Class XII Session 2026-27
Subject - Chemistry
Sample Question Paper - 9

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

General Instructions:

Read the following instructions carefully.

1. There are **33** questions in this question paper with internal choice.
2. SECTION A consists of 16 multiple-choice questions carrying 1 mark each.
3. SECTION B consists of 5 very short answer questions carrying 2 marks each.
4. SECTION C consists of 7 short answer questions carrying 3 marks each.
5. SECTION D consists of 2 case-based questions carrying 4 marks each.
6. SECTION E consists of 3 long answer questions carrying 5 marks each.
7. **All questions are compulsory.**
8. **Use of log tables and calculators is not allowed.**

Section A

1. Molecules whose mirror image is non-superimposable over them are known as chiral. Which of the following molecules is chiral in nature? **[1]**

   a) 2-Bromopropane b) 1-Bromobutane

   c) 2-Bromobutane d) 2-Bromopropan-2-ol

2. An α-helix is a structural feature of: **[1]**

   a) Polypeptides b) Nucleotides

   c) Starch d) Sucrose

3. CH_3CONH_2 on reaction with NaOH and Br_2 in alcoholic medium gives: **[1]**

   a) CH_3CH_2Br b) $CH_3CH_2NH_2$

   c) CH_3COONa d) CH_3NH_2

4. Addition of water to alkynes occurs in an acidic medium and in the presence of Hg^{2+} ions as a catalyst. Which of the following products will be formed on addition of water to but-1-yne under these conditions? **[1]**

   a) $$CH_3 - \overset{O}{\overset{\|}{C}} - OH + H - \overset{O}{\overset{\|}{C}} - H$$

   b) $$CH_3 - CH_2 - \overset{O}{\overset{\|}{C}} - OH + CO_2$$

c)
$$CH_3 - CH_2 - CH_2 - \overset{O}{\overset{||}{C}} - H$$

d)
$$CH_3 - CH_2 - \overset{O}{\overset{||}{C}} - CH_3$$

5. The rate of a reaction increases sixteen times when the concentration of the reactant increases four times. The order of the reaction is **[1]**

a) 2.0 b) 1.5

c) 2.5 d) 0.5

6. Match the items of column I with appropriate entries of column II. **[1]**

Column I	Column II
(a) $\frac{\triangle P}{P^o_A}$	(i) $\frac{\triangle T_b}{m}$
(b) K_b	(ii) mol fraction of solute
(c) i	(iii) $\frac{\triangle T_f}{m}$
(d) K_f	(iv) Ratio of observed molar mass to actual molar mass

a) (a) - (iv), (b) - (i), (c) - (ii), (d) - (iii) b) (a) - (ii), (b) - (iv), (c) - (i), (d) - (iii)

c) (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i) d) (a) - (ii), (b) - (i), (c) - (iv), (d) - (iii)

7. To prepare alkanes containing odd number of carbon atoms, Wurtz reaction is not preferred because: **[1]**

a) a mixture of three different alkyl halides has to be used. b) a mixture of two different alkyl halides has to be used.

c) a lot of reaction mixture goes wasted. d) a mixture of four different alkyl halides has to be used.

8. The most stable ion is **[1]**

a) All are equally stable b) Fe^{2+}

c) Cr^{2+} d) Mn^{2+}

9. When 10 g of radioactive isotope is reduced to 1.25 g in 12 years, the half life period of the isotope is **[1]**

a) 4 years b) 16 years

c) 24 years d) 8 years

10. Pentan-2-one and Pentan-3-one can be distinguished by: **[1]**

a) Tollens' test b) Sodium bicarbonate test

c) Fehling's test d) Iodoform test

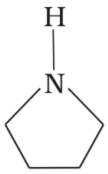
11. Alcoholic compounds react: **[1]**

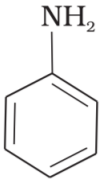
a) both as nucleophiles and electrophiles. b) None of these

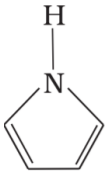
c) only as electrophiles. d) only as nucleophiles.

12. Among the following amines, the strongest Brönsted base is _____. **[1]**

a) NH_3

b) 

c) 

d) 

13. **Assertion (A):** Deoxyribose, $C_5H_{10}O_4$ is not a carbohydrate. **[1]**

Reason (R): Carbohydrates are optically active polyhydroxy aldehyde or polyhydroxy ketone or substances which give aldehyde or ketone on hydrolysis.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

14. **Assertion (A):** Lower aldehydes and ketones are soluble in water but the solubility decreases as the molecular masses increase. **[1]**

Reason (R): Distinction between aldehydes and ketones can be made by Tollen's test.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

15. **Assertion (A):** Addition of HBr to 1 - butene in the presence of peroxide gives 1-bromobutane. **[1]**

Reason (R): It involves the formation of primary radical.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

16. **Assertion (A):** tert-Butoxide is a stronger base than OH^- or $C_2H_5O^-$ but is a much poorer nucleophile. **[1]**

Reason (R): A negatively charged ion is always a more powerful nucleophile than its conjugate acid.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

Section B

17. Calculate the volume of water which could be added to 20 ml of 0.65 m HCl to dilute the solution to 0.2 m? **[2]**

OR

What is expected Van't Hoff factor for $K_4[Fe(CN)_6]$?

18. Write IUPAC name of the complex $[Pt(en)_2Cl_2]$. Draw structures of geometrical isomers for this complex. **[2]**

19. Name the following: **[2]**

i. transition metal which does not exhibit variation in oxidation state in its compounds.

ii. A compound where the transition metal is in the +7 oxidation state.

iii. A member of the lanthanoid series which is well known to exhibit +4 oxidation state.

iv. Ore used in the preparation of potassium dichromate.

20. **Answer the following:** **[2]**

i. The rate of reaction $X \rightarrow Y$ becomes 8 times when the concentration of the reactant X is doubled. Write the rate law of the reaction. **[1]**

ii. What happens to the rate constant k and activation energy E_a as the temperature of a chemical reaction is increased? Justify. **[1]**

21. Write the chemical equation for the following: **[2]**

a. Oxidation of secondary alcohol to ketone by chromic anhydride (CrO_3).

b. Reaction of anisole with a mixture of concentrated sulphuric acid and nitric acid.

c. Reaction of HI with 1-propoxypropane.

Section C

22. Calculate the emf of the following cell: **[3]**

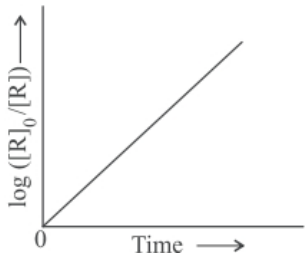
Zn (s) | Zn^{2+} (0·01 M) | | (0·001 M) $^{Ag+}$ | Ag (s)

Given : $E^{\ominus}_{Zn^{2+}/Zn}$ = -0·76 V and

$E^{\ominus}_{Ag^{+}/Ag}$ = +0·80 V

[log 2 = 0·3010, log 3 = 0·4771, log 10 = 1]

23. Observe the graph shown in figure and answer the following questions: **[3]**



a. What is the order of the reaction?

b. What is the slope of the curve?

c. Write the relationship between k and $t_{1/2}$ (half life period)

24. How the following conversions can be carried out? **[3]**

i. Toluene to benzyl alcohol

ii. Benzene to 4-bromonitrobenzene

iii. Benzyl alcohol to 2-phenylethanoic acid

25. What happens when **[3]**

i. Propanone is treated with CH_3MgBr and then hydrolysed?

ii. Ethanal is treated with excess ethanol and acid?

iii. Methanal undergoes Cannizzaro reaction?

26. Give reasons: **[3]**

a. Fuel cells are preferred for production of electrical energy than thermal plants.

b. Iron does not rust even if zinc coating is broken in a galvanized pipe.

c. In the experimental determination of electrolytic conductance, Direct Current (DC) is not used.

27. Haloalkanes react with KCN to form alkyl cyanides as the main product while AgCN forms isocyanides as the chief product. Explain. **[3]**

28. What is the cell potential for the cell at 25^0C [Cr/Cr^{3+}10.1m]//Fe^{2+}(0.01m)/Fe **[3]**

$E^0{}_{cr+/cr} = -0.74V$; E^0Fe^{2+}/Fe = -0.44V.

Section D

29. **Read the following text carefully and answer the questions that follow:** **[4]**

The d-block of the periodic table contains the elements of the groups 3 to 12 and are known as transition elements. In general, the electronic configuration of these elements is (n - 1)d^{1-10} ns^{1-2}. The d-orbitals of the penultimate energy level in their atoms receive electrons giving rise to the three rows of the transition metals i.e. 3d, 4d and 5d series. However, Zn, Cd and Hg are not regarded as transition elements. Transition elements exhibit certain characteristic properties like variable oxidation stables, complex formation, formation of coloured ions, alloys, catalytic activity etc. Transition metals are hard (except Zn, Cd and Hg) and have a high melting point.

i. Why are Zn, Cd and Hg non-transition elements? (1)

ii. Which transition metal of 3d series does not show variable oxidation state? (1)

iii. Why do transition metals and their compounds show catalytic activity? (2)

OR

Why are melting points of transition metals high? (2)

30. The spontaneous flow of the solvent through a semipermeable membrane from a pure solvent to a solution or from a dilute solution to a concentrated solution is called osmosis. The phenomenon of osmosis can be demonstrated by taking two eggs of the same size. In an egg, the membrane below the shell and around the egg material is semipermeable. The outer hard shell can be removed by putting the egg in dilute hydrochloric acid. After removing the hard shell, one egg is placed in distilled water and the other in a saturated salt solution. After some time, the egg placed in distilled water swells-up while the egg placed in salt solution shrinks. The external pressure applied to stop the osmosis is termed as osmotic pressure (a colligative property). **[4]**

Reverse osmosis takes place when the applied external pressure becomes larger than the osmotic pressure.

a. Define reverse osmosis. Name one SPM which can be used in the process of reverse osmosis. **(2)**

b. i. What do you expect to happen when red blood corpuscles (RBC's) are placed in $0.5\% NaCl$ solution? **(1)**

OR

ii. Which one of the following will have higher osmotic pressure in1 M KCl or 1 M urea solution. Justify your answer. **(1)**

c. Why osmotic pressure is a colligative property? **(1)**

Section E

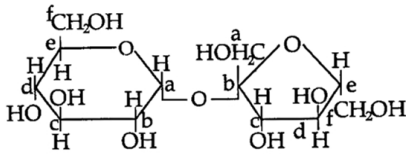
31. **Attempt either A or B** **[5]**

i. **Answer the following questions:** **[1]**

i. What type of substance is phenylanine hydroxylate? Write its importance.

ii. i. What is an anomer?

ii. Structure of a disaccharide formed by glucose and fructose is given below. Identify anomeric carbon atoms in monosaccharide units.



iii. What is the information given by primary structure of proteins?

iv. Write the product obtained when D-glucose reacts with H_2N-OH.

v. Define the following terms:

i. Glycosidic linkage

ii. Native protein

ii. **Answer the following questions:** **[1]**

i. Name the deficiency disease resulting from lack of vitamin A and E in the diet.

ii. Give examples of fat soluble vitamins.

iii. What is anomeric carbon?

iv. Which polymer is stored in the liver of animals?

v. Write the reactions showing the presence of following in the open structure of glucose:

i. an aldehyde group

ii. a primary alcohol

32. **Attempt either A or B** **[5]**

i. **Answer the following questions:** **[1]**

i. Write the IUPAC name of the complex $[Cr(NH_3)_4Cl_2]^+$. What type of isomerism does it exhibit?

ii. Write the IUPAC name of the complex:

$[Co(H_2O)(CN)(en)_2]^{2+}$

iii. Arrange the following complex ions in increasing order of their crystal field splitting energy (Δ_o):

$[Co(NH_3)_6]^{3+}$, $[CoF_6]^{3-}$, $[Co(CN)_6]^{3-}$

iv. Write the electronic configuration of d^5 in terms of t_{2g} and e_g in an octahedral field when:

i. $\Delta_0 > P$ and

ii. $\Delta_0 < P$

v. Write IUPAC name of the complex $[Co(en)_2Cl_2]^+$.

ii. **Answer the following questions:** **[1]**

i. Write the IUPAC name of $[Cu(NH_3)_4]SO_4$.

ii. Write the coordination isomer of $[Cu(NH_3)_4]$ $[PtCI_4]$.

iii. Arrange following complex ions in increasing order of crystal field splitting energy (Δ_O):

$[Cr(Cl)_6]^{3-}$, $[Cr(CN)_6]^{3-}$, $[Cr(NH_3)_6]^{3+}$.

iv. i. Write the IUPAC name of the following complex:
$[Co(NH_3)_4CI(NO_2)]CI$

ii. Write the formula for the following:
Dichloridobis(ethane-1,2-diamine)cobalt(III) chloride

v. In the geometry of a complex compound the molecule is trigonal bipyramidal. What is the hybridization of the central atom?

33. Write short notes on the following: **[5]**

i. Carbylamine reaction

ii. Diazotisation

iii. Hofmann's bromamide reaction

iv. Coupling reaction

v. Ammonolysis

OR

Account for the following:

i. Diazonium salts of aromatic amines are more stable than those of aliphatic amines.

ii. Amines are more basic than alcohols of comparable molecular masses.

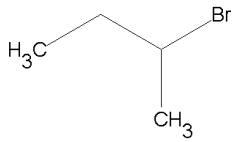
Solution

Section A

1.

(c) 2-Bromobutane

Explanation:



2-Bromobutane

It is a chiral molecule since it does not contain plane symmetry and centre of symmetry.

2. **(a)** Polypeptides

Explanation:

In the secondary structure of Proteins, a polypeptide chain exists in two forms:

i. Alpha helix - stabilized by a hydrogen bond.

ii. Beta pleated sheet.

3.

(d) CH_3NH_2

Explanation:

Product formed is CH_3NH_2

4.

(d) $CH_3 - CH_2 - \overset{\overset{O}{||}}{C} - CH_3$

Explanation:

The product obtain is

$$CH_3CH_2C \equiv CH + H_2O \xrightarrow{H^-, Hg^{2+}} CH_3CH_2\underset{\underset{OH}{|}}{C} = CH_2 \rightleftharpoons CH_3CH_2\underset{\underset{O}{||}}{C} - CH_3$$

5. **(a)** 2.0

Explanation:

2.0

6.

(d) (a) - (ii), (b) - (i), (c) - (iv), (d) - (iii)

Explanation:

(a) - (ii), (b) - (i), (c) - (iv), (d) - (iii)

7.

(b) a mixture of two different alkyl halides has to be used.

Explanation:
Alkyl halides on treatment with sodium metal in dry ethereal (free from moisture) solution give higher alkanes. This reaction is known as the Wurtz reaction and is used for the preparation of higher alkanes containing even a number of carbon atoms. Many side products are formed when two different alkyl halides are used. So this method is not preferred to prepare alkanes having an odd number of C atoms.

8.

(d) Mn^{2+}
Explanation:
For Manganese, +2 is the most stable oxidation state because of d^5 configuration.

9. **(a)** 4 years
Explanation:
Radioactivity follow 1st order kinetics.
$k = \frac{2.303}{t}\log\frac{a}{a-x}$
$k = \frac{2.303}{12}\log\frac{10}{1.25}$
k = 0.1919 log 8
k = $0.1919 \times \log 2^3$
k = $0.1919 \times 3 \times \log 2 = 0.575 \times 0.3010 = 0.173 yr^{-1}$
now,
$t_{1_{/2}} = \frac{0.693}{0.173} = 4.005 yrs \simeq 4 yrs$

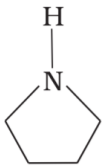
10.

(d) Iodoform test
Explanation:
Iodoform test

11. **(a)** both as nucleophiles and electrophiles.
Explanation:
Alcohols as nucleophile: The bond between O–H is broken when alcohol react as nucleophiles.
Alcohols as electrophile : The bond between C–O is broken when alcohol reacts as electrophiles

12.

(b)



Explanation:
Aniline is a weaker base than NH_3 due to the delocalization of the lone pair of electrons on the N-atom into the benzene ring and less available for protonation. Pyrrole is not at all basic because the lone pair of electrons on N -atom is donated towards aromatic sextet formation. Therefore, pyrrolidine has a strong tendency to accept a proton and hence the strongest base.

13.

(d) A is false but R is true.
Explanation:
Deoxyribose, $C_5H_{10}O_4$ is a carbohydrate and is the sugar moiety of DNA.

14.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation:

The assertion is true that the aldehydes have an oxygen atom that can form a hydrogen bond with the hydrogen atoms of water. So lower aldehydes are soluble in water. But as the chain length increases, the hydrophobic part (the alkyl chain) dominates over the hydrophilic part (the polar -CHO group). So higher molecular weight aldehydes are insoluble in water but lower molecular weight aldehydes are easily soluble in water.

The reason is also correct because aldehydes form a silver mirror with Tollen reagent but ketones do not.

15.

(c) A is true but R is false.

Explanation:

A is true but R is false.

16.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation:

Because of the much bigger size of tert-butoxide ion as compared to $C_2H_5O^-$ and HO^- ion, its attack on a C-atom is sterically much more hindered than on a H-atom.

Section B

17. For dilution -

$M_1V_1 = M_2V_2$

$V_2 = \frac{M_1V_1}{M_2} = \frac{0.65M \times 20\text{ml}}{0.2M} = 65\text{ml}$

Vol of water to be added to 20 ml = $V_2 - V_1$ = 65 ml - 20 ml = 45 ml.

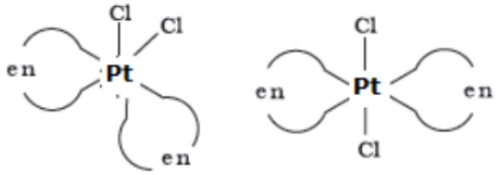
OR

$K_4[Fe(CN)_6] \Leftrightarrow 4K^+ + [Fe(CN)_6]^{4-}$

$\therefore$ Van't Hoff factor (i) = 5, as 5 ions are formed on dissociation.

18. IUPAC name of the complex $[Pt(en)_2Cl_2]$ is Dichloridobis(ethane-1,2-diammine)platinum(IV) ion.

Geometrical isomers:



Cis Trans

19. i. Scandium (Sc)

ii. $KMnO_4$ or any other suitable example.

iii. Cerium (Ce) or any other example.

iv. Chromite ore.

20. Answer the following:

(a) $\frac{dx}{dt} = K[X]^3$

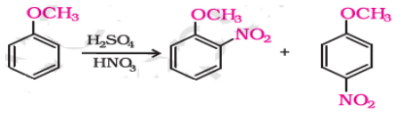
(b) k increases.

Reason: k is proportional to the rate of the reaction/temperature of the reaction.

E_a unchanged/No effect.

Reason: E_a only depends on the nature of reactants/depends on the difference between the energy of activated complex and reactants.

21. a. $R-\underset{\underset{OH}{|}}{CH}-R' \xrightarrow{CrO_3} R-\underset{\underset{O}{||}}{C}-R'$

b. 

c. $CH_3CH_2CH_2OCH_2CH_2CH_3 + HI \rightarrow CH_3CH_2CH_2OH + CH_3CH_2CH_2I$.

Propan-1-ol. 1- Iodopropane

Section C

22. The balanced cell reaction is:

$Zn(s) + 2Ag^+ \longrightarrow Zn^{2+} + 2Ag(s)$

E^o for the cell is 0.80 V (given for $\frac{Ag^+}{Ag}$) and -0.76 V (given for $\frac{Zn^{2+}}{Zn}$).

n the number of moles of electrons transferred, which is 2 in this case.

[A] is the concentration of Zn^{2+}, which is 0.01 M.

[B] is the concentration of Ag^+, which is 0.001 M.

$E = E^\circ - \frac{0.0591}{n}\log\left(\frac{[A]^m}{[B]^n}\right)$

Now, substitute these values into the Nernst equation:

$E = 0.80\ V - \frac{0.0591}{2}\log\left(\frac{0.01}{0.001}\right)$

Calculate the logarithmic term:

$\log\left(\frac{0.01}{0.001}\right) = \log(10) = 1$

Now, substitute this value back into the equation:

$E = 0.80\ V - \frac{0.0591}{2} \cdot 1 = 0.80\ V - 0.02955\ V = 0.77045\ V$

So, the emf of the given cell is approximately 0.770 V.

23. a. First order

b. Slope = $\frac{k}{2.303}$

c. k = $\frac{0.693}{t_{\frac{1}{2}}}$

24. i. Toluene to benzyl alcohol

a. Chlorine, sunlight

b. aq KOH, heat

ii. Benzene to 4-bromonitrobenzene

a. Bromine, ferric bromide,

b. Conc. HNO_3 + conc. H_2SO_4

iii. Benzyl alcohol to 2-phenylethanoic acid

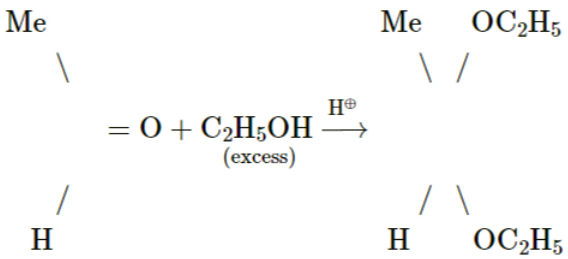
a. Thionyl chloride

b. alc KCN (c) H^+/water

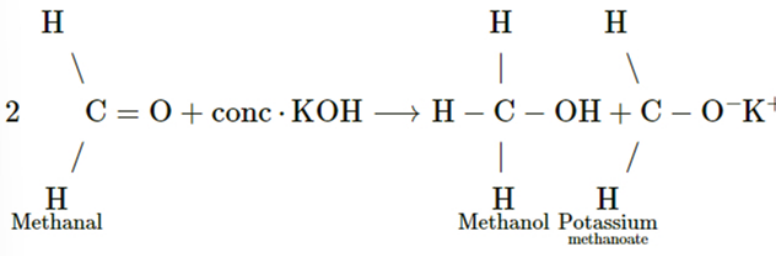
25. i. When propanone is treated with methylmagnesium Bromide and then hydrolysed, tertiary butyl alcohol is formed.

$CH_3 - CO - CH_3 + CH_3MgBr \longrightarrow (CH_3)_3C - OMgBr \xrightarrow{H_3O^+} (CH_3)_3COH$

ii. When ethanal reacts with excess ethanol and acid gives acetal.



iii. Methanal will undergo cannizzaro reaction as it possesses α - hydrogen to form methanol



26. a. Fuel cells are pollution free than thermal plants / Fuel cells have higher efficiency than thermal plants.
    b. Zinc is easily oxidized as compare to iron / E° value of Zn is more -ve than iron
    c. Direct current changes the composition of the solution.
27. KCN form alkyl cyanide as a major products as it is predominantly ionic and provides cyanide ions in solution. Although both carbon and nitrogen atoms of CN are in a position to donate electron pairs, the attack takes place mainly through carbon atom and not through nitrogen atom since C—C bond is more stable than C—N bond. However, AgCN is mainly covalent in nature and nitrogen is free to donate electron pair forming isocyanide as the main product.
28. The cell reaction is

    $2Cr + 3Fe^{2+} 6e^{-} \rightarrow 2Cr^{3+} + 3Fe$

    Nernst Equation-

    $E_{cell} = \left(E^{0}{}_{Fe^{2}} + /_{Fe} - E^{0}{}_{cr^{3+}/cr}\right) - \frac{0.059}{6}\log\frac{[Cr^{3+}]^{2}}{[Fe^{2+}]^{3}}$

    = (-0.44v - (-0.74v) - $\frac{0.059}{6}\log\frac{(0.10)_{2}}{(0.01)^{3}}$

    $= 0.3V - \frac{0.059}{6}\log 10^{4}$

    = 0.3 V - 0.0394 V

    = +0.2606 V

Section D

29. i. It is because neither they nor their ions have incompletely filled d-orbitals.
    ii. Scandium (Sc) and Zinc (Zn).
    iii. It is because they show variable oxidation state, can form intermediate complexes and have large surface area for adsorption of gases.

    OR

    It is due to strong interatomic forces of attraction due to presence of unpaired electrons.
30. a.
    - When external pressure is larger than the osmotic pressure, then the movement of solvent is from solution to solvent side through semi permeable membrane. / The direction of osmosis can be reversed if a pressure larger than the osmotic pressure is applied to the solution side.
    - Cellulose acetate / Or any other suitable example.

    b. i. RBC swells up / Cells swell and may even burst due to endo-osmosis.

    OR

    ii. 1 M KCl,

    $i = 2/KCl$ dissociates into ions, whereas urea does not dissociate.

    c. It depends upon the number of solute particles in the solution.

Section E

31. Attempt either A or B

    (a) Answer the following questions:

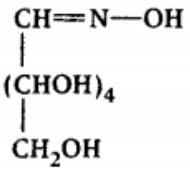
    i. It is an enzyme whose deficiency causes mental redardation.

    ii. i. The isomers which differ only in the configuration of the hydroxyl group at C-1 are called anomers and are referred to as α- and β-forms.

    ii. 'a' carbon of glucose and 'b' carbon of fructose are the anomeric carbon atoms in the monosaccharide units.

iii. Primary structure of proteins tells about the sequence in which various amino acids are linked with each other.

iv. D-glucose on reaction with NH_2OH (hydroxylamine) yield glucose oxime.



v. i. A linkage between two monosaccharide units through oxygen atom.

ii. Protein having a unique three-dimensional structure and biological activity.

(b) Answer the following questions:

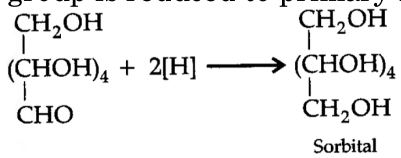
i. Deficiency of A cause Xerophthalmia and E causes muscular weakness.

ii. Fat soluble vitamins are absorbed along with fats in the diet and are stored in body's fatty tissue and in the liver. Vitamin A, D , E and K are fat soluble vitamins.

iii. An anomeric carbon can be identified as the carbonyl carbon (of the aldehyde or ketone functional group) in the open-chain form of the sugar. It can also be identified as the carbon bonded to the ring oxygen and a hydroxyl group in the cyclic form.

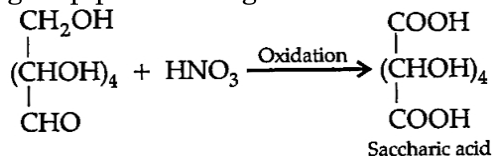
iv. Glycogen is stored in liver of animals. In the liver, glycogen can make up 5-6% of the organ's fresh weight, and the liver of an adult, weighing 1.5 kg, can store roughly 100-120 grams of glycogen.

v. i. **An aldehyde group:** On reduction with sodium amalgam and water, the aldehydic group is reduced to primary alcohol.



Sorbital

ii. **A primary alcohol:** (with nitric acid) On reaction with nitric acid, a primary alcohol group present in glucose is converted into carboxylic acid (-COOH) group.

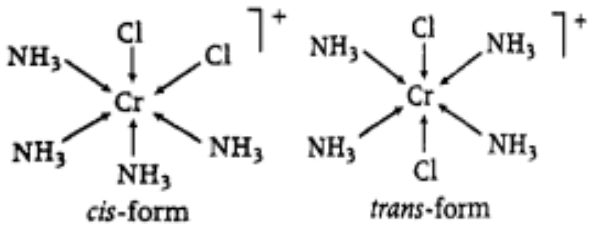


Saccharic acid

32. Attempt either A or B

(a) Answer the following questions:

i. IUPAC name Is tetraamine dichlorido chromium (III) ion.
It shows geometrical isomerism and has two isomers cis and trans that can be represented as:



cis-form *trans*-form

ii. Aquacyanidobis(ethane-1,2-diamine)cobalt(III) ion

iii. $[CoF_6]^{3-} < [Co(NH_3)_6]^{3+} < [Co(CN)_6]^{3-}$

iv. i. $t_{2g}^5\ e_g^0$

ii. $t_{2g}^3 e_g^2$

v. Dichloridobis(ethylenediamine)cobalt(III) ion.

(b) Answer the following questions:

i. Tetraamine copper II sulphate

ii. $[Pt(NH_3)_4][CuCl_4]$

iii. Crystal field splitting energy increases in following complex ion in the order :
$[Cr(Cl)_6]^{3-}$, $[Cr(CN)_6]^{3-}$, $[Cr(NH_3)_6]^{3+}$

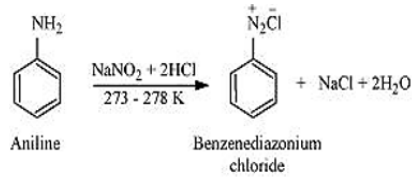
iv. i. Tetraaminechloridonitrito- N-cobalt (III) chloride.
ii. $[CoCl_2(en)_2]Cl$

v. dsp^3 or sp^3d.

33. i. **Carbylamine reaction:** Carbylamine reaction is used as a test for the identification of primary amines. When aliphatic and aromatic primary amines are heated with chloroform and ethanolic potassium hydroxide, carbylamines (or isocyanides) are formed. These carbylamines have very unpleasant odours. Secondary and tertiary amines do not respond to this test. For example,

$$\underset{Methana\,min\,e}{CH_3-NH_2} + CHCl_3 + 3KOH(alc.) \xrightarrow{\Delta} \underset{Methyl\ carbyla\,min\,e}{CH_3-NC} + 3KCl + 3H_2O$$

ii. **Diazotisation:** Aromatic primary amines react with nitrous acid (prepared in situ from $NaNO_2$ and HCl) at 273 - 278 K to form diazonium salts. This conversion of aromatic primary amines into diazonium salts is known as diazotization. For example,

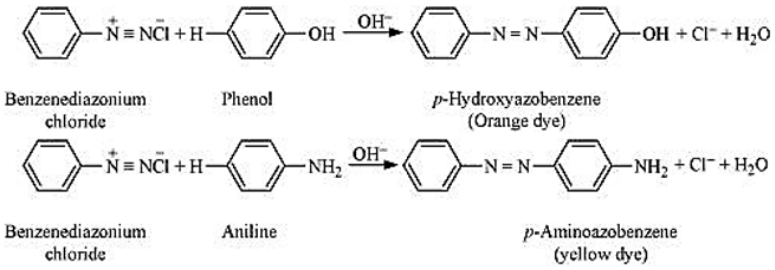


iii. **Hoffmann bromamide reaction:** When an amide is treated with bromine in an aqueous or ethanolic solution of sodium hydroxide, a primary amine with one carbon atom less than the original amide is produced. This degradation reaction is known as Hoffmann bromamide reaction. This reaction involves the migration of an alkyl or aryl group from the carbonyl carbon atom of the amide to the nitrogen atom. For example,

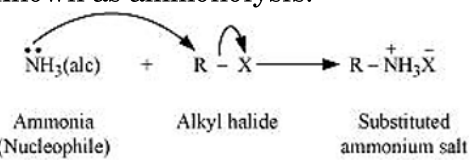
$$\underset{Ethanamide}{CH_3-\overset{O}{\overset{\|}{C}}-NH_2} + Br_2 + 4NaOH \rightarrow \underset{Methana\,min\,e}{CH_3-NH_2} + Na_2CO_3 + 2NaBr + 2H_2O$$

$$\underset{Benzamide}{C_6H_5-\overset{O}{\overset{\|}{C}}-NH_2} + Br_2 + 4NaOH \rightarrow \underset{Aniline}{C_6H_5-NH_2} + Na_2CO_3 + 2NaBr + 2H_2O$$

iv. **Coupling reaction:** The reaction of joining two aromatic rings through the - N = N - bond is known as coupling reaction. Benzene diazonium salt reacts with phenol or aromatic amines to form coloured azo compounds.



v. **Ammonolysis:** When an alkyl or benzyl halide is allowed to react with an ethanolic solution of ammonia, it undergoes nucleophilic substitution reaction in which the halogen atom is replaced by an amino $(-NH_2)$ (-NH_2) group. This process of cleavage of the carbon-halogen bond is known as ammonolysis.



When this substituted ammonium salt is treated with a strong base such as sodium hydroxide, amine is obtained.

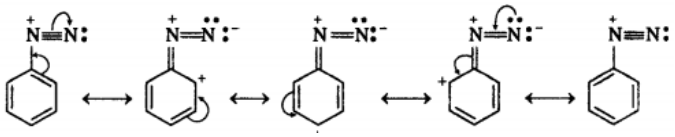
$$R-\overset{+}{N}H_3\overset{-}{X} + NaOH \rightarrow \underset{Amine}{R-NH_2} + H_2O + NaX$$

Though primary amine is produced as the major product, this process produces a mixture of primary, secondary and tertiary amines, and also a quaternary ammonium salt as shown.

$$\underset{(1^\circ)}{RNH_2} \xrightarrow{RX} \underset{(2^\circ)}{R_2NH} \xrightarrow{RX} \underset{(3^\circ)}{R_3N} \xrightarrow{RX} \underset{Quaternary\ ammonium\ salt}{R_4\overset{+}{N}\overset{-}{X}}$$

OR

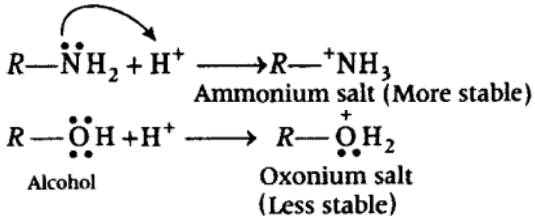
i. The diazonium salts of aromatic amines are more stable than those of aliphatic amines due to dispersal of the positive charge on the benzene ring as shown below.



ii. Amines are more basic than alcohols of comparable masses because

a. N-atom being less electronegative can easily donate its lone pair of electrons to a proton than more electronegative 0-atom which hold electrons more tightly than N. Hence, amines are more basic than alcohols.

b. When an amine accepts a proton, the ammonium salt is formed and when alcohol accepts a proton oxonium salt is formed.



c. Since N being less electronegative can accommodate the positive charge better than the more electronegative O-atom, therefore, ammonium salts are more stable than oxonium salts. As a result, amines are more basic than alcohols.