Chemistry 2019 (Outside Delhi) SET I

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

General Instructions :

(i) **All** questions are compulsory.

(ii) Section A : Questions number **1** to **5** are very short answer questions and carry **1** mark each.

(iii) Section B : Questions number **6** to **12** are short answer questions and carry **2** marks each.

(iv) Section C : Questions number **13** to **24** are also short answer questions and carry **3** marks each.

(v) Section D : Questions number **25** to **27** are long answer questions and carry **5** marks each.

(vi) There is no overall choice. However, an internal choice has been provided in two questions of one mark, two questions of two marks, four questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions

(vii) Use of log tables, if necessary. Use of calculators is **not** allowed.

SECTION-A

1. Out of KCl and AgCl, which one shows Schottky defect and why ?** [1]

OR

Why does ZnO appear yellow on heating ?**

2. Arrange the following in decreasing order of basic character : [1]

$C_6H_5NH_2$, $(CH_3)_3N$, $C_2H_5NH_2$

Answer : Decreasing order of basic character :

$CH_3CH_2NH_2 > (CH_3)_3N > C_6H_5NH_2$

3. What type of colloid is formed when a solid is dispersed in a liquid ? Give an example. [1]

Answer :

Sols are formed when a solid is dispersed in liquid. Example – Paints.

4. Out of Chlorobenzene and Cyclohexyl chloride, which one is more reactive towards nucelophilic substitution reaction and why ? [1]

Answer : Cyclohexyl chloride is more reactive towards nucleophilic substitution reaction, because the carbon bearing the chlorine atom is deficient in electron and seeks a nucleophile. In Chlorobenzene the carbon bearing the halogen is a part of aromatic ring and is electron rich due to the electron density in the ring.

5. What is the basic structural difference between starch and cellulose ? [1]

OR

Write the products obtained after hydrolysis of DNA.

Answer : Starch consists of two components-amylose and amylopectin. Amylose is a long linear chain of α- D -(+)-glucose units joined by C_1-C_4 glycosidic linkage (α-link). Amylopectin is a branched-chain polymer of α-D-glucose units, in which the chain is formed by C_1-C_4 glycosidic linkage and the branching occurs by C_1-C_6 glycosidic linkage. On the other hand, cellulose is a straight-chain polysaccharide of β-D-glucose units joined by C_1-C_4 glycosidic linkage (β-link).

OR

Hydrolysis of DNA yields a pentose sugar (β-D-2deoxyribose), phosphoric acid and nitrogen containing heterocyclic compounds called bases (Adenine, Guanine, Cytosine and Thymine).

SECTION-B

6. Write balanced chemical equations for the following processes :

(a) Cl_2 is passed through slaked lime.

(b) SO_2 gas is passed through an aqueous solution of Fe (III) salt. [2]

OR

(a) Write two poisonous gases prepared from chlorine gas.

(b) Why does Cu^{2+} solution give blue colour on reaction with ammonia ?

Answer : (a) Cl_2 is passed through slaked lime to give bleaching powder $[Ca(OCl)_2]$

$$2Ca(OH)_2 + 2Cl_2 \rightarrow Ca(OCl)_2 + CaCl_2 + 2H_2O$$

(b) When SO_2 gas is passed through an Fe(III) aqueous solution, Fe(III) is reduced to Fe(II) ion :

$$2Fe^{3+} + SO_2 + 2H_2O \rightarrow 2Fe^{2+} + SO_4^{2-} + 4H^+$$

**** Answer is not given due to change in present syllabus.**

OR

(a) Two poisonous gases prepared from chlorine – Phosgene ($COCl_2$) and tear gas (CCl_3NO_2).

(b) Nitrogen in ammonia has a lone pair of electrons, which makes it a Lewis base. It donates the electron pair and forms linkage with metal ions-

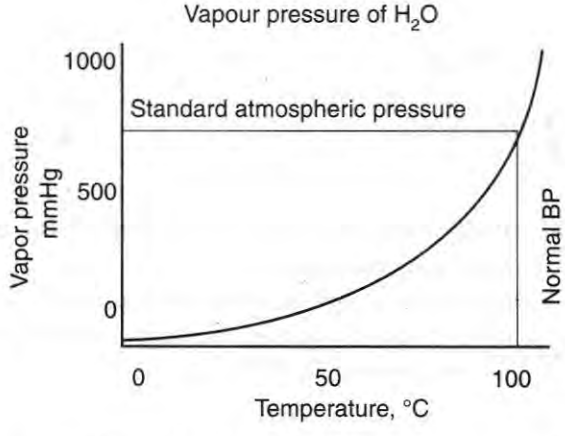
$$Cu^{2+}(aq) + 4NH_3(aq) \rightleftharpoons [Cu(NH_3)_4]^{2+}(aq)$$
(Blue) (Deep blue)

7. Give reasons :

(a) Cooking is faster in pressure cooker than in cooking pan.

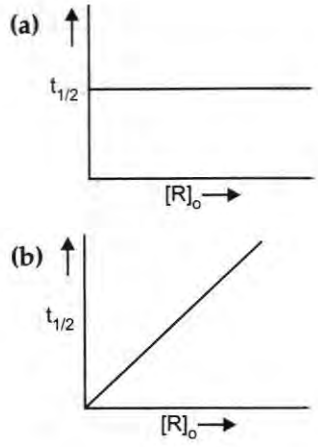
(b) Red Blood Cells (RBC) shrink when placed in saline water but swell in distilled water. **[2]**

Answer : (a) Boiling points increase on increasing the pressure in case of liquids. Water used for cooking attains higher temperature than usual boiling temperature inside the pressure cooker due to the existing high pressure inside the pressure cooker vessel. This leads to faster flow of water inside the vegetables or grains etc. resulting in faster cooking of food in a pressure cooker than in the cooking pan.



(b) Red blood cells shrink when placed in saline water because of exosmosis, *i.e.*, water comes out from the cell to surrounding (more concentrated) to equate the concentration. Whereas, when placed in distilled water concentration within the cell becomes more than the surrounding, hence water comes inside and endosmosis takes place to equate the concentrations.

8. Define order of reaction. Predict the order of reaction in the given graphs :



where $[R]_0$ is the initial concentration of reactant and $t_{1/2}$ is half-life. **[2]**

Answer : It is defined as the sum of powers to which the concentration terms are raised in the rate law equation.

(a) In this graph as $t_{1/2}$ is independent of initial reactant concentration, it is a first order reaction.

(b) In this graph as $t_{1/2}$ is directly proportional to initial concentration of reactant hence, it is a zero order reaction.

9. When $FeCr_2O_4$ is fused with Na_2CO_3 in the presence of air it gives a yellow solution of compound (A). Compound (A) on acidification gives compound (B). Compound (B) on reaction with KCl forms an orange coloured compound (C). An acidified solution of compound (C) oxidises Na_2SO_3 to (D). Identify (A), (B), (C) and (D). **[2]**

Answer :

$$4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$$
Sodium chromate (yellow) A

$$Na_2Cr_2O_4 + H^+ \rightarrow Na_2Cr_2O_7 + 2Na^+ + H_2O$$
Sodium dichromate (B)

$$Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$$
Potassium dichromate (C)

$$K_2Cr_2O_7 + 3Na_2SO_3 + 4H_2SO_4 \rightarrow Cr_2(SO_4) + 3Na_2SO_4 + K_2SO_4 + 4H_2O$$
Chromium sulphate (D)

10. Write IUPAC name of the complex $[Co(en)_2(NO_2)Cl]^+$. What type of structural isomerism is

shown by this complex ? [2]

OR

Using IUPAC norms, write the formulae for the following complexes :

(a) Hexaaquachromium (III) chloride

(b) Sodium trioxalatoferrate (III)

Answer : IUPAC name of $[Co(en)_2(NO_2)Cl]^+$ is Chlorobis(ethane-1,2-diamine)nitrocobalt(III).

This compound shows geometrical isomerism.

OR

(a) Hexaaquachromium(III) chloride–

$[Cr(H_2O)_6]Cl_3$

(b) Sodium trioxalatoferrate(III) –

$Na_3[Fe(C_2O_4)_3]$

11. (a) Although both $[NiCl_4]^{2-}$ and $[Ni(CO)_4]$ have sp^3 hybridisation yet $[NiCl_4]^{2-}$ is paramagnetic and $[Ni(CO)_4]$ is diamagnetic. Give reason. (Atomic no. of Ni = 28).

(b) Write the electronic configuration of d^5 on the basis of crystal field theory when

(i) $\Delta_0 < P$ and

(ii) $\Delta_0 > P$ [2]

Answer : (a) $[NiCl_4]^{2-}$ is a high spin complex and there are two unpaired electrons with $3d^8$ electronic configuration of central metal atom, hence it is paramagnetic. Whereas in $[Ni(CO)_4]$ Ni is in zero oxidation state and contains no unpaired electrons, hence it is diamagnetic in nature.

(b) (i) Electronic configuration of d^5 when $\Delta_0 < P$ is given as $t_{2g}^3 e_g^2$

(ii) Electronic configuration of d^5 when $\Delta_0 > P$ is given as $t_{2g}^5 e_g^0$

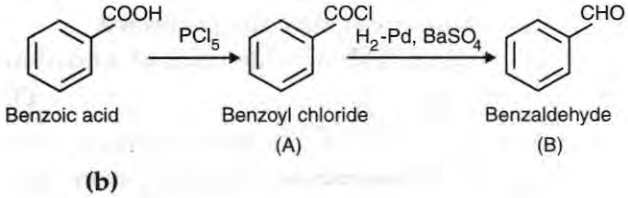
12. Write structures of main compounds A and B in each of the following reactions : [2]

(a) $C_6H_5COOH \xrightarrow{PCl_5} A \xrightarrow{H_2\text{-Pd-BaSO}_4} B$

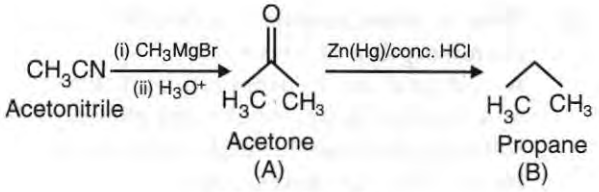
(b) $CH_3CN \xrightarrow[(ii)\ H_3O^+]{(i)\ CH_3MgBr} A \xrightarrow{Zn(Hg)/conc.\ HCl} B$

Answer :

(a)



(b)



SECTION–C

13. The following data were obtained for the reaction :

$A + 2B \rightarrow C$

Experiment	[A]/M	[B]/M	Initial rate of formation of C/M min^{-1}
1	0·2	0·3	$4·2 \times 10^{-2}$
2	0·1	0·1	$6·0 \times 10^{-3}$
3	0·4	0·3	$1·68 \times 10^{-1}$
4	0·1	0·4	$2·40 \times 10^{-2}$

(a) Find the order of reaction with respect to A and B.

(b) Write the rate law and overall order of reaction.

(c) Calculate the rate constant (k). [3]

Answer : The reaction is-

$$A + 2B \rightarrow C$$

(a) It can be seen that when concentration of A is doubled keeping B constant, then the rate increases by a factor of 4 (from 4.2×10^{-2} to 1.68×10^{-1}). This indicates that the rate depends on the square of the concentration of the reactant A. Also, when concentration of reactant B is made four times, keeping the concentration of reactant A constant, the reaction rate also becomes 4 times (2.4×10^{-2} to 6.0×10^{-3}). This indicates that the rate depends on concentration of reactant B to the first power.

(b) So, the rate equation will be :

$$Rate = k[A]^2[B]$$

Overall order of reaction will be 2+1 = 3.

(c) Rate constant can be calculated by putting the values given.

$$4.2 \times 10^{-2}\ M\ min^{-1} = k\ (0.2)^2(0.3)\ M$$

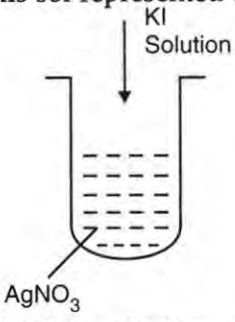
$$k = \frac{0.042}{0.012}$$

$$= 3.5\ min^{-1}$$

14. (a) Write the dispersed phase and dispersion medium of dust.

(b) Why is physisorption reversible whereas chemisorption is irreversible ?

(c) A colloidal sol is prepared by the method given in the figure. What is the charge of AgI colloidal particles formed in the test tube ? How is this sol represented ? **[3]**



Answer : (a) In dust the dispersed phase is solid particles and dispersion medium is air (gas).

(b) Physisorption occurs only because of physical attractive forces, like van der Waals forces between molecules of adsorbate and adsorbent, hence that can be reversed on application of bigger forces but chemisorption occurs due to chemical reaction between molecules of adsorbate and adsorbent, and hence can't be reversed.

(c) When KI solution is added to $AgNO_3$ a positively charged sol results due to absorption of Ag^+ ions from dispersion medium–AgI/Ag^+(positively charged)

15. An element X with an atomic mass of 81 u has density 10·2 g cm^{-3} . If the volume of unit cell is 2·7 × 10^{-23} cm^3, identify the type of cubic unit cell. (Given : N_A = 6·022 × 10^{23} mol^{-1})** **[3]**

16. A solution containing 1·9 g per 100 mL of KCl (M = 74·5 g mol^{-1}) is isotonic with a solution containing 3 g per 100 mL of urea (M = 60 g mol^{-1}). Calculate the degree of dissociation of KCl solution. Assume that both the solutions have same temperature. **[3]**

Answer : Two solutions having same osmotic pressure at a given temperature are called isotonic solution. Now in the given problem, the KCl and urea solutions are given to be isotonic.

Osmotic pressure π is given by the equation – $\pi = (n_2/V)RT$, where, n_2= moles of solute, V = volume of a solution in litre.

Also, $n_2 = w_2/M_2$, where w_2 = grams of solute and M_2 = molar mass of solute.

The other given information are–

Molar mass of KCl = 74.5 g mol^{-1}

Weight of KCl, w_2 = 1.9 g, V = 100 mL

So, for KCl–

$$\pi = (w_2/M_2 \times V)RT$$

$$\pi RT_{KCl} = 1.9/(74.5 \times 100)$$

$$= 2.55 \times 10^{-4}$$

Now as the solutions are isotonic at same temperature :

$$\pi RT_{KCl} = \pi RT_{Urea}$$

Hence, substituting the values for urea :

$$2.55 \times 10^{-4} = 3/M_2 \times 100$$

$$M_2 = 117.6$$

So, the experimentally determined molecular weight of urea is found to be as 117.6, so the degree of dissociation can be given as :

Osmotic pressure (π) =

$$\frac{\text{Experimentally determined molecular weight}}{\text{Actual molecular weight}}$$

$$= 117.6 / 60$$

$$= 1.96 \approx 2$$

$$\alpha = \frac{i-1}{n-1} = \frac{1.96-1}{2-1} = 96\%$$

So, Urea diamerised in the given experimental solution.

17. Write the name and principle of the method used for refining of (a) Zinc, (b) Germanium, (c) Titanium. **[3]**

Answer : (a) Distillation is used for refining zinc. As zinc is a low boiling metal, the impure metal is evaporated and the pure metal is obtained as a distillate.

(b) Zone refining is used for refining Germanium. This method is based on principle that the impurities are more soluble in the melt than in the solid state of the metal.

(c) Titanium is refined by van Arkel method. This method is used for removal of oxygen and nitrogen present as impurity. The crude metal is heated in an evacuated vessel with iodine to obtain metal iodide, which volatilizes being covalent. Later this metal iodide is decomposed through electrical heating to obtain the pure metal.

18. Give reasons for the following :

(a) Transition metals form complex compounds.

(b) E° values of (Zn^{2+}/Zn) and (Mn^{2+}/Mn) are more negative than expected.

(c) Actinoids show wide range of oxidation states. **[3]**

Answer : (a) Transition elements have partly filled d-orbitals due to which they have variable oxidation states which enables them to

**** Answer is not given due to change in present syllabus.**

bind with a variety of ligands and hence form complex compounds.

(b) Oxidation of Zn to Zn^{2+} leads to a completely filled d^{10} configuration in Zn^{2+}, making it more stable. Also, Mn/Mn^{2+} conversion leads to a half filled stable d^5 configuration of Mn^{2+} ion. Hence, E° value for $Zn/Zn^2$and Mn/Mn^{2+}conversion have negative values.

(c) Actinoids show wide range of oxidation states due to their partially filled *f*-orbitals and they have comparable energies as well.

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

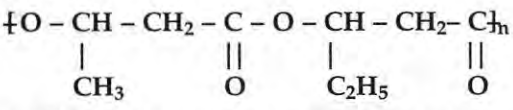
(a) Nylon-6 **(b) Terylene**

(c) Buna-N **[3]**

OR

(a) Is $+CH_2–CH(C_6H_5)+_n$ homopolymer or copolymer ? Give reason.

(b) Write the monomers of the following polymer :

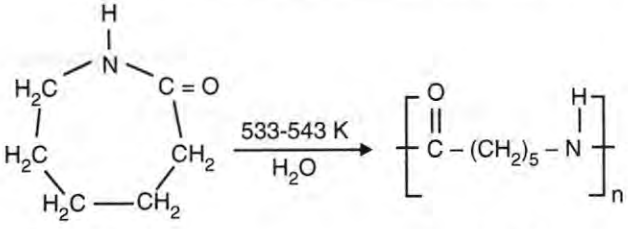


(c) Write the role of benzoyl peroxide in polymerisation of ethene.

Answer :

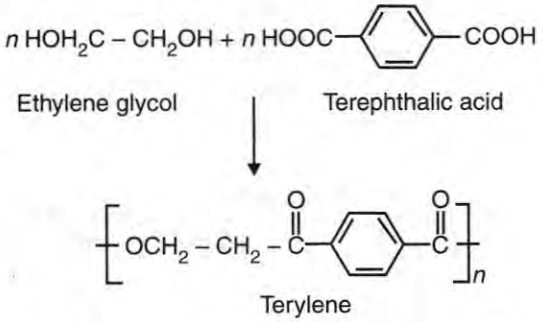
Structures of monomers—

(a) Caprolactum is monomer of Nylon-6



Caprolactum Nylon 6

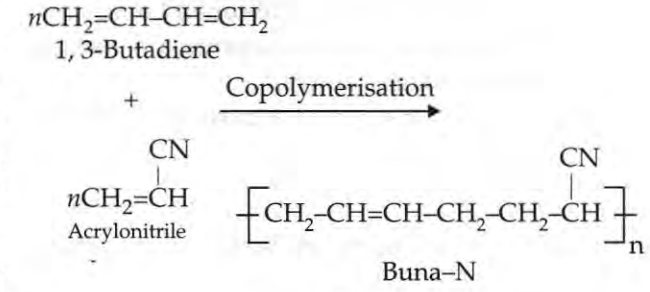
(b) Ethylene glycol and terephthalic acid polymerise to give Terylene –



Ethylene glycol Terephthalic acid

Terylene

(c) 1,3-Butadiene and Acrylonitrile polymerise to give Buna-N—

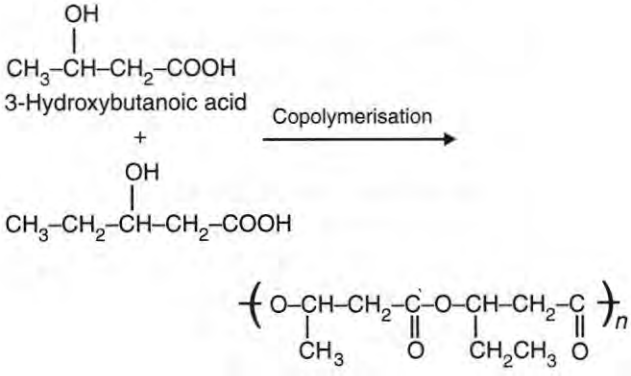


Buna–N

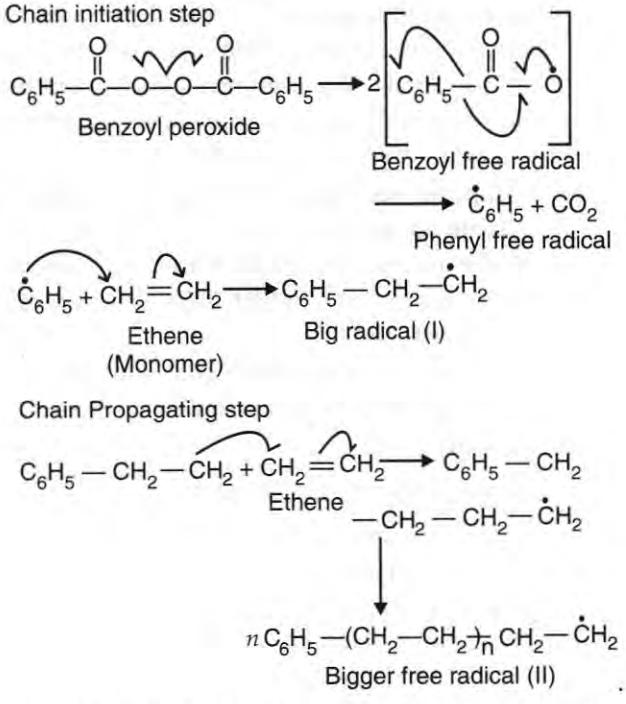
OR

(a) $+CH_2-CH(C_6H_5)+$ is a homopolymer as it is formed by addition polymerization of monomer $CH_2 = CHC_6H_5$(Styrene).

(b) The monomers are 3-Hydroxybutanoic acid and 3-Hydroxypentanoic acid—



(c) Benzoyl peroxide acts as free radical initiator in polymerization of ethene.



20. (a) Pick out the odd one from the following

on the basis of their medicinal properties : Equanil, Seconal, Bithional, Luminal

(b) What types of detergents are used in diswashing liquids ?

(c) Why is the use of aspartame limited to cold foods ? **[3]**

OR

Define the following terms with suitable example of each :

(a) Antibiotics

(b) Antiseptics

(c) Anionic detergents

Answer : (a) 'Bithionol' is the odd one here, as it is an antiseptic whereas others are tranquilizers.

(b) Liquid dishwashing detergents are non-ionic type.

(c) Aspartame is an artificial sweetener which is unstable at cooking temperature hence its use is limited to cold foods.

OR

(a) Antibiotics –These are the compounds (produced by microorganisms or synthetically) which either inhibit the growth of bacteria or kill bacteria. Example : Penicillin.

(b) Antiseptics – These are the chemicals used to kill or prevent the growth of microorganisms when applied to the living tissues. Example – Soframicin.

(c) Anionic detergents – These are sodium salts of sulphonated long chain alcohols or hydrocarbons. In these the anionic part of the molecule is involved in the cleansing action. Example – Sodium lauryl sulphate.

21. Among all the isomers of molecular formula C_4H_8Br, identify :

(a) the one isomer which is optically active.

(b) the one isomer which is highly reactive towards S_N2.

(c) the two isomers which give same product on dehydrohalgenation with alcoholic KOH. **[3]**

Answer : The possible isomers are :

1. $H_3C-CH_2-CH_2-CH_2-Br$

1-Bromobutane

2. $H_3C-CH_2-\underset{\displaystyle Br}{\underset{|}{CH}}-CH_3$

2-Bromobutane

3. $H_3C-CH(CH_3)-CH_2Br$

1-Bromobutane-2-methylpropane

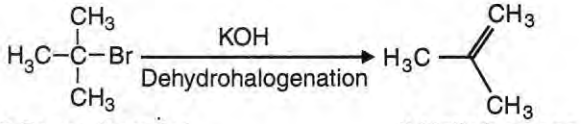
4. $H_3C-\underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{C}}}}-Br$

2-Bromo-2-methylpropane

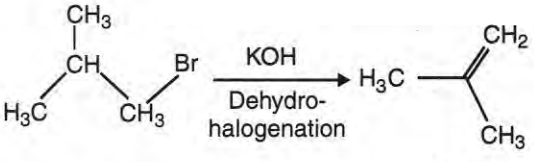
(a) 2- Bromobutane is optically active as C-2 is a chiral carbon here having all the four different groups attached to it.

(b) 1-Bromobutane being primary alkyl halide is highly reactive towards S_N2 reaction.

(c) 2- Bromo-2-methylpropane and 1-Bromo-2-methylpropane would give same product after dehydrohalogenation.



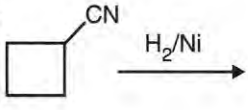
2-Bromo-2-methyl propane — 2-Methylpropene



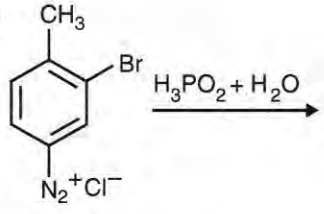
2-Methylpropene

22. Complete the following reactions : **[3]**

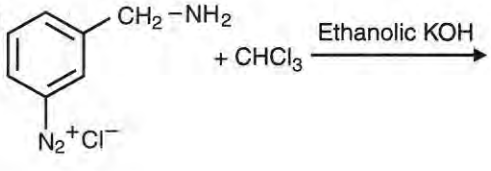
(a)



(b)



(c)



OR

How do you convert the following :

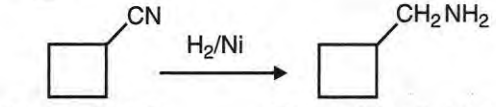
(a) N-phenylethanamide to *p*-bromaniline

(b) Benzene diazonium chloride to nitrobenzene

(c) Benzoic acid to aniline

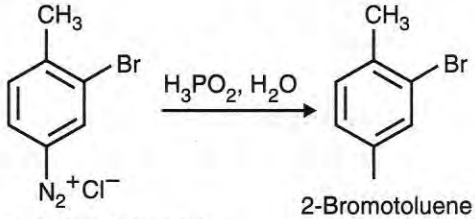
Answer :

(a)



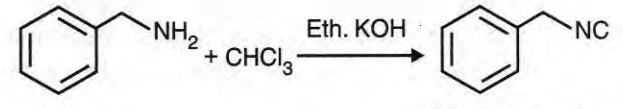
Cyclobutylnitrile Cyclobutylmethylamine

(b)



2-Bromo-4-methylbenzene diazonium chloride 2-Bromotoluene

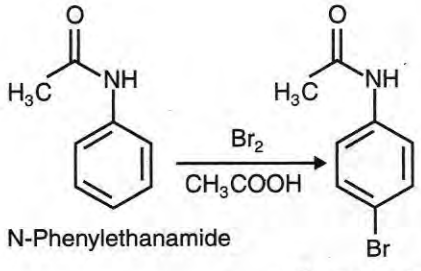
(c)



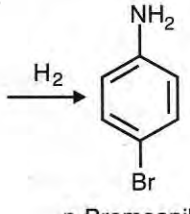
Ethyl amine Benzyl isocyanide

OR

(a)

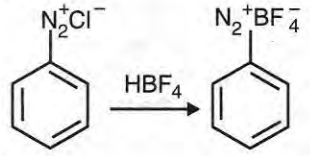


N-Phenylethanamide p-Bromoacetanilide

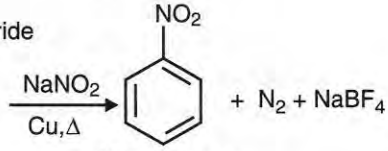


p-Bromoaniline

(b)

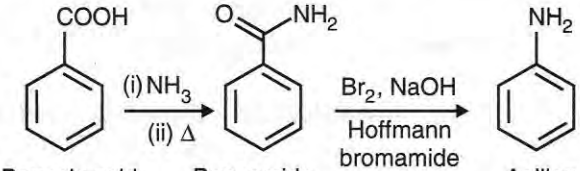


Benzene diazonium chloride



Nitrobenzene

(c)



Benzoic acid Benzamide Aniline

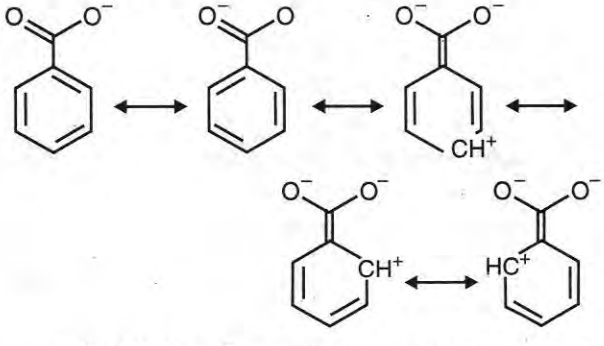
23. (a) Give reasons :

(i) Benzoic acid is a stronger acid than acetic acid.

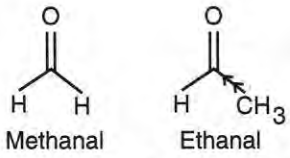
(ii) Methanal is more reactive towards nucleophilic addition reaction than ethanal.

(b) Give a simple chemical test to distinguish between propanal and propanone. [3]

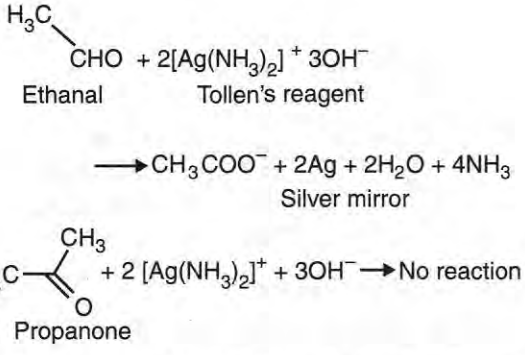
Answer : (a) (i) Benzoic acid is a stronger acid than acetic acid because the benzoate anion (conjugate base of benzoic acid) formed after loss of H^+ is stabilized by resonance, whereas acetate ion (CH_3COO^-) has no such extra stability. Hence, Benzoic acid has more tendency of losing proton compared to acetic acid hence more acidic.



(ii) Methanal is more reactive towards nucleophilic addition reaction than ethanal because in ethanal there is a methyl group attached to the carbonyl carbon (centre for nucleophile attack) and +I effect of the methyl group decreases the nucleophilicity of carbonyl carbon by increasing the electron density at carbonyl carbon.



(b) Propanal and propanone can be distinguished using Tollen's reagent by silver mirror test. Propanal being an aldehyde reacts with Tollen's reagent to give silver deposition whereas propanone being a ketone does not give the reaction.

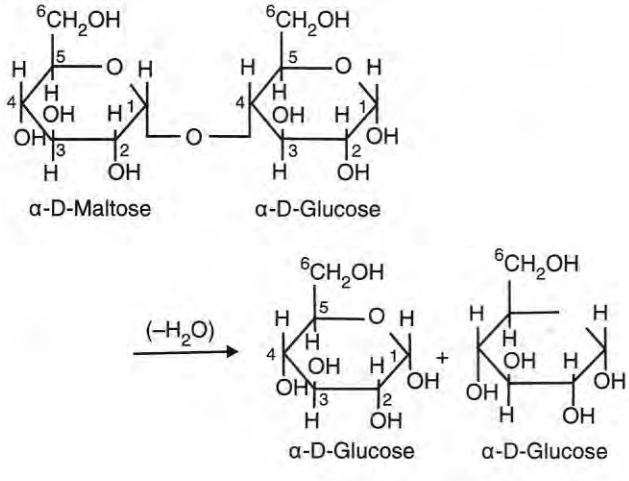


24. (a) What are product of hydrolysis of maltose ?
(b) What type of bonding provides stability to α-helix structure of protein ?
(c) Name the vitamin whose deficiency causes pernicious anaemia. **[3]**

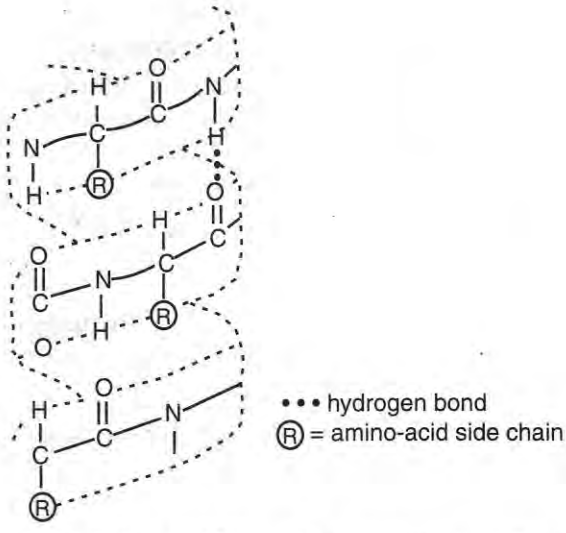
OR

Define the following terms :
(a) Invert sugar
(b) Native protein
(c) Nucleotide

Answer : (a) On hydrolysis maltose gives two molecules of α-D-glucose.



(b) α-Helix structure of proteins is stabilized by hydrogen bonds between –NH group of each amino acid and –COOH group of amino acid at adjacent turn.



(c) Deficiency of Vitamin B_{12} causes pernicious anaemia.

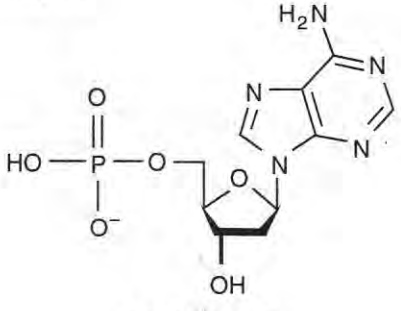
OR

(a) Invert sugar – It is a mixture of glucose and fructose obtained after hydrolysis of sucrose. Sucrose is dextrorotatory, but after hydrolysis gives a mixture of dextrorotatory glucose and levorotatory fructose which outweighs in magnitude and hence the whole mixture becomes levorotatory hence the mixture obtained is called invert sugar.

(b) Native protein – Protein found in a biological system with a unique three-dimensional structure and biological activity is called a native protein.

(c) Nucleotide –They are building blocks of DNA/RNA. These consist of a pentose sugar moiety attached to a nitrogenous base at 1′ position and a phosphoric acid molecule at 5′ position.

Example :



SECTION-D

25. (a) The conductivity of 0·001 mol L^{-1} acetic acid is $4·95 \times 10^{-5}$ S cm^{-1}. Calculate the dissociation constant if Λ_m^0 for acetic acid is 390·5 S cm^2 mol^{-1}.
(b) Write Nernst equation for the reaction at 25°C :

2 Al (s) + 3 Cu^{2+} (aq)→2 Al^{3+} (aq) + 3 Cu (s)

(c) What are secondary batteries ? Give an example. [5]

OR

(a) Represent the cell in which the following reaction takes place :

2Al (s) + 3 Ni^{2+} (0·1M) → 2Al^{3+} (0·01 M) + 3 Ni (s)

Calculate its emf if E^0_{cell} = 1·41 V.

(b) How does molar conductivity vary with increase in concentration for strong electrolyte and weak electrolyte ? How can you obtain limiting molar conductivity (Λ^0_m) for weak electrolyte ?

Answer : (a) Conductivity Λ_m of solution is given by the following equation :

$\Lambda_m = \frac{k}{c}$, where k is dissociation constant and c is the concentration of solution.

Here, given.

Conductivity, $k = 4.95 \times 10^{-5}$ S cm^{-1}

Limiting molar conductivity,

$\Lambda^0_m = 390.5$ S cm^2 mol^{-1}

Concentration,

$$c = 0.001 \text{ mol } L^{-1}$$
$$= 1 \times 10^{-3} \text{ mol } L^{-1}$$

Substituting the given values in above equation

Molar conductivity,

$$\Lambda_m = \left(\frac{49.5 \times 10^{-5} \text{ S cm}^{-1}}{1 \times 10^{-3} \text{ mol L}^{-1}}\right) 10^3 \text{cm}^3 \text{L}^{-1}$$
$$= 49.5 \text{ S cm}^2 \text{ mol}^{-1}$$

Now, degree of dissociation α, is given by

$$\alpha = \frac{\Lambda_m}{\Lambda^\circ_m}$$

Putting the values,

$$\alpha = \frac{49.5}{390.5} \text{ S cm}^2 \text{ mol}^{-1}$$
$$= 0.1267$$

Dissociation constant, k, for acetic acid, can be given as

$$k = \frac{c\alpha^2}{(1-\alpha)}$$
$$= \frac{[1 \times 10^{-3} \text{mol L}^{-1} \times (0.1267)^2]}{(1 - 0.1267)}$$
$$= \frac{0.016 \times 10^{-3} \text{mol L}^{-1}}{0.8733}$$
$$= 1.8 \times 10^{-5} \text{ mol L}^{-1}$$

(b) Nernst equation for the given reaction can be written as

$$E_{cell} = \frac{E^\circ_{cell} - RT}{2F \ln\left(\frac{[Al_3^+]^2}{[Cu^{2+}]^3}\right)}$$

(c) A secondary battery can be recharged after use, by passing current through it in opposite direction so that it can be used again. Example :

The most important secondary cell is lead storage cell. It consists of lead anode and a grid of lead packed with lead dioxide as cathode. A 38% solution of sulphuric acid is used as an electrolyte.

OR

(a) The cell can be represented as

$Al | Al^{3+}(0.01 \text{ M}) || Ni^{2+}(0.1) | Ni$

Cell potential is given by the following equation in this case

$$E_{cell} = \frac{E^\circ_{cell} - RT}{2F \ln\left(\frac{[Al^{3+}]^2}{[Ni^{2+}]^3}\right)}$$

Given

E°_{cell} = 1.41 V, concentration of Al^{3+} ions is 0.01M and Ni^{2+} ions is 0.1 M

Putting the values in equation

$$E_{cell} = \frac{1.41 \text{ V} - 0.059}{2 \log\left(\frac{0.01^2}{0.1^3}\right)}$$

$$= 1.38 \text{ V} \log\left(\frac{1 \times 10^{-4}}{1 \times 10^{-3}}\right)$$
$$= 1.38 - (-1)$$
$$= 2.38 \text{ V}$$

So, emf of the cell is 2.38 V.

(b) For strong electrolytes the molar conductivity is increased only slightly on dilution. A strong electrolyte is completely dissociated in solution and thus, furnishes all ions for conductance. However, at higher concentrations, the dissociated ions are close to each other and thus, the interionic attractions are greater. These forces retard the motion of the ions and thus, conductivity is low. With decrease in concentration (dilution), the ions move away from each other thereby feeling less attractive forces from the counter ions. This results in an increase in molar conductivity with dilution. The molar conductivity approaches a maximum limiting value at infinite dilution designated as $\Lambda_m^{0.}$

In case of weak electrolytes as the solution of a weak electrolyte is diluted, its ionization is increased. This results in more number of ions in solution and thus, there is an increase in molar conductivity, also there is a large increase in the value of molar conductivity with dilution, especially near infinite dilution. However, the conductance of a weak electrolyte never approaches a limiting value. Or in other words it is not possible to find conductance at infinite dilution (zero concentration).

So, limiting molar conductivity for weak electrolytes is obtained by using Kohlrausch law, from the limiting molar conductivities of individual ions ($\lambda°$).

Kohlrausch law of independent migration of ions states that limiting molar conductivity of an electrolyte can be represented as the sum of the individual contributions of the anion and the cation of the electrolyte.

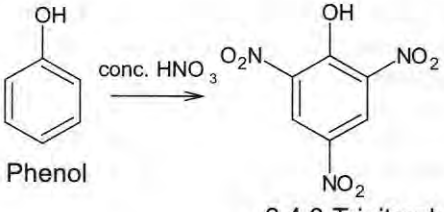
$$\Lambda°_m = \lambda°_+ + \lambda°$$

26. (a) Give equation of the following reactions :
(i) Phenol is treated with conc. HNO_3.
(ii) Propene is treated with B_2H_6 followed by H_2O_2/OH^-.
(iii) Sodium t-butoxide is treated with CH_3Cl.
(b) How will you distinguish between butan–1–ol and butan–2–ol ?
(c) Arrange the following in increasing order of acidity :
Phenol, ethanol, water **[5]**

OR

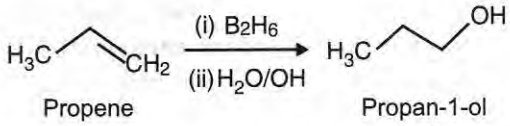
(a) How can your obtain Phenol from (i) Cumene, (ii) Benzene sulphonic acid, (iii) Benzene diazonium chloride ?
(b) Write the structure of the major product obtained from dinitration of 3-methylphenol.
(c) Write the reaction involved in Kolbe's reaction.

Answer : (a) (i) Phenol is treated with conc. HNO_3 to obtain 2,4,6-trinitrophenol picric acid.



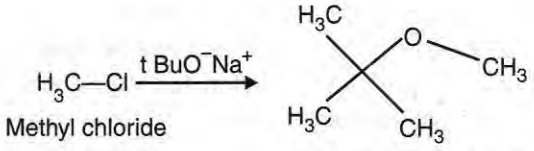
Phenol 2,4,6-Trinitrophenol

(ii) Propene undergoes hydroboration-oxidation when treated with B_2H_6 followed by hydrogen peroxide in basic medium to give propan-1-ol.



Propene Propan-1-ol

(iii) Methyl tert-butyl ether is produced when sodium tert-butoxide is treated with methyl chloride.



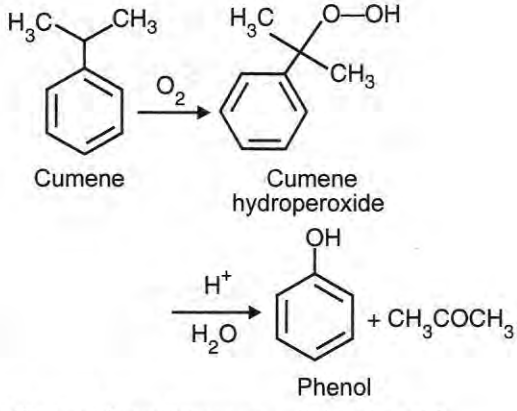
Methyl chloride Methyl tert-butyl ether

(b) Butan-1-ol and Butan-2-ol can be distinguished using Lucas reagent ($ZnCl_2$+HCl), where butan-2-ol would react with Lucas reagent in around 5 minutes to give a white precipitate of 2-chlorobutane, whereas butan-1-ol won't give any reaction at room temperature.

(c) Increasing order of acidity can be given as
Ethanol < water < phenol

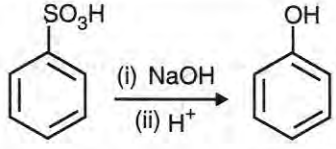
OR

(a) (i) Phenol from cumene



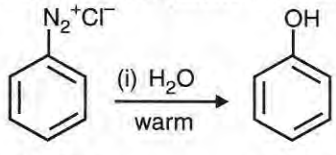
Cumene Cumene hydroperoxide Phenol

(ii) Phenol from benzene sulphonic acid



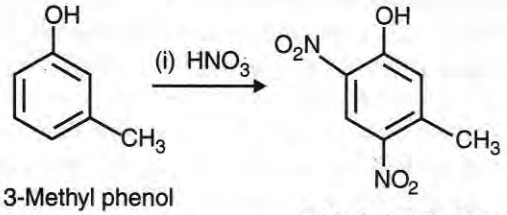
Benzene sulphonic acid Phenol

(iii) Phenol from benzene diazonium chloride



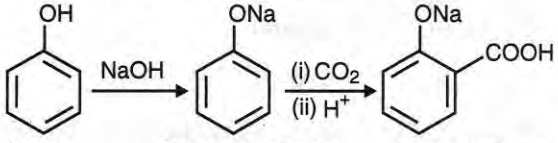
Benzene diazonium chloride Phenol

(b) The combined influence of –OH and $-CH_3$ groups determine the position of the entering groups, also the sterically hindered positions are not substituted.



3-Methyl phenol 3-Methyl-4, 6 dinitrophenol

(c) In Kolbe's reaction phenol is reacted with CO_2 in presence of sodium hydroxide, followed by acidification, to give a carboxylic acid group on 2-position of phenol-



Phenol Sodium phenoxide 2-Hydroxybenzoic acid (Salicylic acid)

27. (a) Account for the following :

(i) Tendency to show – 3 oxidation state decreases from N to Bi in group 15.**

(ii) Acidic character increases from H_2O to H_2Te.

(iii) F_2 is more reactive than ClF_3, whereas ClF_3 is more reactive than Cl_2.

(b) Draw the structure of (i) XeF_2, (ii) $H_4P_2O_7$. **[5]**

OR

(a) Give one example to show the anomalous reaction of fluorine.

(b) What is the structural difference between white phosphorous and red phosphorous ?**

(c) What happens when XeF_6 reacts with NaF ?

(d) Why is H_2S a better reducing agent than H_2O ?

(e) Arrange the following acids in the increasing order of their acidic character :

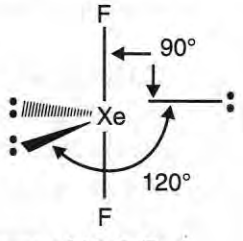
HF, HCl, HBr and HI

Answer : (a) (ii) Acidic character increases from H_2O to H_2Te due to decrease in E—H bond dissociation enthalpy down the group. Thus it becomes easy to lose proton going down the group.

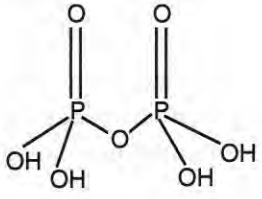
(iii) F_2 is more reactive than ClF_3 because of small size of fluorine atom F—F bond, bond dissociation enthalpy is low (thus is reactive).

Whereas ClF_3 is more reactive than Cl_2 because ClF_3 is an interhalogen compound with weak Cl—F bond (compared to Cl—Cl bond) due to difference in atomic sizes (hence ineffective overlap of orbitals).

(b) (i) Structure of XeF_2 is linear.



(ii) Structure of $H_4P_2O_7$:



OR

(a) Fluorine reacts with cold sodium hydroxide solution to give OF_2.

$2F_2\,(g) + 2NaOH\,(aq) \rightarrow 2NaF\,(aq) + OF_2\,(g) + H_2O\,(l)$

(c) XeF_6 reacts with NaF as follows :

$XeF_6 + NaF \rightarrow Na^+[XeF_7]^-$

(d) Ability to reduce is judged by ease with which an atom can donate its electrons to the species which is getting reduced. Now, the size of oxygen atom in H_2O is smaller than that of Sulphur atom in H_2S, due to which the lone pair of electrons on oxygen are more attracted by the oxygen nucleus, making it difficult to donate the electrons (by oxygen compared to Sulphur, while in H_2S the influence of nucleus is less on lone pair of electrons of sulphur and hence, it can give away its electrons, easily compared to oxygen, and thus acts as a better reducing agent.

(e) The increasing order of acidic character can be written as

$HF < HCl < HBr < HI$

●●

**** Answer is not given due to change in present syllabus.**

Chemistry 2019 (Outside Delhi) SET II

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

Note : Except for the following questions all the remaining questions have been asked in the previous set.

SECTION-A

2. Arrange the following in increasing order of pK_b values :
$C_6H_5CH_2NH_2$, $C_6H_5NHCH_3$, $C_6H_6NH_2$ [1]
Answer : These can be arranged in increasing order of pK_b values as follows :
$C_6H_5CH_2NH_2 < C_6H_5NHCH_3\ C_6H_5NH_2$

3. What type of colloid is formed when a liquid is dispersed in a solid ? Give an example. [1]
Answer : When a liquid is dispersed in a solid, a 'gel' is formed. Example : Butter.

4. Out of chlorobenzene and *p*-nitrochlorobenzene, which one is more reactive towards nucleophilic substitution reaction and why ? [1]
Answer : *p*-Nitro chlorobenzene would be more reactive towards nucleophilic substitution reaction compared to chlorobenzene. In chlorobenzene the carbon bearing the halogen is a part of aromatic ring and is electron rich due to the electron density in the ring so, it does not attract the nucleophile. The $-NO_2$ substitution lessens the electron density on the benzene ring due to its electron withdrawing nature, making the electron density on ring less compared to chlorobenzene, hence *p*-nitro chlorobenzene attracts nucleophiles better.

SECTION-B

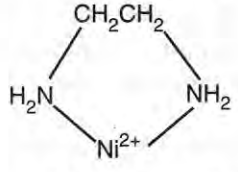
7. Give reasons :
(a) A decrease in temperature is observed on mixing ethanol and acetone.
(b) Potassium chloride solution freezes at a lower temperature than water. [2]
Answer: (a) Upon mixing molecules of ethanol and acetone have strong intermolecular attractions due to which heat is evolved from reaction system and hence cooling of mixture is observed.
(b) Potassium chloride solution is a solution of non -volatile solute KCl and water solution. We know that, at the freezing point of a substance, the solid phase (here ice) is in dynamic equilibrium with the liquid phase. A solution freezes when its vapour pressure equals the vapour pressure of pure solid solvent. Now, according to Raoult's law when a non -volatile solid is added to the solvent (in this case it is KCl), its vapour pressure decreases and now it would become equal to that of solid solvent at lower temperature. Thus, the freezing point of solvent decreases.

10. Define the following terms with a suitable example of each : [2]
(a) Chelate complex
(b) Ambidentate ligand

OR

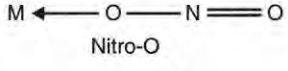
Using IUPAC norms, write the formulae for the following complexes :
(a) Tetraamminediaquacobalt (III) chloride
(b) Dibromidobis (ethane-1, 2-diamine) platinum (IV) nitrate

Answer : (a) Chelate complex –Chelate complexes are coordination or complex compound consisting of a central metal atom attached to a large molecule, called a ligand, in a cyclic or ring structure. The ligands are bi- or polydentate *i.e.*, they can attach to metal atom through two or more than two binding sites. An example of a chelate ring occurs in the ethylenediamine-nickel complex.

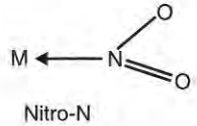


A chelate complex

(b) Ambidentate ligand : Ligands which can ligate (attach to metal atom) through two different atoms is called ambidentate ligand. One example of such ligand is NO_2^-, this can bind through both the atoms, nitrogen and oxygen.



Nitro-O



Nitro-N

OR

IUPAC names

(a) Tetramminediaquacobalt(III)chloride

$[Co(NH_3)_4(H_2O)_2]Cl_3$

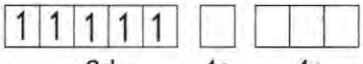
(b) Dibromidobis(ethane-1,2-diamine) platinum(IV) nitrate $-[PtBr_2(en)_2](NO_3)_2$

11. (a) Using valence bond theory, write the hybri-disation and magnetic character of the complex $[Fe(CN)_6]^{4-}$. (Atomic no. of Fe = 26)
(b) Write the electronic configuration of d^6 on the basis of field theory when
(i) $\Delta_0 < P$ and
(ii) $\Delta_0 > P$ **[2]**

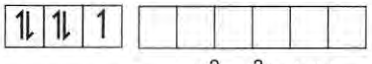
Answer : (a) $[Fe(CN)_6]^{4-}$ is a low spin or inner orbital complex as CN^- is a strong field ligand.

Hybridisation Scheme

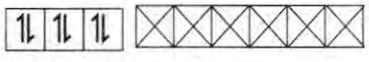
Orbitals of Fe^{3+} ion



d^2sp^3 hybridised orbitals of Fe^{3+}



$[Fe(CN)^6]^{3-}$ (Inner orbitals/Low spin complex)



$[Fe(CN)_6]^{4-}$ is diamagnetic as there is no unpaired electron left.

(b) (i) Electronic configuration of d^6 when $\Delta_0 < P$, that is in case of weak field ligand

$t_{2g}^4 e_g^2$

$dxy^2, dxz^1, d_{yz}1, d_{x^2y^2}1, d_{z^2}1$

(ii) Electronic configuration of d^6 when $\Delta_0 > P$, that is in case of strong field ligand

$t_{2g}^6 e_g^0$

$dxy^2, dxz^2, d_{yz}2, d_{x^2y^2}0, d_{z^2}0$

SECTION C

13. (a) Write the dispersed phase and dispersion medium of milk.

(b) Why is adsorption exothermic in nature ?

(c) Write Freundlich adsoption isortherm for gases at high pressure. **[3]**

Answer : (a) Dispersed phase of milk is liquid and dispersion medium of milk is liquid.

(b) During the process of adsorption molecules of adsorbate and adsorbent come closer to form physical or chemical bonds hence getting stabilized, in this process heat is evolved leading the overall process to be exothermic.

(c) Freundlich adsorption isotherm for gases at high pressure.

It is an empirical relationship between the quantity of gas adsorbed by unit mass of solid adsorbent and pressure at a particular temperature :

$$x/m = k\,p^{1/n} (n > 1)$$

Where, x is the mass of the gas adsorbed on mass m of the adsorbent at pressure p, k and n are constants which depend on the nature of the adsorbent and the gas at a particular temperature.

The relationship is generally represented in the form of a curve x/m is plotted against the pressure. This curve always approach saturation towards high pressure, thus indicating that at adsorption though increases with increase in pressure but till a limit and at high pressures no further adsorption is observed.

15. Write the name and principle of the method used for refining of (a) Tin, (b) Copper, (c) Nickel. **[3]**

Answer : (a) Tin : It is refined through liquation. In this method a low melting metal like tin is made to flow on a sloping surface, where the higher melting impurities are left behind and the lower melting metal is collected at the slope end.

(b) Copper : It is refined through electrolytic refining. Anode is made of impure copper and pure copper stripes are taken as cathode. They are dipped in acidified solution of copper sulphate as electrolyte. The net result of electrolysis is the transfer of copper in pure form from the anode to the cathode and the impurities gets deposited as anode mud.

(c) Nickel : It is refined through Mond's process. In this process, Nickel is heated in a stream of carbon monoxide forming a volatile complex, nickel tetracarbonyl.

$$Ni + 4\,CO \xrightarrow{330-350\ K} Ni(CO)_4$$

The carbonyl is subjected to higher temperature

so that it is decomposed giving the pure metal.

$$Ni(CO)_4 \xrightarrow{450-470\ K} Ni + 4CO$$

16. **Give reason for the following :**

(a) Transition metals show variable oxidation states.

(b) E° value of (Zn^{2+}/Zn) is negative while that of (Cu^{2+}/Cu) is positive.

(c) Higher oxidation state of Mn with fluorine is +4 whereas with oxygen is +7. [3]

Answer : (a) Transition metals show variable oxidation states because their *d*-orbitals are incompletely filled and different arrangements of electrons are possible according to the chemical environment of metal ion hence, the ions can occupy variable oxidation states.

(b) E° value for Zn/Zn^{2+} is negative because conversion of Zn to Zn^{2+} gives it a completely filled d^{10} configuration and extra stability gained by Zn^{2+}. Whereas, conversion of Cu to Cu^{2+}does not give any extra stability, hence it has a positive E° value.

(c) Mn has the highest oxidation state of +4 with fluorine but with oxygen it is +7. This is due to the ability of oxygen to form multiple bonds with the metal ion, whereas fluorine being of small size and devoid of *d*-orbitals can't form multiple bonds.

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

(a) Nylon-6, 6

(b) Bakelite

(c) Buna-S [3]

OR

(a) Write one example each of :

(i) Thermoplastic polymer

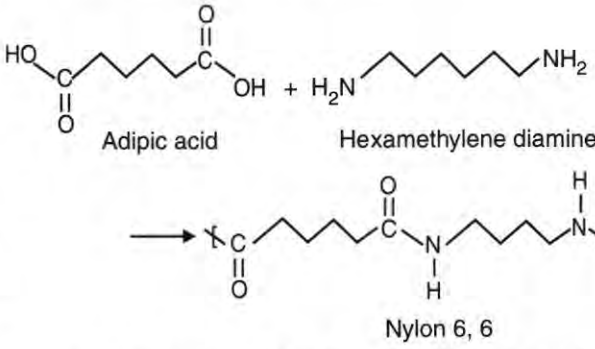
(ii) Elastomers

(b) Arrange the following polymers in the increasing order of their intermolecular forces :

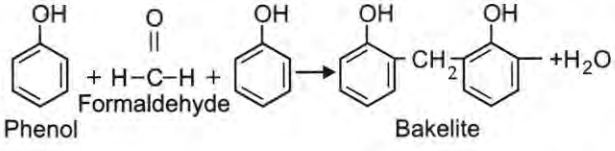
Polythene, Nylon-6, 6, Buna-S

(c) Which factor provides crystalline nature to a polymer like Nylon ?

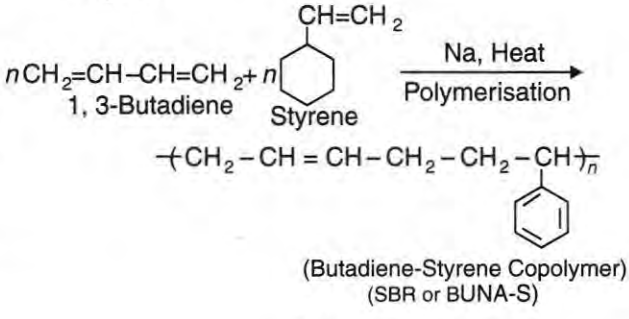
Answer : (a) Monomers of Nylon-6, 6 are adipic acid and hexamethylene diamine.



(b) Monomers of bakelite are phenol and formaldehyde :



(c) Monomers of Buna-S are 1, 3-Butadiene and Styrene



OR

(a)(i) Example of thermoplastic polymer – polythene, polystyrene.

(ii) Example of elastomer – Neoprene.

(b) In increasing order of their intermolecular force, they can be arranged as :

Buna-S < Polythene < Nylon-6, 6

(c) Strong intermolecular forces between the polymer molecules, such as hydrogen bonding leads to closed packed structure, thus imparting crystalline nature to the polymers.

●●

Chemistry 2019 (Outside Delhi) SET III

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

Note : Except for the following questions all the remaining questions have been asked in the previous sets.

SECTION-A

1. **Out of Chlorobenzene and Cyclohexyl chloride, which one is more reactive towards nucleophilic substitution reaction and why ?** [1]

Answer : Cyclohexyl chloride is more reactive towards nucleophilic substitution reaction, because the carbon bearing the chlorine atom is deficient in electron and seeks a nucleophile. In Chlorobenzene the carbon bearing the halogen is a part of aromatic ring and is electron rich due to the electron density in the ring.

2. **Arrange the following in decreasing order of solubility in water :**

$(C_2H_5)_2NH$, $C_2H_5NH_2$, $C_6H_5NH_2$ [1]

Answer : Decreasing order of solubility in water is :

$C_2H_5NH_2 > (C_2H_5)_2NH_2 > C_6H_5NH_2$

3. **What type of colloid is formed when a solid is dispersed in a gas ? Give an example.** [1]

Answer : Aerosol is the type of colloid formed when solid is dispersed in gas. Example : smoke and dust.

5. **What is the difference between amylose and amylopectin ?** [1]

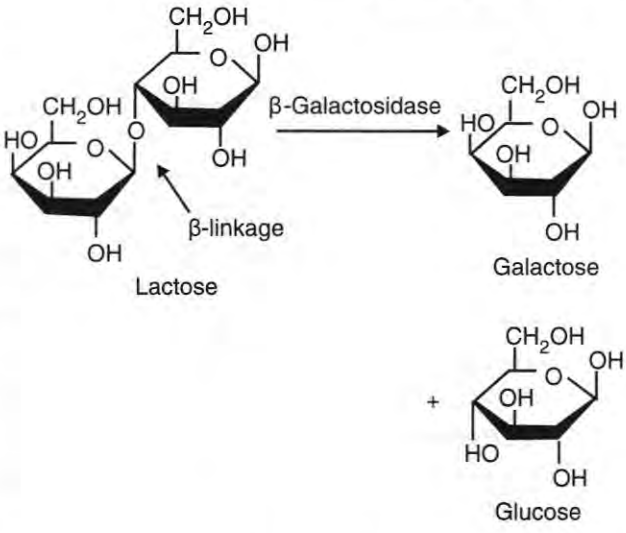
OR

Write the products obtained after hydrolysis of lactose.

Answer : Amylose is a long linear chain of α-D-(+)-glucose units joined by C_1-C_4 glycosidic linkage (α-link), whereas Amylopectin is a branched-chain polymer of α-D-glucose units, in which the chain is formed by C_1-C_4 glycosidic linkage and the branching occurs by C_1-C_6 glycosidic linkage.

OR

Galactose and Glucose are the products obtained after hydrolysis of lactose.



SECTION-B

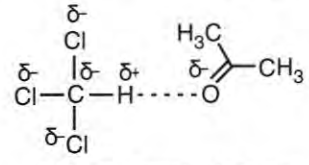
7. **Give reasons :**

(a) An increase in temperature is observed on mixing chloroform and acetone.

(b) Aquatic animals are more comfortable in cold water than in warm water. [2]

Answer :

(a) A mixture of chloroform and acetone forms a solution with negative deviation from Raoult's law. This is because chloroform molecule is able to form hydrogen bond with acetone molecule as shown by the following figure :



Hydrogen bonding between chloroform and acetone

This decreases the escaping tendency of molecules for each component, and consequently the vapour pressure decreases and the temperature of the solution is increased because of stability attained by the molecule by associating and releasing energy.

(b) Solubility of gases in liquid increases on decreasing temperature, hence cold water has more dissolved oxygen because of which aquatic species find themselves more comfort-

able in cold water as compared to hot water.

10. Define the following terms with a suitable example of each : [2]

(a) Polydentate ligand

(b) Homoleptic complex

OR

Using IUPAC norms, write the formulae for the following complexes :

(a) Potassium tri (oxalato) chromate (III)

(b) Hexaaquamanganese (II) sulphate.

Answer : (a) Polydentate ligands : Ligands with several donor atoms are called polydentate ligands. These can bond with metal ion in a complex with the different donor atoms present in them. Example : $N(CH_2CH_2NH_2)_3$.

(b) Homoleptic complex : Complexes in which a metal atom is bound to only one kind of donor groups, *e.g.*, $[Co(NH_3)_6]^{2+}$ are known as homoleptic complex.

OR

(a) $K_3[Cr(C_2O_4)_3]$

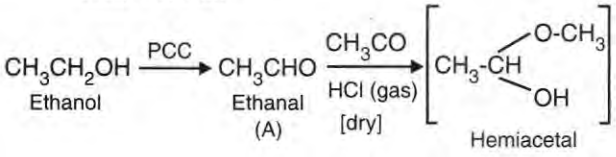
(b) $[Mn(H_2O)_6]SO_4$

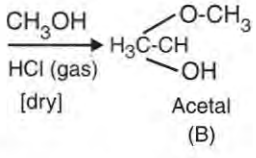
12. Write structures of main compounds A and B in each of the following reactions : [2]

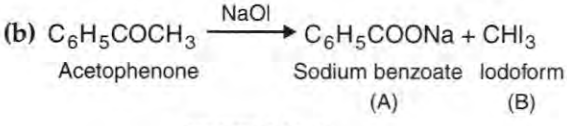
(a) $CH_3CH_2OH \xrightarrow{PCC} A \xrightarrow[HCl\ (gas)]{CH_3OH/dry\ HCl(g)} B$

(b) $C_6H_5COCH_3 \xrightarrow{NaOI} A + B$

Answer : (a)





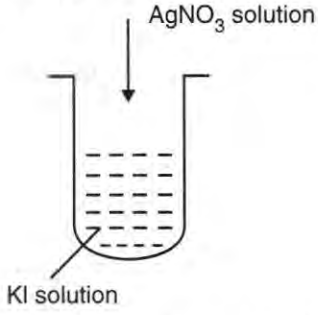


SECTION-C

14. (a) Write the dispersed phase and dispersion medium of butter.

(b) Why does physiosorption decrease with increase in temperature ?

(c) A colloidal sol is prepared by the method given in the figure. What is the charge on AgI colloidal particles formed in the test tube ? How is this sol represented ? [3]



Answer : (a) Butter is an example of 'Gel' type of colloid. Here the dispersed phase is liquid and dispersion medium is solid.

(b) Physisorption occurs because of physical attractive forces, like van der Waals forces between molecules of adsorbate and adsorbent, hence that can be reversed on application of bigger forces. Hence, when temperature is increased, the movement of adsorbed molecules increases, resulting in disturbed attractive forces, detachment of adsorbed molecules from adsorbent surface hence physisorption decreases.

(c) When $AgNO_3$ solution is added to KI, silver iodide, AgI, is precipitated. The precipitated silver iodide adsorbs iodide ions from dispersion medium and negatively charged colloidal sol results. It can be shown as AgI/I^- (negatively charged).

17. Write the principle of the following :

(a) Hydraulic washing

(b) Chromatography

(c) Froth-floatation process [3]

Answer : (a) Hydraulic washing : This method of concentration of ores is based on the differences in gravities of the ore and the gangue particles. It is a type of gravity separation. An upward stream of running water is used to wash the powdered ore. The lighter gangue particles are washed away and the heavier ores are left behind.

(b) Chromatography : Chromatography is a physical method of separation of a mixture in which the components to be separated are distributed between two phases, stationary and mobile phase. The stationary phase may be a solid or a liquid supported on a solid or a gel. The mobile phase may be either a liquid or a gas.

(c) Froth floatation process : Froth floatation is a physicochemical method of concentrating fine minerals. This process utilizes the differ-

ence in surface properties of valuable mineral and gangue (impurity) particles. For example, removal of gangue from sulphide ores.

18. Give reasons for the following :

(a) Transition metals have high enthalpies of atomization.

(b) Manganese has lower melting point even though it has a higher number of unpaired electrons for bonding.

(c) Ce^{4+} is a strong oxidising agent. [3]

Answer : (a) Transition element have high effective nuclear charge and a large number of valence electrons ($(n-1)$ d electrons). So, as a result of greater number of electrons participating, very strong metallic bonds are formed. As a result of the strong inter-atomic metallic bonding, the transition metals have high enthalpies of atomization.

(b) Manganese has lower melting point even though it has a higher number of unpaired electrons for bonding. Melting point depends on the intermolecular or interatomic forces. Stronger the forces, higher the melting point. In Mn there is half filled $3d$ sub-shell ($3d^5$ configuration) which makes it stable and hence, it does not make additional covalent bonds with nearby atoms hence, it has less melting point.

(c) Ce^{4+} is a strong oxidising agent because Ce^{4+} oxidizes others and itself gets reduced to the common and preferred 3+ oxidation state of lanthanoid elements.

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

(a) Novolac

(b) Neoprene

(c) Buna-S [3]

OR

(a) Write on example each of

(i) Cross-linked polymer

(ii) Natural polymer

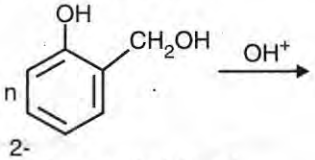
(b) Arrange the following in the increasing order of their intermolecular forces :

Terylene, Buna-N, Polystyrene

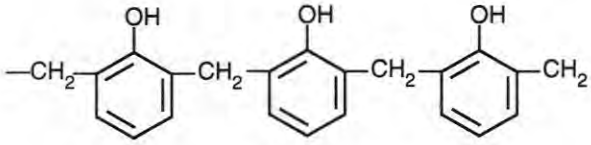
(c) Define biodegradable polymers with an example.

Answer :

(a) Novolac is polymer of 2-hydroxymethyl phenol which is obtained by reaction of phenol and formaldehyde.

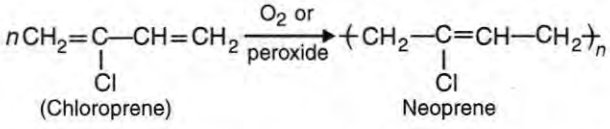


2-Hydroxymethylphenyl phenol



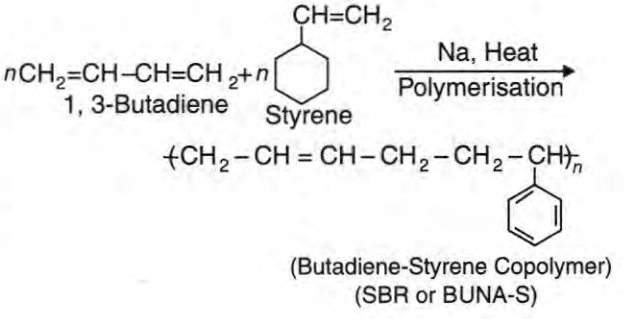
Novalac

(b) Neoprene is polymer of chloroprene or 2-chloro-1,3-butadiene—



(Chloroprene) Neoprene

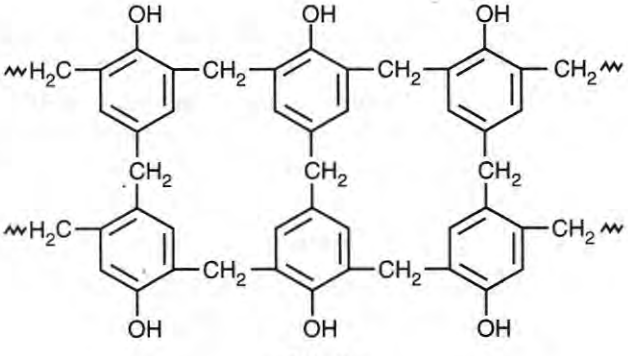
(c) Buna-S is a polymer of 1, 3-Butadiene and Styrene monomers.



(Butadiene-Styrene Copolymer)
(SBR or BUNA-S)

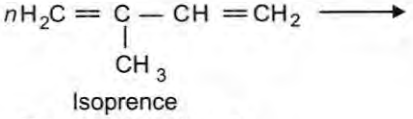
OR

(a) (i) Bakelite is an example of cross-linked polymer—

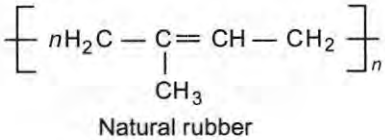


Bakelite

(ii) Rubber is an example of natural polymer—



Isoprence
[2-methyl butadiene]



Natural rubber
[Poly isoprene]

(b) Increasing order of their molecular forces :

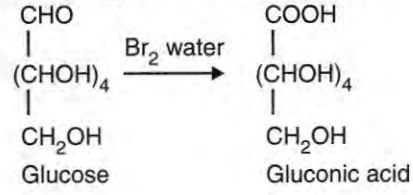
Buna-N < Polystyrene < Terylene

(c) Biodegradable polymer : These are synthetic polymers designed so as to contain functional groups similar to ones present in biopolymers. These are thus easily degraded by environmental degradation process hence, known as Biodegradable polymers.

Example : Poly β-hydroxybutyrate-co-β-hydroxy valerate (PHBV).

23. (a) Write the product when D-glucose reacts with Br_2 (aq). [3]

Answer : (a) When D-glucose reacts with Bromine (aq.) gluconic acid is formed.



●●

Chemistry 2019 (Delhi) SET I

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

SECTION–A

1. Out of NaCl and AgCl, which one shows Frenkel defect and why ? ** [1]

2. Arrange the following in increasing order of boiling points :

$(CH_3)_3N$, C_2H_5OH, $C_2H_5NH_2$ [1]

Answer : Increasing order of boiling point would be :

$(CH_3)_3N < C_2H_5NH_2 < C_2H_5OH$

3. Why are medicines more effective in colloidal state ? [1]

OR

What is difference between an emulsion and a gel ?

Answer : Medicines are effective in colloidal state because in colloidal state they have large surface area and are easily assimilated in body.

OR

Emulsions are the colloids made up of liquids dispersed in liquid dispersion medium whereas gels are liquids dispersed in solid dispersion medium. For example : milk is an emulsion whereas butter is a gel.

4. Define ambidient nucleophile with an example. [1]

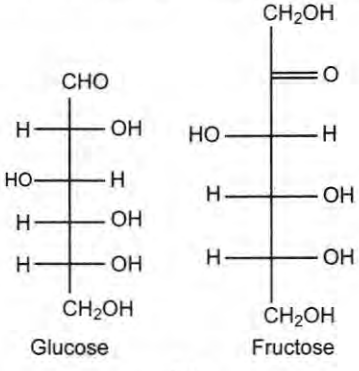
Answer : Ambidient nucleophiles are the ones which can attack through two different atoms present in the same nucleophilic species, such as NO_2^-. This can attack the electrophilic center either through nitrogen or the oxygen.

5. What is the basic structural difference between glucose and fructose ? [1]

OR

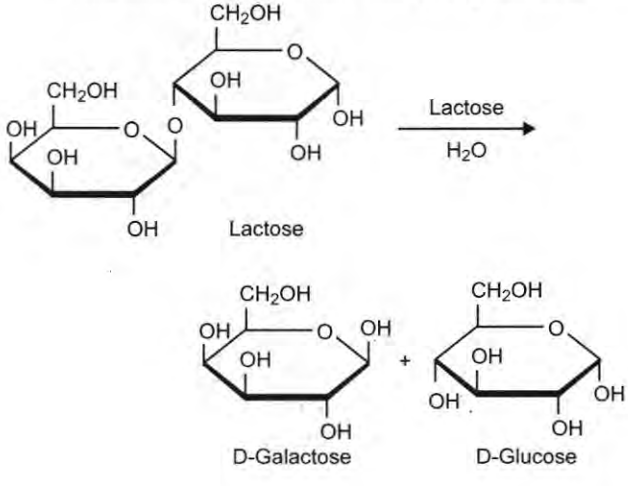
Write the products obtained after hydrolysis of lactose.

Answer : Both glucose and fructose have the molecular formula $C_6H_{12}O_6$ but Glucose has an aldehydic functional group at C-1 (in its open chain structure) and Fructose has a ketonic functional group at C-2. Glucose is an aldohexose whereas fructose is a ketohexose.



OR

The products obtained after hydrolysis of lactose are β-D-glucose and β-D-galactose.



**** Answer is not given due to change in present syllabus.**

SECTION–B

6. Write balanced chemical equations for the following processes :

(i) XeF_2 undergoes hydrolysis.

(ii) MnO_2 is heated with conc. HCl. [2]

OR

Arrange the following in order of property indicated for each set :

(i) H_2O, H_2S, H_2Se, H_2Te– increasing acidic character

(ii) HF, HCl, HBr, HI –decreasing bond enthalpy

Answer : (i) XeF_2 undergoes hydrolysis to give Xe, HF and O_2

$$2XeF_2\ (s) + 2H_2O\ (l) \rightarrow 2Xe\ (g) + 4HF\ (aq) + O_2\ (g)$$

(ii) MnO_2 is heated with conc. HCl to give $MnCl_2$, Cl_2 and H_2O^-

$$MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$$

OR

(i) Increasing order of acidity–

$$H_2O < H_2S < H_2Se < H_2Te$$

(ii) Decreasing bond enthalpy–

$$HF > HCl > HBr > HI$$

7. State Raoult's law for a solution containing volatile components. Write two characteristics of the solution which obeys Raoult's law at all concentrations. [2]

Answer : Raoult's law states that for any solution the partial vapour pressure of each volatile component in the solution is directly proportional to its mole fraction.

The solutions which obey Raoult's law at all concentrations are known as ideal solutions. The two important properties of ideal solutions are as follows :

1. Enthalpy of mixing of the pure components to form the solution is zero

$$\Delta H_{mix} = 0$$

2. Volume of mixing of the pure components to form the solution is zero

$$\Delta V_{mix} = 0$$

8. For a reaction

$$2H_2O_2 \xrightarrow[\text{Alkaline medium}]{I^-} 2H_2O + O_2$$

the proposed mechanism is as given below :

(1) $H_2O_2 + I^- \rightarrow H_2O + IO^-$ **(slow)**

(2) $H_2O_2 + IO^- \rightarrow H_2O + I^- + O_2$ **(fast)**

(i) Write rate law for the reaction.

(ii) Write the overall order of reaction.

(iii) Out of steps (1) and (2), which one is rate determining step ? [2]

Answer : (i) Rate law of the reaction is given by :

$$\text{Rate} = -d[H_2O]/dt = k[H_2O_2][I^-]$$

(ii) As the rate law shows that the reaction is first order with H_2O_2 and I^- both, hence the overall order of the reaction becomes 1+1 = 2.

(iii) Step no. 1 is the slowest among two steps, hence this is the rate determining step.

9. When MnO_2 is fused with KOH in the presence of KNO_3 as an oxidizing agent, it gives a dark green compound (A). Compound (A) disproportionates in acidic solution to give purple compound (B). An alkaline solution of compound (B) oxidises KI to compound (C) whereas an acidified solution of compound (B) oxidises KI to (D). Identify (A), (B), (C) and (D). [2]

Answer : The reaction sequence can be written as–

$$2MnO_2 + 4KOH + O_2 \xrightarrow{KNO_3} \underset{\substack{\text{Potassium}\\\text{manganate (A)}\\\text{Green}}}{2K_2MnO_4} + 2H_2O$$

$$\underset{\text{(A)}}{3MnO_4^{2-}} + 4H^+ + \longrightarrow \underset{\substack{\text{Potassium}\\\text{permanganate (B)}\\\text{Purple}}}{2MnO_4^-} + MnO_2 + 2H_2O$$

$$\underset{\text{(B)}}{2KMnO_4} + H_2O + KI \xrightarrow{\text{Alkaline}} 2MnO_2 + 2KOH + \underset{\substack{\text{Potassium}\\\text{iodate (C)}}}{KIO_3}$$

$$\underset{\text{(B)}}{10KI + 2KMnO_4} + 16HCl + \longrightarrow 2MnCl_2 + 8H_2O + 5I_2 + 12KCl$$

Iodine (D)

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

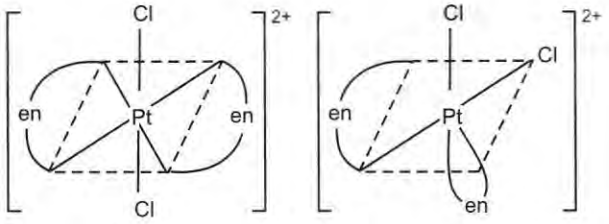
OR

Using IUPAC norms write the formulae for the following :

(i) Hexaamminecobalt (III) sulphate

(ii) Potassium trioxalatochromate (III)

Answer : Dichlorido bis(ethane-1, 2-diammine platinum(II)



OR

(i) Hexaamminecobalt(III) sulphate $[Co(NH_3)_6]_2(SO_4)_3$

(ii) Potassium trioxalatochromate(III) $K_3[Cr(C_2O_4)_3]$

11. Out of $[CoF_6]^{3-}$ and $\{Co(en)_3]^{3+}$, which one complex is :

(i) paramagnetic

(ii) more stable

(iii) inner orbital complex and

(iv) high spin complex

(Atomic no. of Co = 27) **[2]**

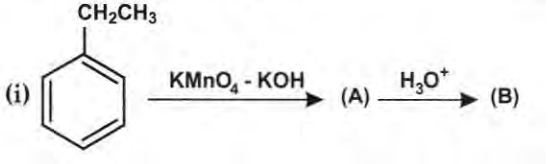
Answer : (i) $[CoF_6]^{3-}$ is paramagnetic as it has four unpaired electrons.

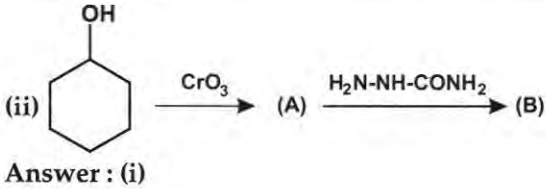
(ii) $[Co(en)_3]^{3+}$ is more stable.

(iii) $[Co(en_3)]^{3+}$ is inner orbital complex.

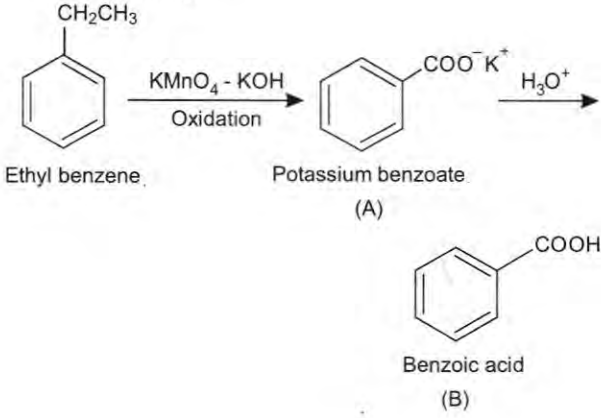
(iv) $[CoF_6]^{3-}$ is high spin complex.

12. Write structures of compound A and B in each of the following reactions : **[2]**

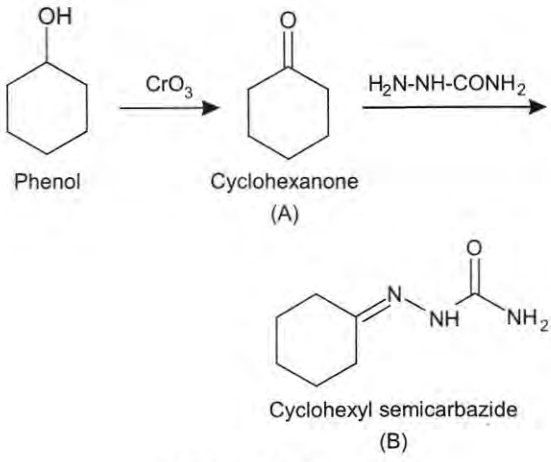




Answer : (i)



(ii)



SECTION–C

13. The decomposition of NH_3 on platinum surface is surface is zero order reaction. If rate constant (k) is 4, × 10^{-3} Ms^{-1}, how long will it take to reduce the initial concentration of NH_3 from 0.1 M to 0.064 M. **[3]**

Answer : Rate law for a zero order reaction can be given as–

$k = [R]^0 - [R] / t$

Substituting the given values–

$4 \times 10^{-3} Ms^{-1} = (0.1 - 0.064)\ M / t$

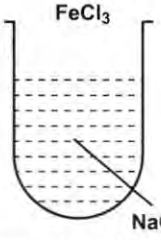
$t = 0.036\ M / 4 \times 10^{-3} Ms^{-1}$

$= 9$ s

So, the time taken would be 9 seconds.

14. (i) What is the role of activated charcoal in gas mask ?

(ii) A colloidal sol is prepared by the given method in figure. What is the charge on hydrated ferric oxide colloidal particles formed in the test tube ? How is the sol represented ? **[3]**



(iii) How does chemisorption vary with temperature ?

Answer : (i) Activated charcoal present in gas mask adsorbs the harmful suffocating gases which surround the user and protects them from the particulate matter and ashes present in coal mines.

(ii) In the given method, $FeCl_3$ is being added to the NaOH solution to give a sol of hydrated ferric oxide, $Fe_2O_3.xH_2O$. The sol formed preferentially adsorbs the negatively charged OH^- present in the solution and hence acquire a negative charge on sol particles. The negatively charged sol formed can be represented as

$Fe_2O_3.\ x\ H_2O/OH^-$ (negatively charged)

(iii) Chemisorption increases with temperature upto a certain extent as then after it starts decreasing, chemisorption occurs due to a chemical reaction between adsorbate and adsorbent, and chemical reactions increase with increase in temperature.

15. An element crystallizes in fcc lattice and with a cell edge of 300 pm. The density of the element is 10.8 g cm^{-3}. Calculate the number of atoms in 108 g of the element.** [3]

16. A 4% solution (w/w) of sucrose (M = 342 g mol^{-1}) in water has a freezing point of 271.15 K. Calculate the freezing point of 5% glucose (M = 180 g mol^{-1}) in water. (Given : Freezing point of pure water = 273.15 K) [3]

Answer : Depression in freezing point can be shown by the given formula–

$$\Delta Tf = k_f m$$

The difference in freezing point,

$$\Delta T_f = 273.15 - 271.15 = 2\ K$$

and $$m = \frac{(w_2 \times 1000)}{(m_2 \times w_1)}$$

For 4% sucrose solution in water–

$$2K = \frac{k_f \times 4 \times 1000}{342 \times 96}$$

$$k_f = 16.42\ K\ kg/mol$$

Now for 5% glucose solution–

$w_2 = 5$ g; $m_2 = 180$ g mol^{-1}; $w_1 = 100 - 5$ g $= 95$ g

$$273.15 - T_{f\,glucose} = \frac{16.42 \times 5 \times 1000}{180 \times 95}$$

$$273.15 - T_{f\,glucose} = 1.877$$

$$T_{f\,glucose} = 273.15 - 4.8$$

$$T_{f\,glucose} = 268.35$$

So, freezing point of 5% solution of glucose is 268.35 K.

17. (a) Name the method of refining which is
(i) used to obtain semiconductor of high purity.
(ii) used to obtain low boiling metal.
(b) Write chemical reactions taking place in the extraction of copper from Cu_2S. [3]

Answer : (a) (i) Zone refining is being used for production of semiconductors like germanium, silicon, boron, gallium etc. of high purity.

(ii) Distillation method is used to obtain low boiling metals such as zinc and mercury.

(b) Chemical reactions involved in extraction of Cu from Cu_2S are :

Cu_2S ore is heated in a reverberatory furnace after mixing with silica. In the furnace, iron oxide 'slags of' as iron silicate and copper is produced in the form of copper matte. This contains Cu_2S and FeS.

The reactions undergo as given below.

$$2FeS + 3O_2 \rightarrow 2FeO + 2SO_2$$

$$FeO + SiO_2 \rightarrow FeSiO_3$$

$$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$$

$$2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$$

18. Give reasons for the following :
(i) Transition elements and their compounds act as catalysts.
(ii) E^o value for (Mn^{2+} / Mn) is negative whereas for (Cu^{2+} / Cu) is positive.
(iii) Actinoids show irregularities in their electronic configuration. [3]

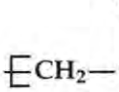
Answer : (i) Transition elements and their compounds act as catalyst due to their ability to adopt multiple oxidation states and to form complexes.

(ii) Mn^{2+} has d^5 configuration (stable half-filled configuration) and it prefers to stay in +2 oxidation state, so, E° value for Mn^{2+}/ Mn is negative.Whereas, the high energy to transform Cu(s) to Cu^{2+} (aq) is not balanced by its hydration enthalpy, hence Cu^{2+} is not favored over Cu^o state and it has positive E^o value.

(iii) Actinoids show irregularities in their oxidation states due to extra stability of empty, half filled and fully filled *f* subshells.

19. Write the structures of monomers used for getting the following polymers :
(i) Nylon–6,6
(ii) Glyptal
(iii) Buna-S [3]

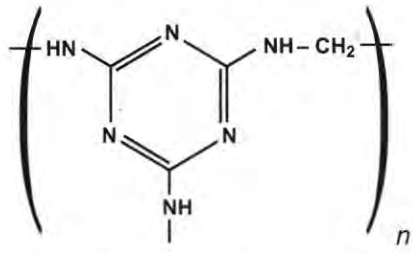
OR



(i) Is $\left(CH_2-CH\right)_n$ a homopolymer or copolymer ? Give reason.

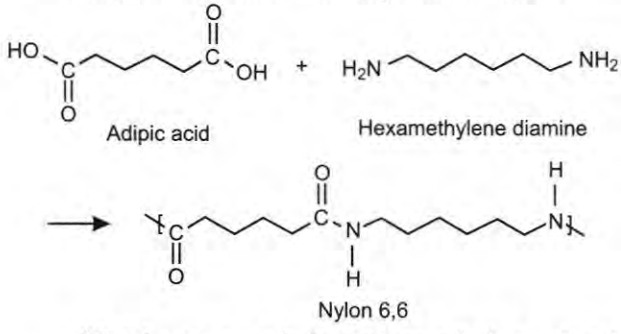
**** Answer is not given due to change in present syllabus.**

(ii) Write the monomers of the following polymer :

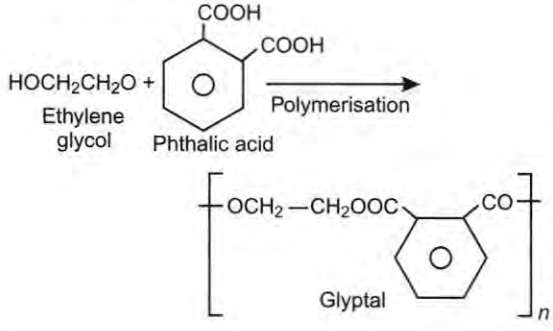


(iii) What is the role of Sulphur in vulcanization of rubber ?

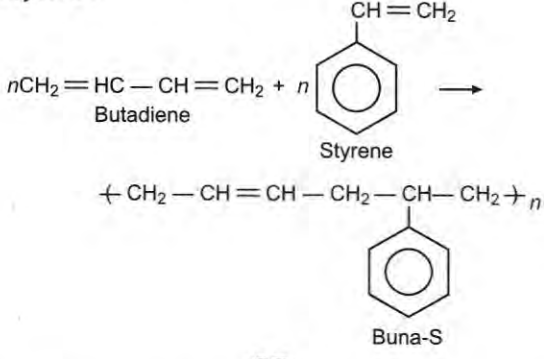
Answer : (i) Monomers of Nylon-6,6 are adipic acid and hexamethylene diamine.



(ii) Monomers of glyptal are ethylene glycol and phthalic acid.



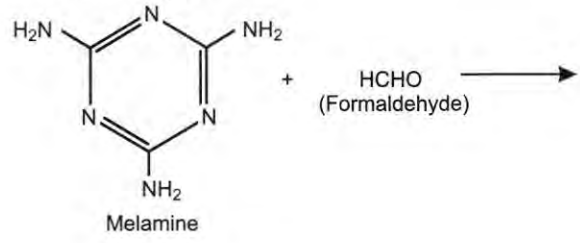
(iii) Monomers of Buna-S are Butadiene and Styrene.

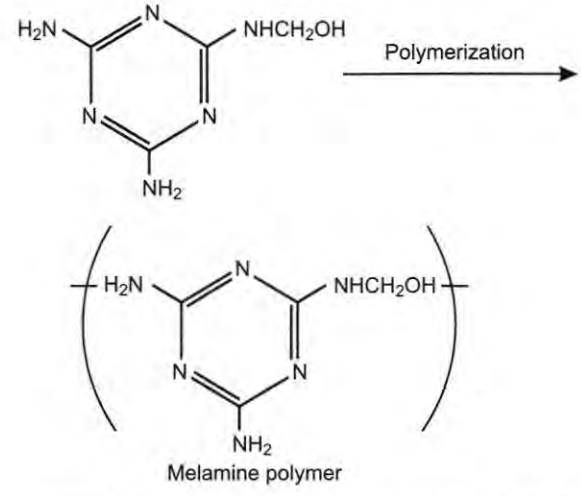


OR

(i) $+CH_2\text{-}CH_2(CH_3)+$ is a homopolymer and the monomer from which it is obtained is $CH_2 = CH(CH_3)$.

(ii) The given polymer is melamine polymer and the monomers are Melamine and Formaldehyde.





(iii) Natural rubber becomes soft at high temperatures. In the vulcanisation process, sulphur forms cross links at the reactive sites of double bonds in rubber monomers and thus the rubber gets stiffened.

20. (i) What type of drug is used in sleeping pills ?

(ii) What type of detergents are used in toothpastes ?

(iii) Why the use of alitame as artificial sweetener is not recommended ? **[3]**

OR

Define the following terms with a suitable example in each :

(i) Broad-spectrum antibiotics

(ii) Disinfectants

(iii) Cationic detergents

Answer : (i) Tranquilizers are used in sleeping pills.

(ii) Anionic detergents are used in toothpastes.

(iii) It is difficult to control the sweetness of food by using alitame hence its use is not recommended.

OR

(i) Broad spectrum antibiotics : Antibiotics which kill or inhibit a wide range of Gram-positive and Gram-negative bacteria are said

to be broad spectrum antibiotics. Ampicillin is an example.

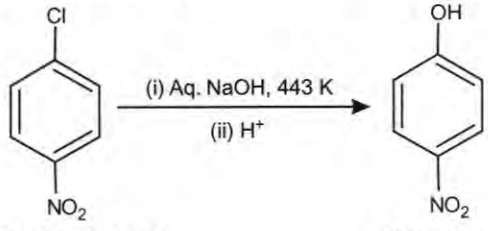
(ii) Disinfectants : These are chemicals which are applied to inanimate objects such as floors, drainage system, instruments etc. Example is 1% solution of phenol.

(iii) Cationic detergents : These are quarternary ammonium salts of amines with acetates, chlorides or bromides as anions. Example is Cetyltrimethyl ammonium bromide.

21. (i) Out of $(CH_3)_3C–Br$ and $(CH_3)_3C–I$, which one is more reactive towards S_N1 and why ?
(ii) Write the product formed when *p*-nitrochlorobenzene is heated with aqueous NaOH at 443 K followed by acidification.
(iii) Why *dextro* and *laevo* – rotatory isomers of Butan-2-ol are difficult to separate by fractional distillation ? **[3]**

Answer : (i) $(CH_3)_3C–I$ is more reactive than $(CH_3)_3C—Br$ towards S_N1 reaction because, C–I bond being weaker than C–Br bond (due to larger size of I^- compared to Br^-) forms the tertiary carbocation easily.

(ii) 4-Nitrophenol is formed as product when *p*-nitro chlorobenzene is heated with NaOH at 443 K and acidified later.

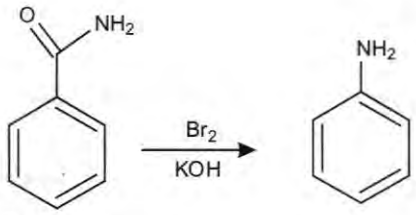


4-Nitrochlorobenzene 4-Nitrophenol

(iii) *Dextro-* and *laevo-* rotatory isomers of Butan-2-ol are stereoisomers of each other and have same physical properties. As they have same boiling points, thus it is difficult to isolate them through fractional distillation.

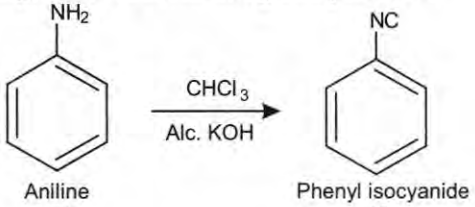
22. An aromatic compound 'A' on heating with Br_2 and KOH forms a compound 'B' of molecular formula C_6H_7N which on reacting with $CHCl_3$ and alcoholic KOH produces a foul smelling compound 'C'. Write the structures and IUPAC names of compounds A, B and C. **[3]**

Answer : As the chemical combination Br_2 and KOH are used for Hofmann Bromamide reaction where an amide is reduced to amine, the compound B, C_6H_7N seems to be Aniline. The reaction can be suggested as follows :



Benzamide (A) Aniline (B)

Then aniline undergoes carbylamine reaction to give the foul smelling compound C.



Aniline (B) Phenyl isocyanide (C)

IUPAC names are as follows :

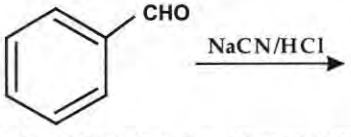
Compound A – Benzamide

Compound B – Aniline or Benzenamine

Compound C – Isocyanobenzene or phenylisocyanide.

23. Complete the following reactions : **[3]**

(i)



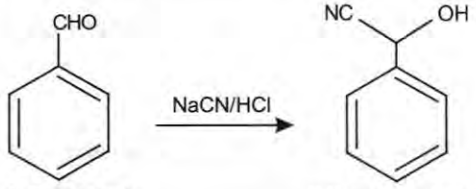
(ii) $(C_6H_5CH_2)_2Cd + 2CH_3COCl$

(ii)

OR

Write chemical equations for the following reactions :
(i) Propanone is treated with dilute $Ba(OH)_2$.
(ii) Acetophenone is treated with Zn(Hg)/ conc. HCl.
(iii) Benzoyl chloride is hydrogenated in presence of $Pd/BaSO_4$.

Answer : (i)

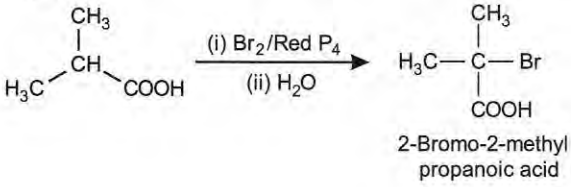


Benzaldehyde 2-Phenyl-2-hydroxy ethane nitrile

(ii) $(C_6H_5CH_2)_2Cd + 2CH_3COCl \longrightarrow 2\ CH_3COCH_2C_6H_5 + CdCl_2$

Methyl benzyl ketone

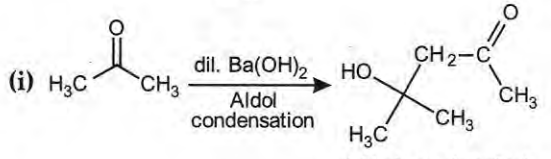
(iii)



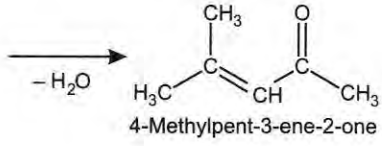
2-Bromo-2-methyl propanoic acid

OR

(i)

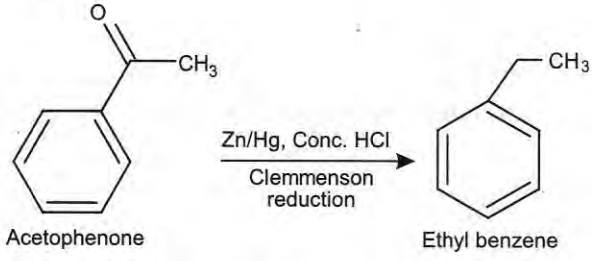


4-Hydroxy-4-methyl pentane 2-one



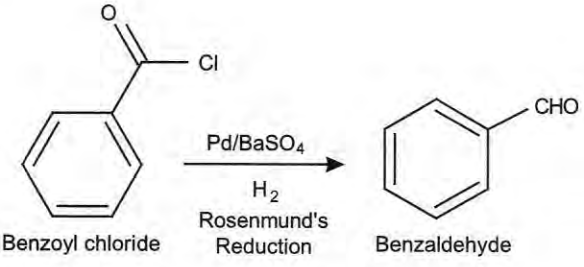
4-Methylpent-3-ene-2-one

(ii)



Acetophenone Ethyl benzene

(iii)



Benzoyl chloride Benzaldehyde

24. Differentiate between the following :

(i) Amylose and Amylopectin

(ii) Peptide linkage and Glycosidic linkage

(iii) Fibrous proteins and Globular proteins. **[3]**

OR

Write chemical reactions to show that open structure of D-glucose contains the following :

(i) Straight chain

(ii) Five alcohol groups

(iii) Aldehyde as carbonyl group.

Answer : (i) Difference between Amylose and Amylopectin —

S.No.	Amylose	Amylopectin
1.	Water soluble.	Water insoluble.
2.	Constitutes about 15-20% of starch.	Constitutes about 80-85% of starch.
3.	It has un-branched chain.	It has branched chain.

(ii) Difference between Peptide linkage and Glycosidic linkage —

S.No.	Peptide linkage	Glycosidic linkage
1.	It is an amide formed between –COOH group of one amine and $–NH_2$ group of second amino acid molecule.	It is an oxide linkage, that is two monosaccharides are joined through an oxygen atom.
2.	It is found in protein molecules.	It is found in carbohydrate molecules.

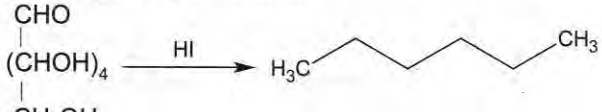
(iii) Difference between Fibrous proteins and Globular Proteins —

S.No.	Fibrous protein	Globular protein
1.	In these polypeptide chains run parallel and are held together by hydrogen and disulphide bonds.	In these chains of polypeptide coil around to give a spherical shape.
2.	Usually insoluble in water. Examples are Keratin and myosin.	Usually soluble in water. Examples are albumin and insulin.

OR

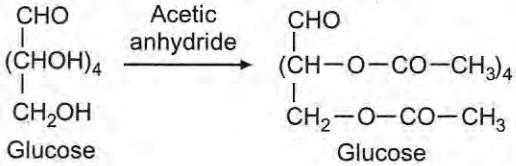
(i) Open chain structure of Glucose is straight chain can be shown as follows–

On prolonged heating with HI, it forms *n*-hexane, this shows that glucose has straight open chain structure.



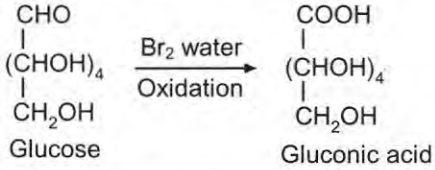
Glucose *n*-hexane

(ii) On acetylation with acetic anhydride, glucose gives glucose pentaacetate, this shows that glucose has five alcoholic groups.



Glucose Glucose pentaacetate

(iii) Glucose gets oxidized to six carbon carboxylic acid (Gluconic acid) on reaction with a mild oxidising agent like bromine water. This indicates that the carbonyl group is present as an aldehydic group.

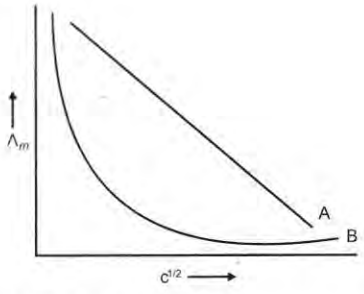


SECTION–D

25. **E^{o}_{cell} for the given redox reaction is 2.71 V**
$Mg_{(s)} + Cu^{2+}_{(0.01\ M)} \rightarrow Mg^{2+}_{(0.001\ M)} + Cu_{(s)}$
Calculate E_{cell} for the reaction. Write the direction of flow of current when an external opposite potential applied is
(i) less than 2.71 V and
(ii) greater than 2.71 V. **[5]**

OR

(a) A steady current of 2 amperes was passed through two electrolytic cells X and Y connected in series containing electrolytes $FeSO_4$ and $ZnSO_4$ until 2.8g of Fe deposited at the cathode of cell X. How long did the current flow ? Calculate the mass of Zn deposited at the cathode of cell Y.
(Molar mass : Fe = 56 g mol^{-1}, Zn = 65.3 g mol^{-1}, 1F = 96500 C mol^{-1})
(b) 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 :
(i) Predict the nature of electrolytes A and B.
(ii) What happens on extrapolation of Λ_m to concentration approaching zero for electrolytes A and B ?
Answer : The cell can be represented as :

$Mg\,|\,Mg^{2+}\,(0.001\ M)\,||\,Cu^{2+}\,(0.01\ M)\,|\,Cu$

$$E_{cell} = \frac{E^{\circ}_{cell} - RT}{2F\ \ln\left(\frac{[Mg^{2+}]}{[Cu^{2+}]}\right)}$$

Putting the given values,

$$E_{cell} = \frac{E^{\circ}_{cell} - RT}{2F\ \ln\left(\frac{[Mg^{2+}]}{[Cu^{2+}]}\right)}$$

$$= 2.71 - \left(\frac{0.059}{2}\right) \log\left(\frac{0.001}{0.01}\right)$$

$$= 2.68 - (-1)$$

$$= 3.68\ V$$

(i) When external opposite potential is less than 2.71 V then electron flows from Mg rod to Cu rod hence current flows from Cu to Mg.

(ii) When external opposite potential is greater than 2.71 V then electron flows from Cu rod to Mg rod and current flows from Mg to Cu.

OR

(a) Charge = Current × Time

Now, in the given experiment, 2.8 g of iron was deposited or

$\frac{2.8}{56}$ = 0.05 moles of iron were deposited.

Now, as it is a 2 electron transfer process :
1 mol of iron is deposited by 2 × 96500 C of charge
Hence, 0.05 mol of iron will need 0.05 × 2 × 96500 C of charge

= 9650 C

So,

9650 C = 2 A × t

Time = 4825 seconds = 80.41 minutes
Similarly,
So, same amount of charge will flow to deposit Zn as well, keeping that in mind
2 × 96500 C of charge can deposit 1 mol of Zn
Hence, 9650 C of charge would deposit

$$= \left(\frac{1}{2} \times 96500\ C\right) \times 9650 = 0.05\ mol$$

Weight of Zinc deposited

= 0.05 mol × 65.3 g mol^{-1} = 3.26 g

(b) (i) The electrolyte A is a strong electrolyte, and the electrolyte B is a weak electrolyte.

(ii) On extrapolation for electrolyte A limiting value of conductance is obtained that is conductance at zero concentration or infinite dilution.

The curve obtained for a strong electrolyte shows that there is a small decrease in molar conductivity with increase in concentration. In other words, the molar conductivity is increased only slightly on dilution (for observing dilution effects, go towards zero on X-axis). A strong electrolyte is completely

dissociated in solution and thus, furnishes all ions for conductance. However, at higher concentrations, the dissociated ions are close to each other and thus, the inter-ionic attractions are greater. These forces retard the motion of the ions and thus, conductivity is low. With decrease in concentration (dilution), the ions move away from each other thereby feeling less attractive forces from the counter ions. This results in an increase in molar conductivity with dilution. The molar conductivity approaches a maximum limiting value at infinite dilution designated as Λ_m^0.

For electrolyte B :

The curve obtained for B shows that there is a large increase in the value of molar conductivity with dilution, especially near infinite dilution. This is because as the solution of a weak electrolyte is diluted, its ionization is increased. This results in more number of ions in solution and thus, there is an increase in molar conductivity. However, the conductance of a weak electrolyte never approaches a limiting value. Or in other words it is not possible to find conductance at infinite dilution (zero concentration).

26. (a) How do you convert the following :

(i) Phenol to Anisole

(ii) Ethanol to Propan–2–ol

(b) Write mechanism of the following reaction :

$$CH_3OH \xrightarrow[443\ K]{H_2SO_4} CH_2 = CH_2 + H_2O$$

(c) Why phenol undergoes electrophilic substitution more easily than benzene ? [5]

OR

(a) Account for the following :

(i) *o*–nitrophenol is more steam volatile than *p*-nitrophenol.

(ii) *t*-butyl chloride on heating with sodium methoxide gives 2-methylpropene instead of *t*-butyl methylether.

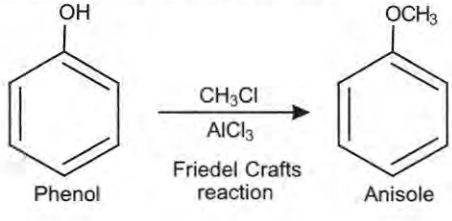
(b) Write the reaction involved in the following :

(i) Riemer Tiemann reaction

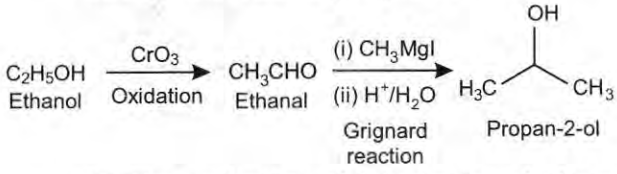
(ii) Friedal Crafts Alkylation of Phenol

(c) Give simple chemical test to distinguish between Ethanol and Phenol.

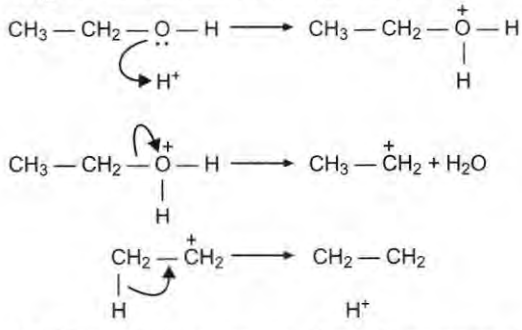
Answer : (a) (i) Conversion of phenol to anisole can be done as follows.



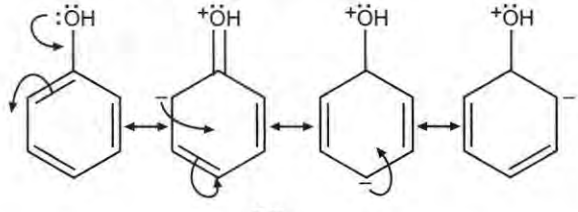
(ii) Ethanol can be converted to propan-2-ol through the following sequence :



(b) The mechanism of dehydration of ethanol to give ethene can be written as follows :

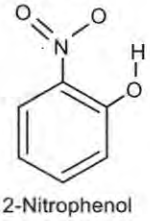


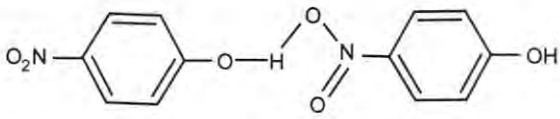
(c) The –OH group in phenol increases the electron density on the benzene ring hence electrophilic substitution reaction is more prominent in phenol compared to benzene. The lone pair of oxygen on phenolic–OH group takes part in the resonance and makes the ring electron rich, hence activating the ring for incoming electrophiles.



OR

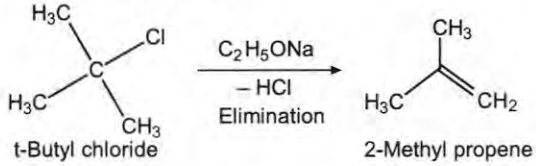
(a) (i) This difference arises due to the difference in extent of association of molecules with each other. In *o*-nitrophenol the nitro and hydroxyl group present in same molecule forms a hydrogen bond (intra-molecular) and thus have least association with nearby molecules, whereas in *p*-nitrophenol the nitro and hydroxyl groups of adjacent molecules form hydrogen bonds (intermolecular) which result in long range association of molecules. Hence, large amount of energy is required to break the intermolecular hydrogen bonds hence, high boiling point than the 2-nitrophenol molecules.





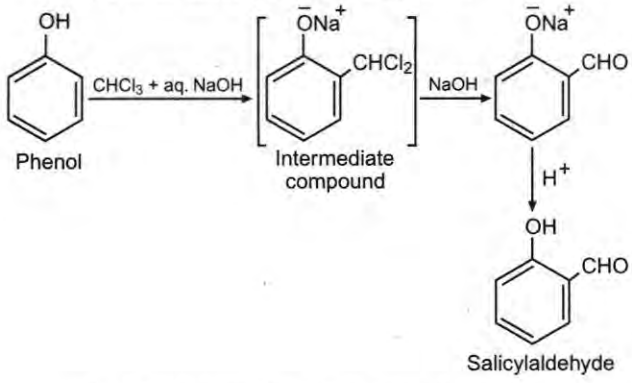
4-Nitrophenol

(ii) Sodium methoxide acts as strong base and extracts a proton from one of the methyl groups of *t*-butyl chloride giving rise to a primary carbanion which quickly loses Cl - to give a double bond, hence the product formed is 2-methyl propene.



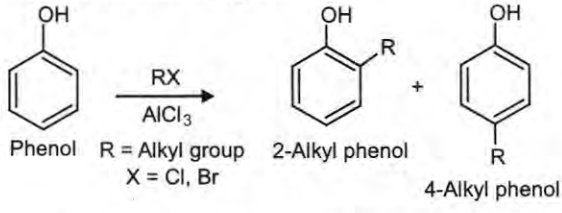
t-Butyl chloride 2-Methyl propene

(b) (i) Reimer-Tiemann reaction :



Phenol Intermediate compound Salicylaldehyde

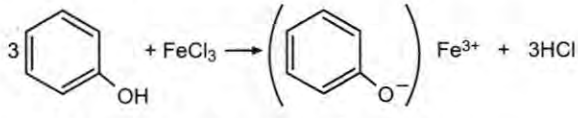
(ii) Friedal Crafts alkylation of phenol can be shown as following :



Phenol R = Alkyl group X = Cl, Br 2-Alkyl phenol 4-Alkyl phenol

(c) Chemical test to distinguish between ethanol and phenol :

On adding neutral $FeCl_3$, phenol gives a violet coloured solution but ethanol does not.



27. Give reasons for the following :

(i) Sulphur in vapour state shows para-magnetic behaviour.

(ii) N-N bond is weaker than P—P bond.**

(iii) Ozone is thermodynamically less stable than oxygen.

**** Answer is not given due to change in present syllabus.**

(b) Write the name of gas released when Cu is added to

(i) dilute HNO_3 and

(ii) conc. HNO_3 [5]

OR

(a) (i) Write the disproportionation reaction of H_3PO_3.**

(ii) Draw the structure of XeF_4.

(b) Account for the following :

(i) Although Fluorine has less negative electron gain enthalpy yet F_2 is strong oxidizing agent.

(ii)Acidic character decreases from N_2O_3 to Bi_2O_3 in group 15.**

(c) Write a chemical reaction to test sulphur dioxide gas. Write chemical equation involved.

Answer : (a) (i) In vapour phase sulphur partly exists as S_2 molecule and S_2 molecule like O_2 molecule has two unpaired electrons in anti-bonding π orbital, hence it shows paramagnetic behaviour.

(iii) Ozone (O_3) is thermodynamically less stable than dioxygen (O_2) because decomposition of ozone into dioxygen results in the liberation of heat (ΔH is negative) and increase in entropy (ΔS is positive). These two effects reinforce each other.

(b) (i) When Cu is added to dil. HNO_3 Nitrogen monoxide (NO) is released–

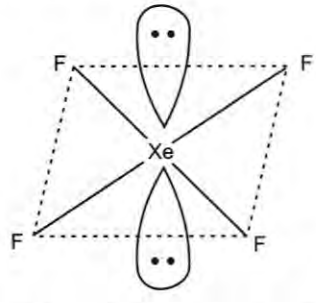
$$3Cu + 8HNO_3 \text{ (dil.)} \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$$

(ii) When Cu is added to conc. HNO_3 Nitrogen dioxide (NO_2) is released :

$$Cu + 4HNO_3\text{(conc.)} \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$$

OR

(a) (ii) Structure of XeF_4



(b) (i) Although Fluorine has less electron gain enthalpy yet it is a strong oxidising agent due to its low enthalpy of dissociation of F—F

bond and high enthalpy of hydration of F^- ion.

(c) Sulphur dioxide behaves as a reducing agent when moist, this property is being used for its test in laboratory. It decolorizes the purple coloured potassium permanganate(VII) solution :

$$5SO_2+2KMnO_4+2H_2O \rightarrow 2H_2SO_4+2MnSO_4+K_2SO_4$$

Purple colour solution — light brown colour

●●

Chemistry 2019 (Delhi) SET II

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

Note : Except for the following questions, all the remaining questions have been asked in previous set.

SECTION–A

2. Arrange the following in increasing order of base strength in gas phase : [1]

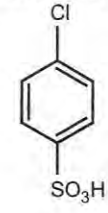
$(CH_2H_5)_3N$, $C_2H_5NH_2$, $(C_2H_3)_2NH$

Answer : In gas phase the basicity order will be –

$(C_2H_5)_3N > (C_2H_5)_2NH > C_2H_5NH_2$

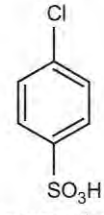
3. Why conductivity of silicon increasies on doping with phosphorus ?** [1]

5. Write IUPAC name of the given compound :



[1]

Answer :



4-Chlorobenzene-1-sulphonic acid

SECTION-B

8. Write two differences between an ideal solution and a non-ideal solution. [2]

Amswer : Differences between Ideal and non-ideal solutions–

S.No.	Ideal solution	Non-ideal solution
1.	Follows Raoult's law.	Does not follo Raoult's law.
2.	2. $\Delta H_{mix} = 0$, $\Delta V_{mix} = 0$	$\Delta H_{mix} \neq 0$, $\Delta V_{mix} \neq 0$

**** Answer is not given due to change in present syllabus.**

10. Write IUPAC of the complex $[Cr(NH_3)_4Cl_2]^+$. Draw structures of geometrical isomers for this complex. [2]

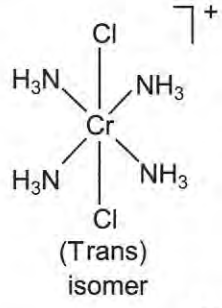
OR

Using IUPAC norms write the formulae for the following :

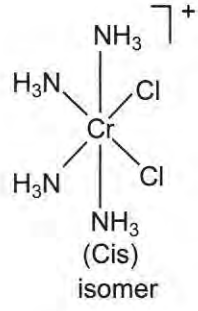
(i) Pentamminenitrito-O-cobalt(III) chloride

(ii) Potassium tetracyanidonickelate (II)

Answer : The IUPAC name for $[Cr(NH_3)_4Cl_2]^+$ is tetraammine dichlorochromium(III) :



(Trans) isomer



(Cis) isomer

OR

(i) Pentamminenitritocobalt(III)chloride :

$[Co(NH_3)_5ONO]Cl_2$

(ii) Potassium tetracyanidonickelate (II) :

$K_2[Ni(CN)_4]$

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

(i) diamagnetic

(ii) more stable

(iii) outer orbital compelx and

(iv) low spin complex ?

(Atomic no. of (Co = 27) [2]

Answer : $[Co(C_2O_4)_3]^{3-}$ has d^2sp^3 hybridisation (low spin complex) and $[CoF_6]^{3-}$ has sp^3d^2 hybridisation (high spin complex).

(i) $[Co(C_2O_4)_3]^{3-}$ is diamagnetic

(ii) $[Co(C_2O_4)_3]^{3-}$ is more stable.

(iii) $[CoF_6]^{3-}$ is outer orbital complex

(iv) $[Co(C_2O_4)_3]^{3-}$ is low spin complex.

SECTION-B

17. (i) Write the role of 'CO' in the purification of nickel.

(ii) What is the role of silica in the extraction of copper ?

(iii) What type of metals are generally extracted by electrolytic method ? [3]

Answer : (i) Role of CO in purification of Nickel : Mond process is the technique used to purify nickel. The impure nickel reacts with carbon monoxide at 50-60° C to form the gas nickel carbonyl, leaving the impurities as solids. Nickel carbonyl is subjected to higher temperature so that it is decomposed giving the pure metal.

$$Ni + 4CO \xrightarrow{330\text{-}350\ K} Ni(CO)_4$$

$$Ni(CO)_4 \xrightarrow{450\text{-}470\ K} Ni + 4CO$$

(ii) Role of silica in extraction of Copper : The role of silica in the metallurgy of copper is to remove the iron oxide obtained during the process of roasting. If the sulphide ore of copper contains iron, then silica (SiO_2) is added as flux before roasting.

$$FeO + SiO_2 \rightarrow FeSiO_3(slag)$$

(iii) Metals whose ions easily get reduced in solution or molten state are generally extracted by electrolytic method.

18. Give reasons for the following :

(i) Transition metals form alloys.

(ii) Mn_2O_3 is basic whereas Mn_2O_7 is acidic.

(iii) Eu^{2+} is a strong reducing agent. [3]

Answer : (i) Transition metal forms alloys because the atomic sizes of transition metals are very similar to each other. As the atomic sizes are very similar, one metal can replace the other metal from its lattice and form a solid solution. This solid solution is known as alloy.

(ii) In Mn_2O_3 manganese has +3 oxidation state, it has lone pairs of electrons which can be donated (Lewis base), hence it is basic in nature. Whereas in Mn_2O_7 manganese has +7 oxidation state. Higher oxidation states are short of electrons, meaning they can accept electrons and thus function as Lewis acids. So, Mn_2O_7 is acidic.

(iii) Reducing agent is that which can reduce other species and itself gets oxidized. Eu^{2+} readily changes to the common +3 oxidation state shown by the lanthanides by losing one more electron. So, $Eu^{2+}$is regarded as a strong reducing agent.

20. (i) Why bithional is added in soap ?

(ii) Why magnesium hydroxide is a better antacid than sodium bicarbonate ?

(ii) Why soaps are biodegradable whereas detergents are non-biodegradable ? [3]

OR

Define the following terms with a suitable example in each :

(i) Antibiotics

(ii) Artificial sweeteners

(iii) Analgesics

Answer : (i) Bithional is added in soap to impart antiseptic properties to soap.

(ii) Sodium bicarbonate if taken in excess can make the stomach alkaline in turn stimulating more acid release, hence magnesium hydroxide is better antacid than sodium bicarbonate because being insoluble, it does not increase the pH above neutrality.

(iii) Soaps are sodium or potassium salts of long chain fatty acids whereas the hydrocarbon portion of synthetic detergents contain highly branched hydrocarbon chain which is not easy for the bacteria to degrade. Hence, soaps are biodegradable but synthetic detergents are not.

OR

(i) Antibiotics : They are the compounds (produced by microorganisms or synthetically) which either inhibit the growth of bacteria or kill bacteria. Example : Penicillin.

(ii) Artificial sweeteners : They are the compounds which make the food sweet in taste without adding calories to the food. Example – Aspartame.

(iii) Analgesics : These are the compounds which reduce or abolish pain without causing impairment of consciousness, mental confusion or any other disturbances to central nervous system. They are of two types, Narcotic (Morphine) and non-narcotic (Example : Paracetamol).

21. Write the structures of main products when benzene diazonium chloride reacts with the following reagents.

(i) CuCN

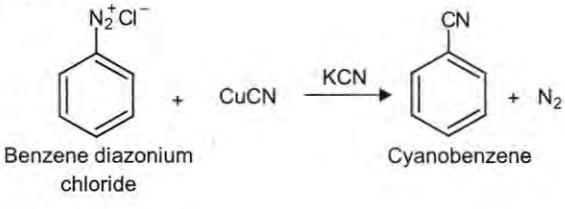
(ii) CH_3CH_2OH

(iii) KI [3]

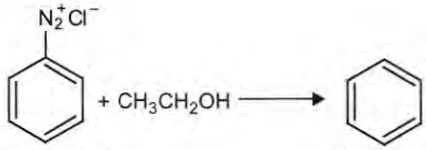
Answer :

The products will be as follows :

(i)

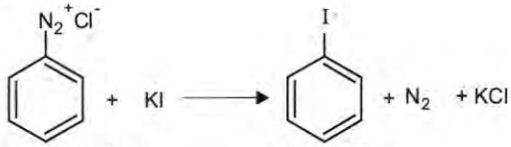


(ii)



+ N_2 + CH_3CHO + HCl

(iii)



●●

Chemistry 2019 (Delhi) SET III

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

Note : Except for the following questions, all the remaining questions have been asked in previous sets.

SECTION–A

1. Arrange the following in decreasing order of solubility in water :

$(CH_3)_3N$, $(CH_3)_2NH$, CH_3NH_2 **[1]**

Answer : Decreasing order of solubility in water is–

$CH_3NH_2 > (CH_3)_2NH > (CH_3)_3N$

2. What type of stoichiometric defect is shown by ZnS and why ?** **[1]**

3. Write one sterochemical difference between S_N1 and S_N2 reactions. **[1]**

Answer : Products of S_N1 reactions are usually racemic in nature, whereas Products of S_N2 reactions have inverted configuration compared to the starting reactant.

SECTION-B

7. State Henry's law and write its two applications. **[2]**

Answer : Henry's law states that the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas present above the surface of liquid or solution.

The most commonly used form of above law can be put as–

'The partial pressure of the gas in vapour phase (p) is proportional to the mole fraction of the gas (x) in the solution:.

$$p = K_H x$$

Applications :

1. To increase the solubility of CO_2 in soft drinks and soda water, the sealing is done under high pressure.

2. Tanks used by scuba divers are filled with air diluted with helium gas in order to avoid accumulation of nitrogen in bubbles in their blood. As increased pressure underwater increases solubility of nitrogen in the blood.

11. Write the hybridization and magnetic character of following complexes:

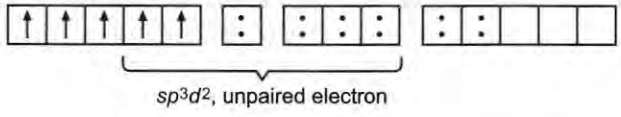
(a) $[Fe(H_2O)_6]^{2+}$

(b) $[Fe(CO)_5]$

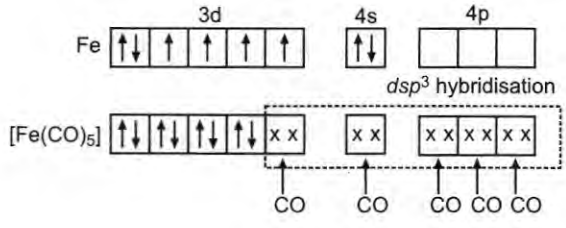
(Atomic no. of Fe = 26) **[2]**

Answer : (a) The hybridisation in $[Fe(H_2O)_6]^{3+}$ is sp^3d^2. As there are five unpaired electrons, it is strongly paramagnetic in nature.

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



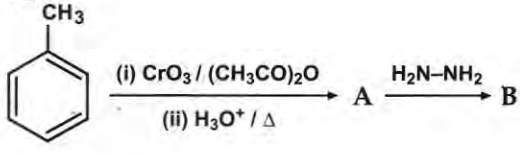
(b) $[Fe(CO)_5]$ has dsp^3 hybridisation and no unpaired electron, hence it is diamagnetic in nature.



12. Write structures of main compounds A and B in each of the following reactions : **[2]**

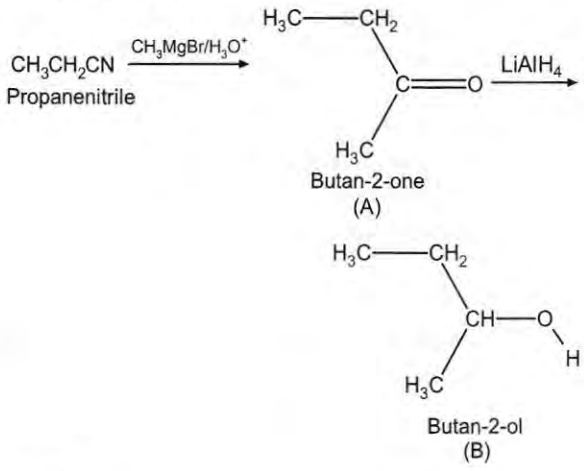
(i) $CH_3CH_2CN \xrightarrow{CH_3MgBr\,/\,H_2O^+} A \xrightarrow{LiAlH_4} B$

(ii)

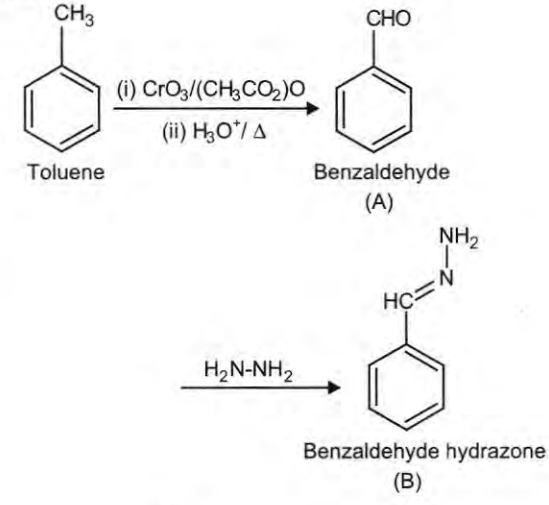


**** Answer is not given due to change in present syllabus.**

Answer : (i)



(ii)



SECTION-C

17. How will you convert the following :
(i) Impure nickel to pure nickel
(ii) Zinc blende to zinc metal
(ii) $[Ag(CN)_2]^-$ to Ag **[3]**

Answer : (i) Impure nickel can be converted to pure nickel by Mond's process. In this process, Nickel is heated in a stream of carbon monoxide forming a volatile complex, nickel tetracarbonyl

$$Ni + 4CO \xrightarrow{330\text{-}350\ K} Ni(CO)_4$$

The carbonyl is subjected to higher temperature so that it is decomposed giving the pure metal.

(ii) Zinc can be obtained from zinc blende as follows :

$$\underset{\text{Zinc blende}}{2ZnS} + \underset{\text{From air}}{O_2} \xrightarrow{\text{Roasting}} 2\,ZnO + 2SO_2$$

$$\underset{\text{Zinc oxide}}{ZnO} + C \xrightarrow{\text{Reduction}} Zn + CO_2$$

(iii) $[Ag(CN)_2]^{2-}$ can be converted into Ag by treating with zinc (a more electropositive element than silver). Hence, on treatment with zinc metal, Zn oxidizes to furnish Zn^{2+} ions, which go into solution replacing the Ag^+ ions, which are in turn reduced to metallic silver and deposited in pure form.

$$2[Ag(CN)_2]^{2-}(aq) + Zn(s) \rightarrow [Zn(CN)_4]^{2-}(aq) + 2Ag(s)$$

18. Give reasons for the following :
(i) The transition metals generally form coloured compounds.
(ii) E° value for (Mn^{3+}/Mn^{2+}) is highly positive than that for (Cr^{3+}/Cr^{2+}) couple.
(iii) The chemistry of actinoids elements is not so smooth as that of the lanthanoids. **[3]**

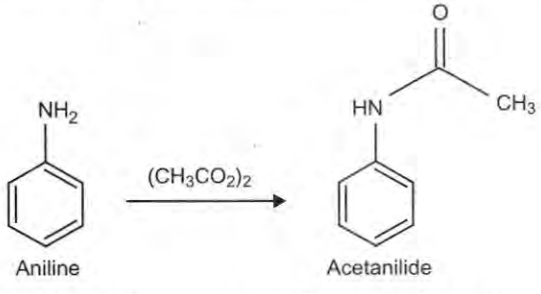
Answer : (i) Transition metals have partly filled *d*-orbitals. So, the single electrons available in *d*-orbitals absorb energy and go to higher unoccupied electronic energy levels. When they come back, they emit energy in visible range and hence impart colour.

(ii) E° value for Mn^{3+}/Mn^{2+} is highly positive because Mn^{2+} has a stable d^5 configuration and it is reluctant to lose one electron to achieve the 3+ state. Cr^{2+} has $3d^4$ configuration and losing another electron to achieve $3d^3$ configuration is not that difficult, hence the E° value is not more positive compared to Mn^{3+}/Mn^{2+}.

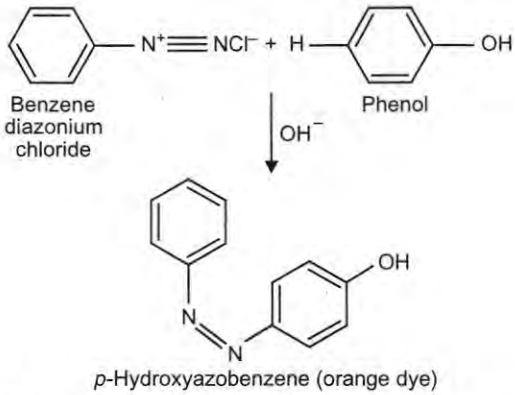
(iii) Chemistry of actinoid elements is not so smooth in view of their ability to exist in different oxidation states. Also, many of the actinoid elements are radioactive which makes the study of these elements difficult.

22. Write equations of the following reactions :
(i) Acetylation of aniline
(ii) Coupling reaction
(iii) Carbyl amine reaction **[3]**

Answer : (i) Acetylation of aniline :



(ii) Coupling reaction : Benzene diazonium chloride reacts with other suitable aromatic compounds to give azo compounds. This reaction is known as coupling reaction.



p-Hydroxyazobenzene (orange dye)

(iii) Carbylamine reaction : Aliphatic and aromatic primary amines on heating with chloroform and ethanolic potassium hydroxide form isocyanides or carbylamines.

$$\underset{\text{Ethylamine}}{C_2H_5NH_2} + \underset{\text{Chloroform}}{CHCl_3} + 3KOH \xrightarrow{\Delta} \underset{\text{Ethyl isonitrile}}{C_2H_5NC} + 3KCl + 3H_2O$$

(Potassium hydroxide)

24. Define the following with a suitable example in each :

(i) Oligosaccharides

(ii) Denaturation of protein

(iii) Vitamins **[3]**

OR

Write the reactions involved when D-glucose is treated with the following reagents :

(i) Br_2 water

(ii) H_2N–OH

(iii) $(CH_3CO)_2O$

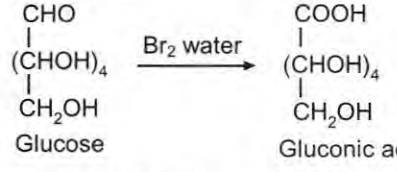
Answer : (i) Oligosaccharide : Carbohydrates that yield two to ten monosaccharide units on hydrolysis are known as oligosaccharides. They are further classified as disaccharides, trisaccharides, tertrasaccharides etc., depending upon the number of monosaccharides they provide upon hydrolysis. Disaccharides are the most common, *e.g.*, maltose.

(ii) Denaturation of protein : Protein found in a biological system with a unique three-dimensional structure and biological activity is called a native protein. When a native protein is subjected to physical change like temperature, chemical or pH change, the hydrogen bonds within the protein structure are disturbed causing globules to unfold and α-helix to uncoiled. The secondary and tertiary structures of protein molecule is destroyed, in turn losing their biological activity, this is known as denaturation of protein. Example is coagulation of egg white on boiling.

(iii) Vitamins : These are the organic compounds required in the diet in small amounts to perform specific biological functions for normal maintenance of optimum growth and health of organisms. Example – Vitamins A, B, C, D etc.

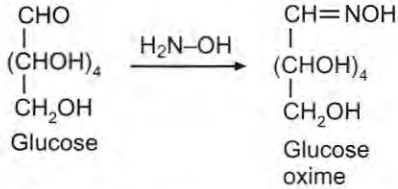
OR

(i) Reaction of glucose with Br_2 water (a mild oxidising agent) gives gluconic acid, this reaction indicates that carbonyl group of glucose is an aldehydic group :



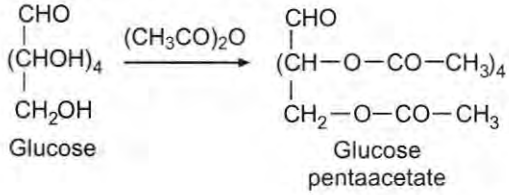
Glucose Gluconic acid

(ii) Reaction of glucose with H_2N—OH (hydroxylamine) gives oxime, this reaction confirms that there is a carbonyl group present in glucose :



Glucose Glucose oxime

(iii) Reaction of glucose with $(CH_3CO)_2O$ (acetic anhydride) gives glucose pentaacetate, this reaction confirms that there are five hydroxyl groups present in glucose :



Glucose Glucose pentaacetate

●●