and will push electrons into cell *A*.

The electrode reactions will be

$Zn \rightarrow Zn^{2+} + 2e^-$ (Anode)

$Cu^{2+} + 2e^- \rightarrow Cu$ (Cathode)

OR

(i) The cell reactions are :

$Zn_{(s)} \longrightarrow Zn^{2+}_{(aq)} + 2e^-$ (Anode)

$Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$ (Cathode)

Net reaction :

$Zn_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$

$E^\circ_{cell} = E^\circ_{right} - E^\circ_{left} = 0.34\ V - (-0.76\ V) = 1.10\ V$

(ii) (a) Electrolyte *A* is a strong electrolyte while electrolyte *B* is a weak electrolyte.

(b) For electrolyte *A*, the plot becomes linear near high dilution and thus can be extrapolated to zero concentration to get the molar conductivity at infinite dilution.

For weak electrolyte *B*, λ_m increases steeply on dilution and extrapolation to zero concentration is not possible. Hence, molar conductivity at infinite dilution cannot be determined.

33. (i) (a) Structure of ICl_4^- :

No. of electrons in valence shell of the central I atoms = 7

No. of electrons provided by four Cl atoms = 4 × 1 = 4

Charge on central atom = 1

$\therefore$ Total no. of electrons around the central atom = 7 + 4 + 1 = 12

Total no. of electron pairs around the central atom

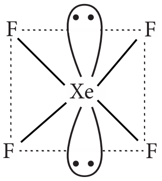
$= \dfrac{12}{2} = 6$

But the no. of bond pairs = 4

($\because$ four I — Cl bonds)

$\therefore$ No. of lone pairs = 6 – 4 = 2

Therefore, according to VSEPR theory ICl_4^- should be square planar.



Now, a noble gas compound having 12 electrons in the valence shell of the central atom is XeF_4, with square planar structure.

(b) In BrO_3^-, since O is more electronegative than Br, therefore, –ve charge stays on the O atom. Therefore, in BrO_3^-, there are two Br═O bonds and one Br—O⁻ bond. Total number of electrons in the valence shell of the central Br atom = 8

$\therefore$ No. of electron pairs around Br atom $= \dfrac{8}{2} = 4$

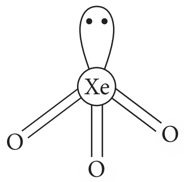
But total number of bond pairs

$= 2 \times 1\ (Br{=}O) + 1 \times (Br{-}O^-) = 3$

Thus, lone pairs = 4 – 3 = 1

Thus, BrO_3^- has 3 bond pairs and one lone pair. Therefore, according to VSEPR theory, it should be pyramidal.

Now a noble gas compound having 8 electrons in the valence shell of the central atom is XeO_3.



(ii) $6NaOH + 3Cl_2 \longrightarrow 5Na\overset{-1}{Cl} + Na\overset{+5}{Cl}O_3 + 3H_2O$

Yes, this reaction is disproportionation reaction as chlorine from zero oxidation state changes to –1 and +5, oxidation states.

OR

(i) (a) Fluorine atom being smaller in size, the interelectronic repulsions between the non-bonding electrons present in the 2*p*-orbitals of fluorine atoms are much larger than similar interelectronic repulsion in the 3*p*-orbitals of chlorine atoms.

(b) Cl_2 bleaches coloured material by oxidation :

$Cl_2 + H_2O \longrightarrow 2HCl + [O]$

Coloured material + [O] $\longrightarrow$ Colourless

and hence, bleaching is permanent.

In contrast, SO_2 bleaches coloured material by reduction and hence, bleaching is temporary. When the bleached colourless material is exposed to air, it gets oxidised and the colour is restored.

$SO_2 + 2H_2O \longrightarrow H_2SO_4 + 2[H]$

Coloured material + [H] $\longrightarrow$ Colourless material $\xrightarrow[\text{Oxidation}]{\text{Aerial}}$ Coloured material

(ii) (a) Bond dissociation enthalpy and hence thermal stability of hydrides decreases from H_2O to H_2Te. Therefore, H_2Te releases hydrogen readily. Hence, H_2Te is the strongest reducing agent amongst all the hydrides of group 16.

(b) All the group 16 hydride have angular shape involving sp^3 hybridisation. Due to stronger lone pair-lone pair repulsions than bond pair-bond pair repulsions, the bond angle in water decreases from the tetrahedral value. As we move down the group from O to Te, the size of central atom increases and its electronegativity decreases. As a result the position of the two bond pairs shifts away from the central atom as we move from H_2O to H_2Te. Consequently the repulsions between the bond pairs decreases from H_2O to H_2Te and therefore bond angle decreases. Thus H_2O has the highest bond angle among group 16 hydrides.

(c) As the size of the element increases down the group, the E—H bond dissociation energy decreases and hence E—H bond breaks more easily. Thus H_2O has the highest thermal stability among group 16 hydrides.

☺ ☺ ☺