Chemistry 2011 (Outside Delhi) SET I

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

1. **Define 'order of a reaction'.** [1]
Answer : The sum of powers of the concentrations of the reactants in the rate law expression is called the order of a reaction.

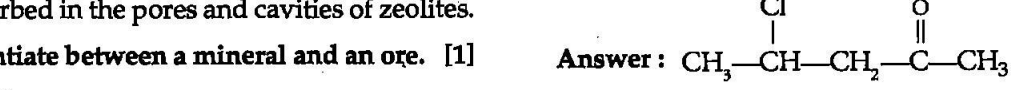
2. **What is meant by 'shape selective catalysis' ?** [1]
Answer : Catalysis using selective absorbents like zeolites as catalyst is called shape selective catalysis. In this catalysis small sized molecules are absorbed in the pores and cavities of zeolites.

3. **Differentiate between a mineral and an ore.** [1]
Answer :

S.No.	Mineral	Ore
1.	These are naturally occurring chemical substances obtained from earth crust by mining.	Ores are those minerals from which metals can be extracted profitably and conveniently.
2.	All minerals are not ores.	All ores are minerals.

4. **What is meant by 'lanthanoid contraction' ?** [1]
Answer : The lanthanoid contraction refers to the steady and regular decrease in atomic radii along the period from La^{+3} to Lu^{+3}.

5. **Write the IUPAC name of the following compound :**
$CH_2 = CHCH_2Br$ [1]
Answer : 3-Bromo-1-propene

6. **Draw the structure of 4-chloropentan-2-one.** [1]
Answer :


7. **How would you convert ethanol to ethene ?** [1]
Answer :
$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[H_2SO_4]{\text{warm conc.}} \underset{\text{Ethene}}{CH_2 = CH_2} + H_2O$$

8. **Rearrange the following in an increasing order of their basic strengths :** [1]
$C_6H_5NH_2$, $C_6H_5N(CH_3)_2$, $(C_2H_5)_2NH$ and CH_3NH_2.
Answer :
$$C_6H_5NH_2 < C_6H_5N(CH_3)_2 < CH_3NH_2 < (C_2H_5)_2NH$$

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

9. **Explain how you can determine the atomic mass of an unknown metal if you know its mass density and the dimensions of unit cell of its crystal.**** [2]

10. **Calculate the packing efficiency of a metal crystal for a simple cubic lattice.**** [2]

Answer : Edge length = a

11. **State the following :** [2]

(i) Raoult's law in its general form in reference to solutions.

(ii) Henry's law about partial pressure of a gas in a mixture.

Answer : (i) Raoult's Law : The partial vapour pressure of each component of a solution is equal to the vapour pressure of pure component multiplied by its mole fraction in the solution.

$$P = P_A x_A + P_B x_B$$

Where

P = Total vapour pressure of solution.

P_A and P_B = vapour pressure of components A and B.

x_A and x_B = mole fractions of components A and B.

(ii) Henry's Law : It states that the partial pressure of gas in vapour phase (P) is directly proportional to mole fraction of gas (x) in the solution and is expressed as

$$P = K_H . x$$

where K_H is Henry constant.

12. **What do you understand by the rate law and rate constant of a reaction ? Identify the order of a reaction if the units of its rate constant are :** [2]

(i) $L^{-1}mol\ s^{-1}$

(ii) $L\ mol^{-1}\ s^{-1}$

Answer : Rate law of a chemical reaction is the expression relating the rate of reaction to the concentrations or pressures of various reactants taking part in the reaction.

The rate of reaction at unit concentration of all reactants is known as the rate constant (K)

(i) Zero order (ii) Second order

13. **The thermal decomposition of HCO_2H is a first order reaction with a rate constant of 2.4 × 10^{-3} s^{-1} at a certain temperature. Calculate how long will it take for three-fourths of initial quantity of HCO_2H to decompose. (log 0.25 = −0.6021)** [2]

Answer : $t = \frac{2.303}{k} \log \frac{a}{a-x}$

$k = 2.4 \times 10^{-3}$

$x = \frac{3}{4} = 0.75$

$$t = \frac{2.303}{2.4\times10^{-3}} \log \frac{1}{1-0.75}$$

$$= \frac{2.303}{2.4\times10^{-3}} \log 0.25$$

$$= \frac{2.303}{2.4\times10^{-3}} \times 0.6020 = 577.6 \text{ sec.}$$

14. **Describe the principle controlling each of the following processes :** [2]

(i) Vapour phase refining of titanium metal

(ii) Froth floatation method of concentration of a sulphide ore

Answer : (i) Titanum is converted to its volatile form which is evaporated and then decomposed to give pure titanium.

(ii) The ore particles get adsorbed on oil droplets and come to the surface where they can be collected as froth gangue is wetted by water and gets settle down.

15. **How would you account for the following :** [2]

(i) Cr^{2+} is reducing in nature while with the same d-orbital configuration (d^4) Mn^{3+} is an oxidizing agent.

(ii) In a transition series of metals, the metal which exhibits the greatest number of oxidation states occurs in the middle of the series.

Answer : (i) Cr^{2+} has configuration d^4 which easily changes to d^3 due to stable half filled t^2g orbitals. Therefore, Cr^{2+} is reducing agent and Mn^{3+} easily changes to Mn^{2+} and acts as an oxidizing agent.

(ii) Due to presence of more unpaired electrons and more number of partially filled orbitals in the middle of a transition series,these metals exhibit the greatest number of oxidation states.

16. **Complete the following chemical equations :** [2]

(i) $MnO_4(aq) + S_2O_3^{2-}(aq) + H_2O(l) \rightarrow$

(ii) $CrO_7^{2-}(aq) + Fe^{2+}(aq) + H^+(aq) \rightarrow$

OR

State reasons for the following :

(i) Cu (i) ion is not stable in an aqueous solution.

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

(ii) Unlike Cr^{3+}, Mn^{2+}, Fe^{3+} and the subsequent other M^{2+} ions of the 3*d* series of elements, the 4*d* and the 5*d* series metals generally do not form stable cationic species.

Answer :

(i) $8MnO_4^-(aq) + 3S_2O_3^{2-}(aq) + H_2O(l) \rightarrow 8MnO_2(s) + 6SO_4^{2-}(aq) + 2OH^-(aq)$

(ii) $Cr_2O_7^{2-}(aq) + 6Fe^{2+}(q) + 14H^+(aq) \rightarrow 2Cr^{3+}(aq) + 6Fe^{3+}(aq) + 7H_2O(l)$

OR

(i) Cu^{2+} is more stable than Cu^+ because hydration energy of Cu^{2+} is high and it is therefore, stable in aqueous solution. Therefore, Cu^+ disproportionates to Cu^{2+} and Cu.

$$2Cu^+ \rightarrow Cu^{2-} + Cu$$

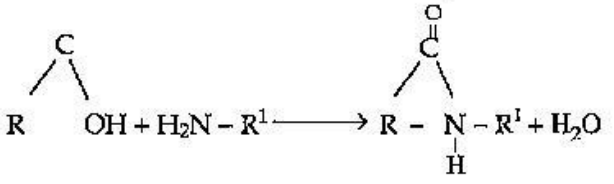
(ii) Because of Lanthanoid contraction, expected increase in size does not occur. That is why they do not form stable cations.

17. Explain what is meant by the following : [2]

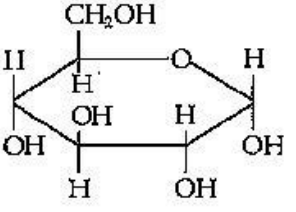
(i) Peptide linkage

(ii) Pyranose structure of glucose

Answer : (i) Peptide linkage is the peptide bond formed between amino acids. It is a covalent bond formed between amino group of one molecule and carboxylic acid group of another molecule, causing the release of one molecule of water.



(ii) Cyclic structure of glucose is called pyranose because it resembles pyran ring. Its structure includes a six membered ring with 5-carbon atoms and one oxygen atom having no double bonds.



18. Write the main structural difference between DNA and RNA. Of the four bases, name those which are common to both DNA and RNA. [2]

Answer :

	DNA	RNA
1.	Sugar present in DNA, is 2-deoxy D-ribose	In RNA, sugar is D-ribose
2.	DNA is double stranded molecule	RNA is single stranded molecule
3.	DNA can replicate	RNA can not replicate

Aderine, cytonine and guanine are bases present in both DNA and RNA

19. A solution prepared by dissolving 8.95 mg of a gene fragment in 35.0 mL of water has an osmotic pressure of 0.335 torr at 25°C. Assuming that the gene fragment is a non-electrolyte, calculate its molar mass. [3]

Answer : Given, V = 35 ml, T = 298 k, π = 0.335 torr, $W_2 = 8.95 \times 10^{-3}$ g

$M_2 = ?$

$$\pi = CRT \Rightarrow \pi = \frac{W_2 RT}{M_2 V} \text{ or } M_2 = \frac{W_2 RT}{\pi V}$$

$$= \frac{8.95 \times 10^{-3} \times 0.0821 \times 298 \times 760 \times 1000}{0.335 \times 35}$$

$$= \frac{166416.3716}{11.725} = 14193.3 \text{ g mol}^{-1}$$

$M_2 = 1.42 \times 10^4$ g mol^{-1}

20. Classify colloids where the dispersion medium is water. State their characteristics and write an example of each of these classes. [3]

OR

Explain what is observed when

(i) an electric current is passed through a Solution

(ii) a beam of light is passed through a Solution

(iii) an electrolyte (say NaCl) is added to ferric hydroxide sol

Answer : Colloids can be classified into two types where the dispersion medium is water. They are as follows :

1. Hydrophillic Colloids or Lyophillic : The substances when mixed with dispersion medium form colloidal solution directly are called hydrophilic colloids. They are quite stable, reversible solutions and can't get precipated easily. *e.g.*, Gum starch, etc.

2. Hydrophobic Colloids or Lyophobic : The substances which do not form colloidal solution with dispersion medium are called hydrophobic colloids. They are unstable, irreversible solutions and can be easily precipitated. *e.g.*, Metals and their sulphides.

OR

(i) When electric current is passed through a solution, then positively charged ions move

towards cathode and negatively charged ions move towards anode. Then they get coagulate. This is known as Electrophoresis.

(ii) When a beam of strong light is passed through solution, light gets scattered by the colloidal particles and path of light becomes visible. This is known as Tyndall effect.

(iii) When NaCl is added to ferric hydroxide sol then a negatively charged solution is obtained with absorption of OH^- ion.

21. How would you account for the following : [3]

(i) H_2S is more acidic than H_2O.

(ii) The N–O bond in NO_2^- is shorter than the N–O bond in NO_3^-

(iii) Both O_2 and F_2 stabilize high oxidation states but the ability of oxygen to stabilize the higher oxidation state exceeds that of fluorine.

Answer : (i) Size of sulphur is larger than oxygen due to which S–H bond length increases and hence the bond dissociation energy of S–H is less than O–H. Therefore S–H easily loses H^+ and is more acidic than H_2O.

(ii) Due to tendency of nitrogen to form $p\pi$–$p\pi$ multiple bonds, there is a difference in N–O bond lengths of NO_2 and NO_3.

(iii) Due to the property of oxygen to form double bonds with the metal atoms, oxygen stabilizes the higher oxidation state even more than fluorine.

22. Explain the following terms giving a suitable example in each case : [3]

(i) Ambident ligand

(ii) Denticity of a ligand

(iii) Crystal field splitting in an octahedral field

Answer : (i) Ligands which can ligate to the central atom in two places ligands such as SCN which can attach at either S atom or N atom are called ambidentate ligand.

(ii) The number of donor atoms of a ligand when bound with central atom in a coordination complex is called its denticity.

(iii) The splitting of five degenerate *d*-orbitals in two sets, one with three orbitals and another with two orbitals is known as crystal field splitting.

23. Rearrange the compounds of each of the following sets in order of reactivity towards S_N2 displacement : [3]

(i) 2-Bromo-2-methylbutane, 1-Bromopentane, 2-Bro-mopentane

(ii) 1-Bromo-3-methylbutane, 2-Bromo-2-methyl-butane, 2-Bromo-3-methylbutane

(iii) 1-Bromobutane, 1-Bromo-2,2-dimethylpropane, 1- Bromo-2-methylbutane.

Answer : (i) 1-bromopentane > 2-bromopentane > 2-bromo-2-methylbutane.

(ii) 1-bromo-3 methylbutane > 2-bromo-3-methylbutane > 2-bromo-2-methyl butane.

(iii) 1-bromobutane > 1-bromo-3-methylbutane > 1-bromo-2-, 2-dimethylpropane.

24. How would you obtain the following : [3]

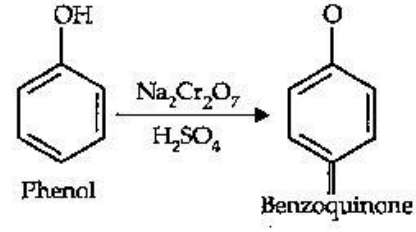
(i) Benzoquione from phenol

(ii)2-Methylpropan-2-ol from methylmagnesium bromide

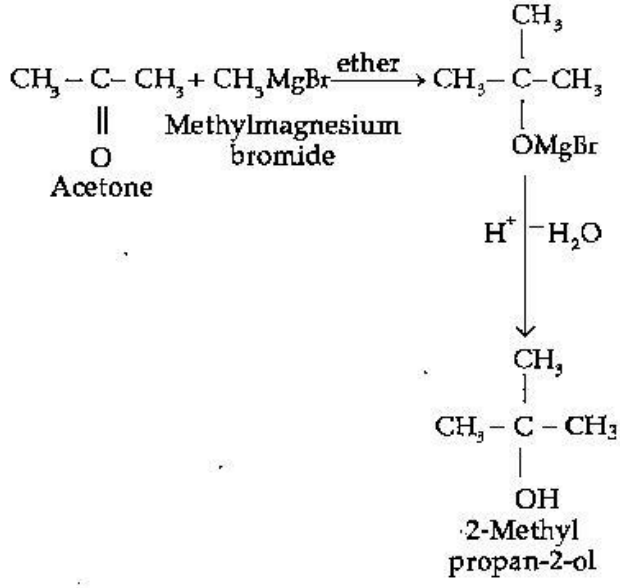
(iii) Propan-2-ol from propene

Answer :

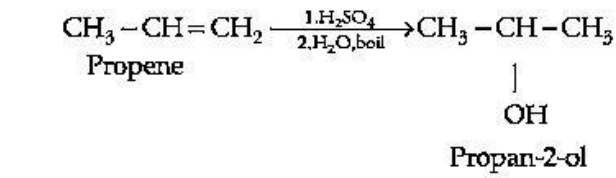
(i)



(ii)



(iii)



25. State reasons for the following : [3]

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

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

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

Answer : (i) Higher value of pK_b means lower basicity, therefore, aniline is less basic than methylamine because in aniline the lone pair of electrons on N atom gets delocalized over the benzene ring and remains unavailable for protonation due to resonance but this is absent in methylamine.

(ii) Ethylamine forms H-bonds with water therefore, it is soluble in water but aniline does not form H-bonds with water due to its larger hydrocarbon part and is insoluble in water.

(iii) In primary amines, two H-atoms are attached to N-atom and they undergo intermolecular H-bonding, but tertiary amines due to the absence of H-atom on N-atom do not undergo H-bonding . Therefore, primary amines have higher boiling point than tertiary amines.

26. Draw the structures of the monomers of the following polymers : [3]

(i) Polythene (ii) PVC (iii) Teflon

Answer : (i) Ethene —$CH_2 = CH_2$—

(ii) Vinyl chloride —$CH_2 = CHCl$—

(iii) Tetraflouroethylene —$CF_2 = CF_2$—

27. What are the following substances ? Give one example of each. [3]

(i) Food preservatives

(ii) Synthetic detergents

(iii) Antacids

Answer : (i) Chemicals added to food to prevent its spoilage by killing or preventing the growth of microorganisms like bacteria, yeasts and moulds.

e.g., sodium benzoate.

(ii) Synthetic detergents are sodium or potassium salts of long chain sulphonic acids. They don't precipitate in hard water. *e.g.*, Sodium laurylsulphate.

(iii) Antacids are chemicals consumed to get relief from acidity in the stomach by neutralizing excess acid. *e.g.*, milk of magnesia.

28. (a) What type of a battery is lead storage battery ? Write the anode and cathode reactions and the overall cell reaction occurring in the operation of a lead storage battery. [5]

(b) Calculate the potential for half-cell containing

0.10 M $K_2Cr_2O_7$ (*aq*), 0.20 M Cr^{3+} (aq) and 1.0×10^{-4} M H^+ (aq). The half-cell reaction is and the standard electrode potential is given as $E^\circ = 1.33$ V.

$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$

OR

(a) How many moles of mercury will be produced by electrolyzing 1.0 M $Hg(NO_3)_2$ solution with a current of 2.00 A for 3 hours ? [$Hg(NO_3)_2 = 200.6$ g mol^{-1}]

(b) A voltaic cell is set up at 25°C with the following half-cells Al^{3+} (0.001 M) and Ni^{2+} (0.50 M). Write an equation for the reaction that occurs when the cell generates an electric current and determine the cell potential.

(Given : $E^\circ_{Ni^{2+}|Ni} = -0.25$V, $E^\circ_{Al^{3+}|Al} = -1.66$V)

Answer : (a) Lead storage battery is a secondary cell (rechargable). The electrode reaction is as follows :

At anode : $Pb(s) + SO_4^{2-}(aq) \longrightarrow PbSO_4(s) + 2e^-$

At cathode :

$$PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O$$

Overall reaction :

$$Pb(s) + PbO_2(s) + 4H^+(aq) + 2SO_4^{2-}(aq) \longrightarrow PbSO_4(s) + 2H_2O$$

(b) $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

$0.1\,M \quad 10^{-4}\,M \quad 0.2\,M$

$$E = E^\circ - \frac{0.059}{6} \log \frac{[Cr^{3+}]^2}{[Cr_2O_7^{2-}][H^+]^{14}}$$

$$E = 1.33 - \frac{0.059}{6} \log \frac{(0.20)^2}{(0.10)(10^{-4})^{14}}$$

$E = 1.33\,V - 0.55\,V$

$E = 0.78\,V$

OR

(a) $Hg^{2+} + 2e^- \rightarrow Hg$

Quantity of electricity (Q) = $I \times t = 2 \times 3 \times 60 \times 60 = 21600$C

2F (2×96500 C) deposits Hg = 1 mole

$\because$ 1C deposits e Hg = $\frac{1}{2 \times 96500}$

$\therefore$ 21600 C deposits e Hg

$$= \frac{1}{2 \times 96500} \times 21600$$

$$= 0.1119 \text{ mole}$$

(b) $2Al + 3Ni^{2+} \rightarrow 3Ni - 2Al^{3+}$

$$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$$

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{n}\log\frac{[Al^{3+}]^2}{[Ni^{+2}]^3}$$

$$E_{cell} = E^{\circ}_{Ni^{2+}/Ni} - E^{\circ}_{Al^{3+}/Al} - \frac{0.059}{6}\log\frac{[Al^{3+}]^2}{[Ni^{2+}]^3}$$

$$E_{cell} = -0.25 - (-1.66) - \frac{0.059}{6}\log\frac{[0.001]^2}{[0.50]^3}$$

$$E_{cell} = 1.41 - 0.00985\log\frac{1}{125}$$

$$E_{cell} = 1.41 - 0.00985 \times -2.0969$$

$$= 1.41 + 0.0206 = 1.43V$$

29. (a) Draw the structures of the following molecules : [5]

(i) $(HPO_3)_3$ (ii) BrF_3**

(b) Complete the following chemical equations :

(i) $HgCl_2 + PH_3 \longrightarrow$

(ii) $SO_3 + H_2SO_4 \longrightarrow$

(iii) $XeF_4 + H_2O \longrightarrow$

OR

(a) What happens when

(i) Chlorine gas is passed through a hot concentrated solution of NaOH ?

(ii) Sulphur dioxide gas is passed through an aqueous solution of a Fe(III) salt ?

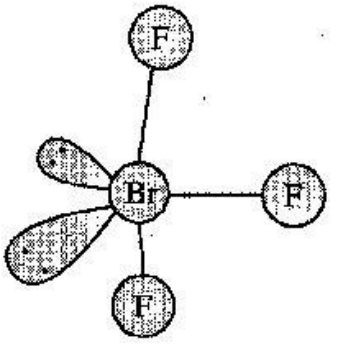
(b) Answer the following :

(i) What is the basicity of H_3PO_3 and why ?**

(ii) Why does fluorine not play the role of a central atom in interhalogen compounds ?

(iii) Why do noble gases have very low boiling points ?

Answer : (a) (ii) BrF_3



(b) (i) $3HgCl_2 + 2PH_3 \rightarrow Hg_3P_2 + 6HCl$

(ii) $SO_3 + H_2SO_4 - H_2S_2O_7$

(iii) $6XeF_4 + 12H_2O - 4Xe + 2XeO_3 + 24HF + 3O_2$

OR

(a)(i)

$6NaOH + 3Cl_2 \rightarrow 5NaCl + NaClO_3 + 3H_2O$

(ii) $2Fe^{3+} + SO_2 + 2H_2O - 2Fe^{2+} + SO_4^{2-} + 4H^+$

(b)(ii) Since fluorine is the most electro-negative halogen, it does not acts as a central atom in interhalogen compounds due to absence of *d*-orbital.

(iii) Noble gases are monoatomic with weak Vander Waals forces of attraction and hence have low boiling points.

30. (a) Illustrate the following name reactions : [5]

(i) Cannizzaro's reaction

(ii) Clemmensen reduction

(b) How would you obtain the following :

(i) But-2-enal from ethanal

(ii) Butanoic acid from butanol

(iii) Benzoic acid from ethylbenzene

OR

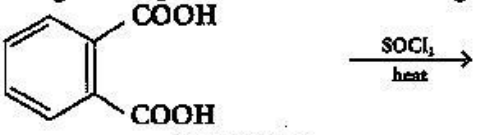
(a) Give chemical tests to distinguish between the following :

(i) Benzoic acid and ethyl benzoate

(ii) Benzaldehyde and acetophenone

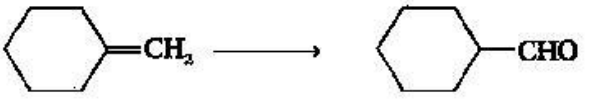
(b) Complete each synthesis by giving missing reagents or products in the following :

(i)



(ii) $C_6H_5CHO \xrightarrow{H_2HCONHNH_2}$

(iii)



Answer : (a) (i) Aldehydes having no α -hydrogen atom undergoes self oxidation and reduction on treatment with concentrated alkali and produce alcohol and carboxylic acid salt.

(ii)

$$\underset{\text{Formaldehyde}}{2HCHO} \xrightarrow[\text{conc.}]{NaOH} \underset{\text{methanol}}{CH_3-OH} + \underset{\text{sodium formate}}{H-COONa}$$

(ii) Reduction of aldehydes and ketones to their respective hydrocarbons. On treating with zinc amalgam and concentrated hydro-chloric acid

$$\underset{\text{Ethanal}}{CH_3CHO} \xrightarrow[HCl]{Zn-Hg} \underset{\text{Ethane}}{CH_3CH_3} + H_2O$$

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

(b)(i)

$$2CH_3CHO \xrightarrow{\text{dil.NaOH}} CH_3-\underset{\text{3-Hydroxybutanal}}{\underset{|}{\overset{OH}{CH}}}-CH_2-CHO$$

Ethanal

$$\downarrow H^+/H_2O$$

$$CH_3-CH=CH-CHO \leftarrow$$

But-2-enal

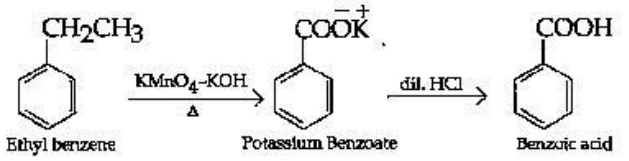
(ii) $CH_3CH_2CH_2CH_2OH \xrightarrow{CrO_3-H_2SO_4}$

Butan-1-ol

$CH_3CH_2CH_2COOH$

Butanoicacid

(iii)



Ethyl benzene — Potassium Benzoate — Benzoic acid

OR

(a) (i) Benzoic acid gives CO_2 gas on reacting with $NaHCO_3$ but ethyl benzoate does not

(ii) Acetophenone gives iodoform test but benzaldehyde does not

$C_6H_5COCH_3 + 4NaOH + 3I_2 \rightarrow$

Acetophenone Sod.hypoiodide

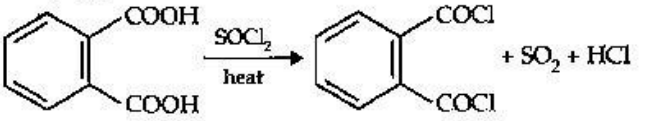
$C_6H_5COONa + CHI_3 + 3H_2O + 3NaI$

Sod.benzote Iodoform (yellow ppt.)

$C_6H_5CHO + NaOI \rightarrow$ No yellow ppt. of Iodoform

(Benzaldehyde)

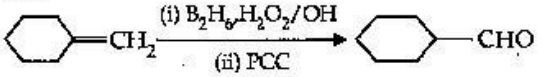
(b)(i)



(ii)

$$C_6H_5CHO \xrightarrow{H_2NCONHNH_2} C_6H_5CH=NNHCONH_2 + H_2O$$

(iii)



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Chemistry 2011 (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 previous set.

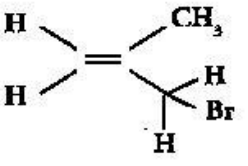
2. What are lyophobic colloids ? Given one example for them. [1]

Answer : Colloids in which the colloidal particles have no affinity for the dispersion medium and they do not form colloidal solution are lyophobic colloids, like, $Al(OH)_3$ and As_2S_3 sols.

3. Why is it that only sulphide ores are concentrated by 'froth floatation process' ? [1]

Answer : Due to the affinity of heavy oil droplets to adsorb sulphide particles. The ore particles come on the surface as froth, gangue particles are wetted by water and get settle down.

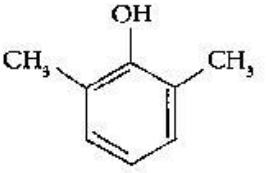
5. Write the IUPAC name of the following compound: [1]



Answer : 3-Bromo-2-methyl prop-1-ene

6. Draw the structure of 2, 6-Dimethylphenol. [1]

Answer :



9. Define the following terms in relation to crystalline solids : [2]**

(i) Unit Cell

(ii) Coordination number

12. A reaction is of second order with respect to a reactant. How is the rate of reaction affected if the concentration of the reactant is reduced to half ? What is the unit of rate constant for such a reaction ? [2]

Answer : Rate $= K[A]^2 = ka^2$

If $[A] = \frac{1}{2}a$, then Rate $= K\left(\frac{a}{2}\right)^2 = \frac{1}{4}ka^2$

$\therefore$ Rate $= \frac{1}{4}$ of original rate

The unit of rate constant is L mol^{-1} s^{-1}

14. Describe the principle controlling each of the following processes : [2]

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

(i) Zone refining of metals

(ii) Electrolytic refining of metals

Answer : (i) Zone refining of Metals : It is based on the principle that impurities are more soluble in molten state of metal than in the solid state.

(ii) Electrolytic refining : Impure metal is made of anode, thin sheet of pure metal is made of cathode and a salt of the metal is used as an electrolyte. On passing current, metal from anode goes into the solution and ions in the solution reduce on cathode leading to deposition of pure metal.

15. Explain giving a suitable reason for each of the following : [2]

(i) Transition metals and their compounds are generally found to be good catalysts.

(ii) Metal-metal bonding is more frequent for the 4*d* and the 5*d* series of transition metals than that for the 3*d* series.

Answer : (i) Due to presence of vacant orbitals and tendency to form large number of oxidation states, transition metals have a high tendency to form complexes and hence acts as a catalysts.

(ii) In transition metals of 4*d* and 5*d* series the 4*d* and 5*d* electrons are at greater distance from the nucleus therefore they are less tightly held to the atom by the nucleus and hence contribute more to metallic bonding as compared to transition metals of 3*d* series.

19. What mass of NaCl must be dissolved in 65.0 g of water to lower the freezing point of water by 7.50°C ? The freezing point depression constant (K_f) for water is 1.86°C/m. Assume Van't Hoff factor for NaCl is 1.87. (Molar mass of NaCl = 58.5 g) [3]

Answer : Given, $M_2 = 58.5\ g\ mol^{-1}$

$W_1 = 65\ g,\ \Delta T_f = 7.5°C$

$K_f = 1.86\ K\ kg\ mol^{-1}$

$i = 1.87$

$$\Delta T_f = \frac{iK_f \times W_2 \times 1000}{W_1 \times M_2}$$

$$W_2 = \frac{\Delta T_f . W_1 \times M_2}{i \times K_f \times 1000} = \frac{7.5 \times 65 \times 58.5}{1.87 \times 1.86 \times 1000}$$

$$= \frac{28518.75}{3478.2} = 8.1999$$

∴ Mass of NaCl to be dissolved $W_2 = 8.1999\ g = 8.209 g$.

22. Write the structures and names of all the stereoisomers of the following compounds : [3]

(i) $[Co(en_3)]Cl_3$ (ii) $[Pt(NH_3)_2Cl_2]$

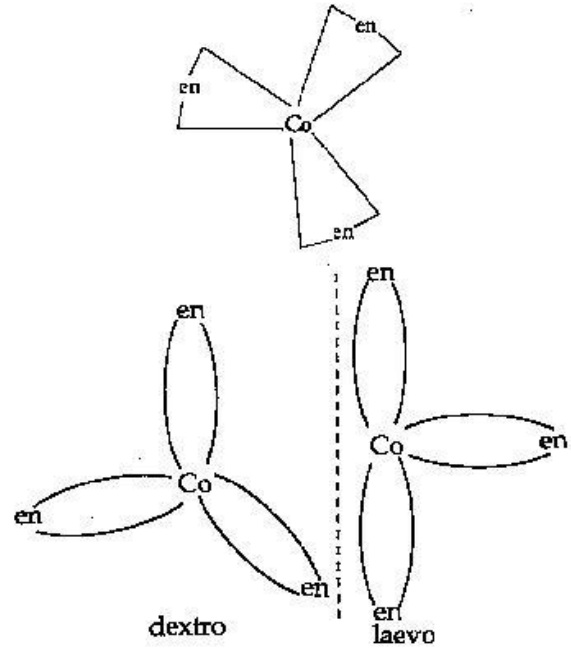
(iii) $[Fe(NH_3)_4Cl_2]Cl$

Answer : (i) Stereoisomerism is of two types :

(1) Geometrical isomerism

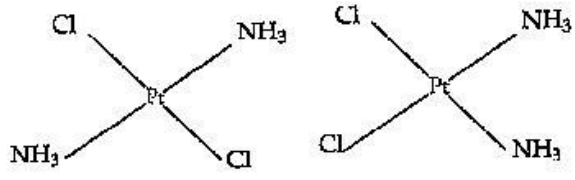
(2) Optical isomerism

$[Co(en)_3]Cl_3$: Tris (ethylenediammine) cobalt (III) chloride



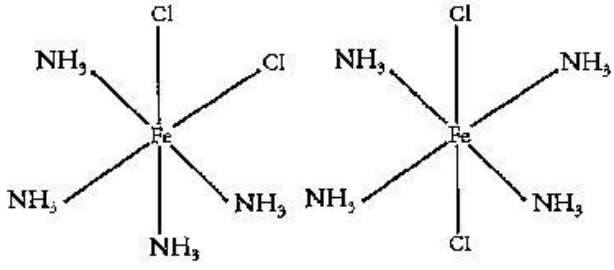
(ii) $[Pt(NH_3)_2Cl_2]$ Diammine dichloridoplatinum(ii)

Geometrical isomers



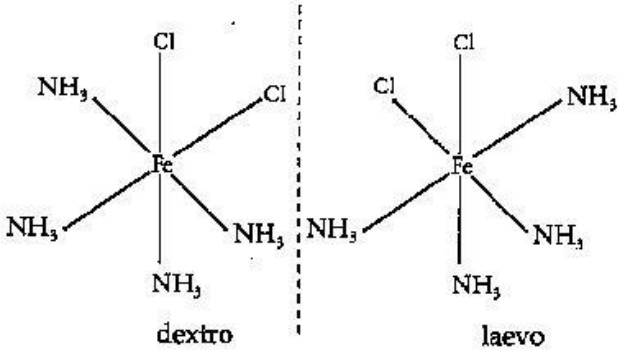
cis-form trans-form

(iii) $[Fe(NH_3)_4Cl_2]Cl$ Tetraammine dichloride iron (III) chloride



cis-form trans-form

Optical isomer Only cis form



27. (a) **Differentiate between a disinfectant and an antiseptic. Give one example of each.**

(b) **What is tincture of iodine and what is it used for ?** [3]

Answer : (a)

	Disinfectant	Antiseptic
1.	Chemical substances used to kill microorganisms	Chemical substances which prevent growth of microorganisms and may even kill them.
2.	They are applied on non-living objects	They are safe to apply on living tissues.
3.	They are used in drains, toilets, floors etc.	They are used on wounds, cut, ulcers etc.
4.	Example : Phenol (1%)	Example : Soframycin

Answer : (b) 2-3% solution of iodine in alcohol and water is called tincture iodine and is widely used as an antiseptic.

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Chemistry 2011 (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 previous sets.

1. **Define 'activation energy' of a reaction.** [1]
Answer : Activation energy is the minimum energy that is to be provided to the reactants for the reaction to take place.

2. **What is meant by 'reverse osmosis' ?** [1]
Answer : When a pressure higher than osmotic pressure is applied the solvent will flow from the solution into the pure solvent through the semipermeable membrane, called reverse osmosis.

3. **What type of ores can be concentrated by magnetic separation method ?** [1]
Answer : Ores with different magnetic properties and impurities which are magnetic in nature can be concentrated by magnetic separation method.
e.g. Chromite (Fe O. Cr_2O_3), Magnetite (Fe_3O_4)

14. **Describe the principle controlling each of the following processes :** [2]
(i) Preparation of cast iron from pig iron.
(ii) Preparation of pure alumina (Al_2O_3) from bauxite ore.
Answer : (i) Preparation of cast iron from pig iron : The iron obtained from blast furnace is called pig iron. Cast iron is prepared by melting pig iron with scrap iron and coke using hot air blast. It has slightly lower carbon content (about 3%). It is extremely hard and brittle.
(ii) Preparation of pure alumina from bauxite ore : The principal ore of aluminium is bauxite $Al_2O_3.xH_2O$. Bauxite is concentrated by digesting the powdered ore with concentrated solution of NaOH at 473-523K. The Al_2O_3 is leached out as sodium aluminate. The sodium aluminate is neutralized by passing CO_2 gas and hydrated Al_2O_3 is precipitated which is filtered, dried and heated to give pure Al_2O_3.

$$Al_2O_3(s) + 2NaOH(aq) + 3H_2O(l) \rightarrow 2Na[Al(OH)_4](aq)$$

$$2Na[Al(OH)_4](aq) + CO_2(g) \rightarrow Al_2O_3.xH_2O + 2NaHCO_3(aq)$$

$$\underset{\text{Hydrated alumina}}{Al_2O_3.xH_2O} \xrightarrow{1470K} \underset{\text{(pure alumina)}}{Al_2O_3(s)} + xH_2O(g)$$

15. **Explain giving reasons :** [2]
(i) Transition metals and their compounds generally exhibit a paramagnetic behaviour.
(ii) The chemistry of actinoids is not so smooth as that of lanthanoids.
Answer : (i) Transition metals and their compounds exhibit a paramagnetic behaviour due to presence of unpaired electrons in the Penultimate shell of *d*-orbital.
(ii) Lanthanoids show limited number of oxidation states, +2, +3, +4 because of large energy gap between 4*f* and 5*d* subshells. Actinoids show a number of oxidation states +4, +5, +6, +7 due to small energy difference between 5*f*, 6*d* and 7*s* subshells.

18. Write such reactions and facts about glucose which cannot be explained by its open chain structure. [2]

Answer : Limitations of open chain structure of glucose :

(i) Glucose does not forms $NaHSO_3$ as addition product.

(ii) Glucose penta-acetate does not reacts with NH_2OH due to absence of aldehyde group.

21. How would you account for the following : [3]

(i) NF_3 is an exothermic compound but NCl_3 is not.**

(ii) The acidic strength of compounds increase in the order :

$$PH_3 < H_2S < HCl$$

(ii) As electronegativity increases in the same period from left to right so their electronegativity is in the increasing order P < S < Cl. Therefore, acidic strength increases in the order,

$$PH_3 < H_2S < HCl$$

(iii) SF_6 is protected by six F atoms and hence does not allow to attack on sulphur atom.

22 Write the state of hybridization, the shape and the magnetic behaviour of the following complex entitles : [3]

(i) $[Cr(NH_3)_4Cl_2]Cl$

(ii) $[Co(en)_3]Cl_3$

(iii) $K_2[Ni(CN)_4]$

Answer : (i) d^2sp^3, octahedral, diamagnetic

(ii) d^2sp^3, octahedral, diamagnetic

(iii) dsp^2, square planar, diamagnetic

26. Write the names and structures of the monomers of the following polymers : [3]

(i) Buna-S

(ii) Dacron

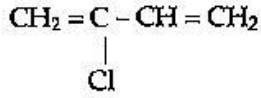
(iii) Neoprene

Answer : (i) Buna-S : 1,3-Butadiene

$CH_2 = CH - CH = CH_2$ and styrene $C_6H_5CH = CH_2$

(ii) Dacron : Ethylene glycol $HOCH_2CH_2OH$, Terephthalic acid

(iii) Neoprene : Chloroprene



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Chemistry 2011 (Delhi) SET I

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

1. 'Crystalline solids are anisotropic in nature'. What does this statement mean ?** [1]

2. Express the relation between conductivity and molar conductivity of a solution held in a cell. [1]

Answer : The molar conductivity of a solution is related to conductivity of that solution as :

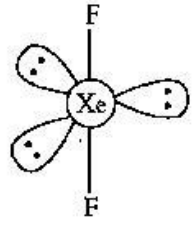
$$\Lambda_m = \frac{K}{C} = \frac{\text{Conductivity}}{\text{Concentration}}$$

3. Define 'Electrophoresis'. [1]

Answer : Electrophoresis is the phenomenon of movement of colloidal particles under the applied electric field.

4. What is the structure of XeF_2 molecule ? [1]

Answer :

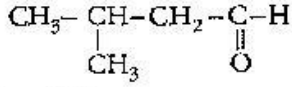


5. Write the IUPAC name of the following compound : $(CH_3)_3CCH_2Br$ [1]

Answer : 1-bromo-2, 2-dimethylpropane

6. Draw the structure of 3-methylbutanal. [1]

Answer :



7. Arrange the following compounds in an increasing order of their solubility in water : [1]

$C_6H_5NH_2$, $(C_2H_5)_2NH$, $C_2H_5NH_2$

Answer : $C_6H_5NH_2 < (C_2H_5)_2NH < C_2H_5NH_2$

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

8. **Define Biodegradable polymers.** [1]

Answer : Bio-degradable polymers are natural polymers that disintegrated themselves over a period of time by enzymatic hydrolysis. *e.g.*, starch, cellulose, etc.

9. **The chemistry of corrosion of iron is essentially an electro-chemical phenomenon. Explain the reactions occurring during the corrosion of iron in the atmosphere.** [2]

Answer : According to electrochemical theory of rusting, the impure iron surface behaves like small electrochemical cell in the presence of water containing dissolved oxygen or carbon dioxide. In this cell pure iron acts as an anode and impure iron surface acts as cathode. Moisture having dissolved CO_2 or O_2 acts as an electrolyte. The reactions at cathode and anode are as follows :

At anode : $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$

At cathode : $H_2O + CO_2 \rightleftharpoons \underset{\text{Carbonic acid}}{H_2CO_3}$

Net Reaction : $2Fe(s) + O_2(g) + 4H^+ \rightarrow 2Fe^{2+} + 2H_2O$

$H_2CO_3 \rightleftharpoons 2H^+ + CO_3^{2-}$

$H_2O \rightleftharpoons H^+ + OH^-$

$H^+ + e^- \rightarrow H$

$4H + O_2 \rightarrow 2H_2O$

10. **Determine the values of equilibrium constant (K_c) and ΔG° and for the following reaction :** [2]

$Ni(s) + 2Ag^+(aq) \rightarrow Ni^{2+}(aq) + 2Ag(s)$, $E^\circ = 1.05V (1F = 96500\ C\ mol^{-1})$

Answer : According to the formula

$\Delta G^\circ = -nFE^\circ = -2 \times 96500 \times 1.05$

or $\Delta G^\circ = -202650\ J\ mol^{-1} = -202.65\ KJ\ mol^{-1}$

Now $\Delta G^\circ = -202\,650\ J\,mol = 1$

$R = 8.314\ J/mol$, $T = 298\ K$

$$\log K = -\frac{\Delta G^\circ}{2.303RT} \Rightarrow \log K = -\frac{-202650}{2.303 \times 8.314 \times 298}$$

$$\log K = \frac{-202650}{5705.84831} = 35.52$$

$K = \text{Antilog of } 35.52 \quad \therefore K = 0.35 \times 10^7$

11. **Distinguish between 'rate expression' and 'rate constant' of a reaction.** [2]

Answer : Rate constant is the rate of reaction when the concentration of each reactant is taken as unity.

Rate expression expresses the rate of reaction in terms of molar concentrations of the reactants with each term raised to their power, which may or may not be same as the stoichiometric coefficient of that reactant in the balanced chemical equation.

12. **Give reason for :** [2]

(i) The N-O bond in NO_2^- is shorter than the N-O bond in NO_3^-.**

(ii) SF_6 is kinetically an inert substance.

OR

State reasons for each of the following :

(i) All the P-Cl bonds in PCl_5 molecules are not equivalent.**

(ii) Sulphur has greater tendency for catenation than oxygen.

(ii) SF_6 is kinetically inert due to high oxidizing power and electronegativity of fluorine atom which causes steric hindrance and it unables to further react with any other atom.

OR

(ii) Sulphur has a much greater tendency for catenation than oxygen because of its bigger size and low electronegativity due to which the S-S bond is stronger than O-O bond and there is more interelectronic repulsion in O-O than in S-S bond.

13. **Assign reasons for the following :** [2]

(i) Copper (I) ion is not known in aqueous solution.

(ii) Actinoids exhibit greater range of oxidation states than lanthanoids.

Answer : (i) In aqueous solution Cu^+ undergoes disproportionation to form a more stable Cu^{2+} ion.

$$2Cu^+(aq) \rightarrow Cu^{2+}(aq) + Cu(s)$$

The higher stability of Cu^{2+} ion in aqueous solution may be attributed to its greater negative $\Delta_{hyd}H$ than that of Cu^+ ion. It compensates the second ionisation enthalpy of Cu involved in the formation of Cu^{2+} ions.

(ii) Actinoids exhibit greater range of oxidation states than lanthanoids. This is because there is less energy difference between 5*f* and 6*d* orbitals belonging to actinoids than the energy difference between 4*f* and 5*d* orbitals in case of lanthanoids.

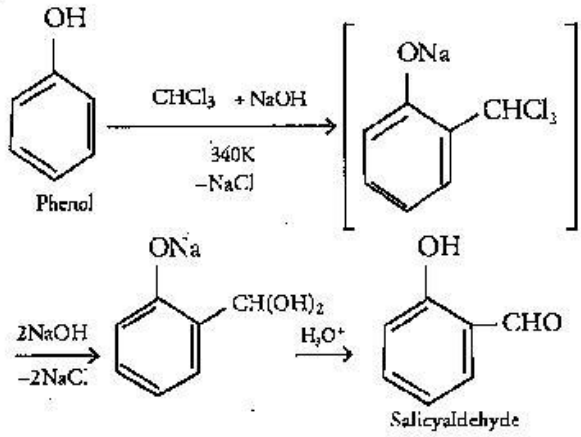
14. **Explain the following giving one example for each :** [2]

(i) Reimer-Tieman reaction.

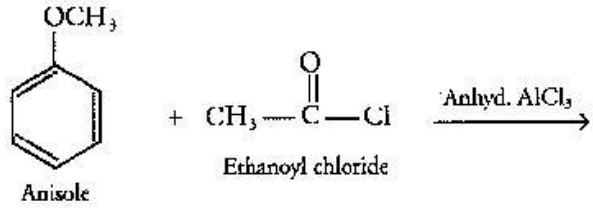
(ii) Friedel Craft's acetylation of anisole.

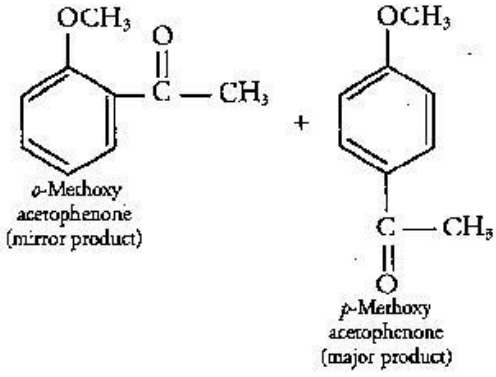
Answer : (i) When phenol is treated with chloroform in presence of aqueous NaOH at 340 K followed by hydrolysis gives salicylaldehyde.

** **Answer is not given dut to the change in present syllabus.**



(ii) When anisole is treated with acetylchloride in presence of anhydrous $AlCl_3$, 2-methoxy acetophenone is formed.





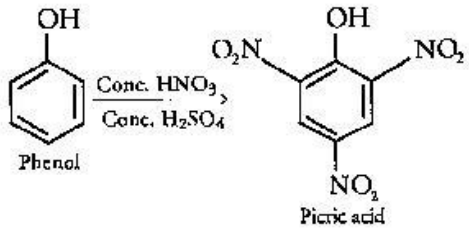
15. How would you obtain : [2]

(i) Picric acid (2, 4, 6-Trinitrophenol) from phenol.

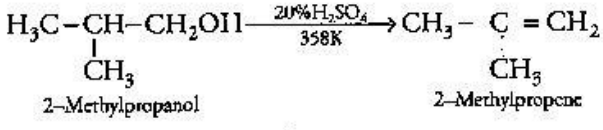
(ii) 2-Methylpropene from 2-methylpropanol ?

Answer :

(i)

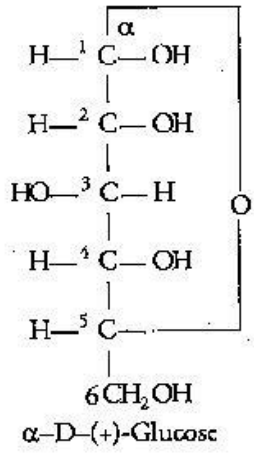


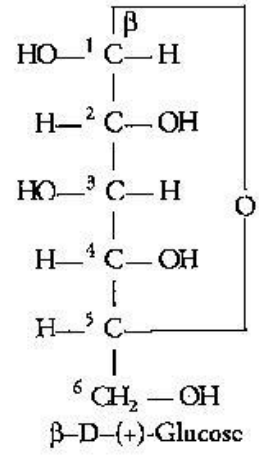
(ii)



16. What is essentially the difference between α-form of glucose and β-form of glucose ? Explain. [2]

Answer : In α-form of glucose OH group lies at C1 towards right but in β-form of glucose it is towards left. This is because OH group at C1 in glucose is chiral.





17. Describe what you understand by primary structure and secondary structure of proteins.[2]

Answer : Primary structure of proteins refer to the sequence in which amino acids are joined together by peptide linkage. The sequence of amino acids in primary structure is very specific. Any change in the sequence of amino acids creates a different protein with different biological activity.

Secondary structure of proteins refers to the conformation which arises due to the coiling of polypeptide chain due to intramolecular hydrogen bonding between carbonyl (>C=O) and –NH groups. Depending upon the size of –R group, there are two secondry structures of protein, *i.e.*, α-Helix and β-Pleated sheet like structure.

18. Mention two important uses of the following[2]

(i) Bakelite (ii) Nylon-6

Answer : Bakelite : It is used in the manufacture of electrical switches, protective coatings, barrels, etc.

Nylon-6 : It is used in making Fabrics, tyre cords, mountaineering ropes etc.

19. Silver crystallizes in face-centered cubic unit cell. Each side of this unit cell has a length of 400 pm. Calculate the radius of the silver atom. (Assume the atoms just touch each other on the

diagonal across the face of the unit cell. That is each face atom is touching the four corner atoms).** [3]

20. Nitrogen pentoxide decomposes according to equation : [3]

$$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$$

The first order reaction was allowed to proceed at 40°C and the data below were collected :

$[N_2O_5](M)$	Time (min)
0.400	0.00
0.289	20.0
0.209	40.0
0.151	60.0
0.109	80.0

(i) Calculate the rate constant. Include units with your answer.

(ii) What will be the concentration of N_2O_5 after 100 minutes ?

(iii) Calculate the initial rate of reaction.

Answer : (i) We know that

$$k = \frac{2.303}{t} \log \frac{[A_0]}{[A]}$$

Substituting the values we get,

$$k = \frac{2.303}{20} \log \frac{0.400}{0.289}$$

$$k = \frac{2.303}{20} \log 1.3840$$

or $$k = 0.11515 \log 1.3840$$

$\therefore$ $$K = 0.0163 \text{ min}^{-1}$$

(ii) Using the formula, $k = \frac{2.303}{t} \log \frac{[A_0]}{[A]}$

or $$\log \frac{0.400}{[A]} = \frac{0.0163 \times 100}{2.303}$$

or $$\log \frac{0.400}{[A]} = 7.0777$$

$\therefore$ $$[A] = 0.078M$$

(iii) Initial rate, $R = k[N_2O_5]$

$$= 0.0163 \times 0.400$$

$$= 0.00652 \text{ M min}^{-1}$$

21. Explain how the phenomenon of adsorption finds application in each of the following processes : [3]

(i) Production of vacuum

(ii) Heterogeneous catalysis

(iii) Froth Floatation Process

OR

Define each of the following terms :

(i) Micelles

(ii) Peptization

(iii) Desorption

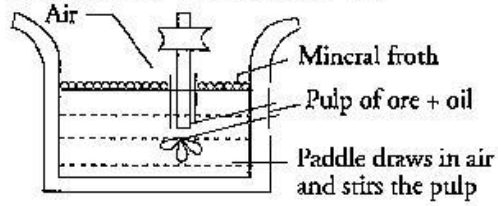
Answer : (i) In vacuum flask activated charcoal is placed between the walls of the flask so that any gas which enters into annular space either due to glass imperfection or diffusion through glass is adsorbed and create a vacuum.

(ii) If the catalysts and reactants are present in different phase, the process of catalysis is called as heterogenous catalysis. For example, manufacture of NH_3 from N_2 and H_2 by Haber's process using iron as catalyst

$$N_{2(g)} + 3H_{2(g)} \xrightarrow{Fe(s)} 2NH_{3(g)}$$

In this process, the reactants are in gaseous phase whereas catalyst is in solid phase.

(iii) This method is used for removing gangue from sulphide ores. In this powdered ore is mixed with collectors (*e.g.*, pine oil, fatty acids etc.) and froth stabilizers (*e.g.*, cresols, aniline) which enhance non-wettability of the mineral particles and froth stabilisation respectively. As a result of which ore comes with froth and gangue remains in the solution.



OR

(i) When soaps and detergents are added to water, a cluster of charged particle is formed by the aggregation of variety of molecules. Thus formed is called micelle.

(ii) The process of converting a fresh precipitate into colloidal particles by shaking it with the dispersion medium in the presence of a small amount of a suitable electrolyte is called peptization.

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

(iii) The process of removal of adsorbed substance from the surface of a solid or a liquid by heating or by reducing pressure is called desorption.

22. Describe the principle behind each of the following processes : [3]

(i) Vapour phase refining of a metal.

(ii) Electrolytic refining of a metal

(iii) Recovery of silver after silver ore was leached with NaCN.

Answer : (i) Vapour Phase Refining : The impure metal is first converted to its unstable volatile compound which is evaporated and then decomposed by heating at higher temperature to give pure metal, leaving behind the impurities.

(ii) In this method impure metal is made anode and a thin sheet of pure metal is made cathode, and are put in a suitable electrolyte containing soluble salt of same metal. On passing current the more basic metal remains in the solution and the less basic one go to the anode and gets deposited as anode mud.

(iii) NaCN acts as a leaching agent or oxidizing agent, thus oxidizes Ag to Ag^+ which then combines with CN^- ions to form respective soluble complex.

$4Ag(s) + 8CN^-(aq) + O_2(g) + 2H_2O(l) \rightarrow [Ag(CN)_2]^-$ (aq) silver $+ 4\,OH^-(aq)$

Soluble complex

23. Complete the following chemical equations : [3]

(i) $MnO_4^- + C_2O_4^{2-} + H^+ -$

(ii) $KMnO_4 \xrightarrow{\text{Heated}}$

(iii) $Cr_2O_7^{2-} + H_2S + H^+ \rightarrow$

Answer :

(i) $MnO_4^- \; 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$

(ii) $2KMnO_4 \xrightarrow{\text{Heated}} K_2MnO_4 + MnO_2 + O_2$

(iii)

$$Cr_2O_7^{2-} + 8H^+ + 3H_2S \rightarrow 2Cr^{3+} + 3S + 7H_2O$$

24. Write the name, stereochemistry and magnetic behaviour of the following : [3]

(At. Nos. Mn = 25, Co = 27, Ni = 28

(i) $K_4[Mn(CN)_6]$

(ii) $[Co(NH_3)_5Cl]Cl_2$

(iii) $K_2[Ni(CN)_4]$

Answer : (i) Potassiumhexacyanomanganate(II)

Shape : Octahedral

Magnetic Behaviour : Paramagnetic (one unpaired electron)

Hybridization : d^2sp^3

(ii) Pentaamminechloridocobalt (III) chloride

Shape : Octahedral

Hybridization : d^2sp^3

Magnetic Behaviour : Dimagnetic (no unpaired electrons)

(iii) Potassiumtetracyanonicklate(II)

Shape : Square planar

Hybridization : dsp^2

Magnetic Behaviour : Dimagnetic (no unpaired electrons)

25. Answer the following : [3]

(i) Haloalkanes easily dissolves in organic solvents, why ?

(ii) What is known as a racemic mixture ? Give an example.

(iii) Of the two bromoderivatives, $C_6H_5CH(CH_3)Br$ and $C_6H_5CH(C_6H_5)Br$, which one is more reactive in S_N1 substitution reaction and why ?

Answer : (i) Haloalkanes dissolve in organic solvents because the new intermolecular attraction between haloalkanes and organic solvent molecules have the same strength as the one being broken in the separate haloalkanes and solvent molecules.

(ii) Racemic mixture is an equimolar mixture of two enantiomers and is hence optically inactive. *e.g.* (± butan-2-ol)

(iii) The carbocation intermediate derived from $C_6H_5CH(C_6H_5)Br$ *i.e.* $C_6H_5\overset{+}{C}HC_6H_5$ is more stable as compared to the carbocation $C_6H_5\overset{+}{C}HCH_3$ obtained from $C_6H_5CH(CH_3)Br$ because it is stabilized by two phenyl groups due to resonance.

26. (a) Explain why an alkylamine is more basic than ammonia ? [3]

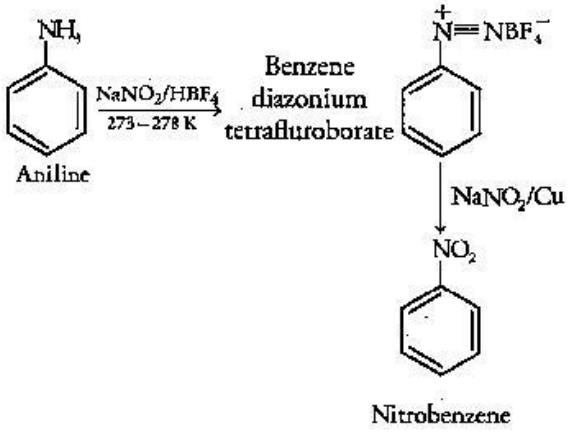
(b) How would you convert :

(i) Aniline to nitrobenzene

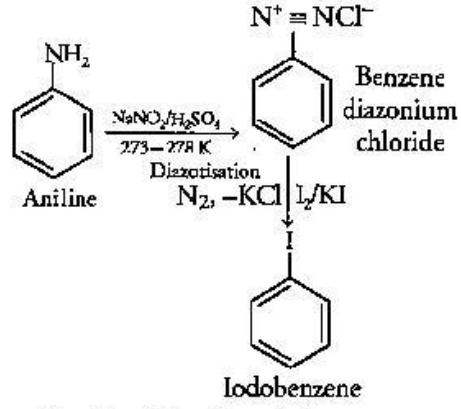
(ii) Aniline to iodobenzene

Answer : (a) Alkyl groups are electron donating groups and increases the electron density on nitrogen in alkylamine making them more basic than ammonia.

(b) (i) $C_6H_5NH_2 \xrightarrow[HCl]{NaNO_2} C_6H_5N_2^+Cl^- \xrightarrow{NaNO_2} C_6H_5NO_2$



(ii)



27. Describe the following giving one example for each : [3]

(i) Detergents (ii) Food preservatives

(iii) Antacids

Answer : (i) Detergents are soluble salts of sodium potassium sulphonic acids unlike soaps they are non-biodegradble but they can be conveniently used both with soft and hard water. *e.g.* Sodium alkylbenzene sulphonate.

(ii) Food preservatives are chemicals used to preserve food by preventing microbial growth *e.g.* Sodium benzoate, Table salt, etc.

(iii) The substances which are taken to neutralize the excess acid and maintaining the pH to an appropriate level in stomach are called antacids. There are two types of anatacids systemic antacids, *e.g.*, $NaHCO_3$ and non-systemic *e.g.* Milk of magnesia.

28. (a) Differentiate between molality and molarity of a solution. How does a change in temperature influence their values ? [5]

(b) Calculate the freezing point of an aqueous solution containing 10.50 g of $MgBr_2$ in 200 g of water. (Molar mass of $MgBr_2$ = 184 g) (K_f for water = 1.86 K kg mol^{-1}

OR

(a) Define the terms osmosis and osmotic pressure. Is the osmotic pressure of a solution a colligative property ? Explain.

(b) Calculate the boiling point of a solution prepared by adding 15.00 g of NaCl to 250.0 g of water. (K_b for water = 0.512 K kg mol^{-1}, Molar mass of NaCl = 58.44 g)

Answer : (a) Molarity is the number of moles of solute dissolved in 1 litre of solution. It is temperature dependent.

$$M = \frac{W \times 1000}{\text{Molecular mass} \times V}$$

Molality is the number of moles of solute dissolved per 1 kg of the solvent. It is temperature independent.

$$M = \frac{W \times 1000}{M_2 \times W}$$

Molality is independent of temperature, whereas molarity is a function of temperature because volume depends on temperature and mass does not.

(b) Since $MgBr_2$ is an isotonic compound. Hence undergoes complete dissociation

	$MgBr_2 \rightarrow$	Mg^{2+} +	$2Br^-$
Initial moles	1	0	0
After dissociation	0	1	2

Total number of moles = 1 + 2 = 3

Thus, $i = \frac{3}{1} = 3$

Using the formula

$DT_f = iK_f m \qquad T_f^\circ - T_f = iK_f m$

or $0°C - T_f = 3 \times 1.86 \times \frac{10.50}{184} \times \frac{1000}{200}$

or $-T_f = \frac{58590}{30800} = 1.59°C$

$\therefore T_f = 1.59°C$

or $T_f = -1.59°C$ or 271.41 K

OR

(a) Osmosis is the phenomenon of flow of solvent through a semi-permeable membrane from the region of higher concentration to the region of lower concentration.

The osmotic pressure of a solution is the excess pressure that must be applied to the solution to prevent the passage of solvent molecule through a semi-permeable membrane into the solution.

Yes, osmotic pressure is a colligative property as it depends only on the amount of solute present in the solution.

(b) Initial moles after dissociation

$NaCl \rightarrow Na^+ + Cl^-$

1 0 0

0 1 1

(Total no. of moles 1 + 1 = 2)

$\therefore \qquad i = \frac{2}{1} = 2$

Initial moles after dissociation

$DT_b = iK_b m$

$T_b - T_b^\circ = 2 \times 0.512 \times \frac{15 \times 1000}{58.44 \times 250}$

or $T_b - 373\ K = \frac{15360}{14610} = 1.05\ K$

or $T_b = 1.05\ K + 373\ K$

$\therefore T_b = 374.05\ K$

29. Give chemical tests to distinguish between : [5]

(i) Propanal and propanone

(ii) Benzaldehyde and acetophenone

(b) How would obtain :

(i) But-2-enal from ethane

(ii) Butanoic acid from butanol

(iii) Benzoic acid from ethylbenzene

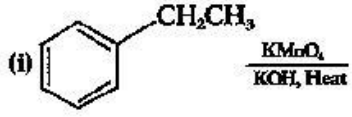
OR

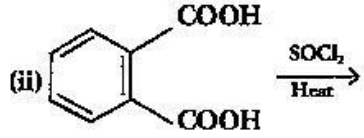
(a) Describe the following giving linked chemical equations

(i) Cannizzaro reaction

(ii) Decarboxylation

(b) Complete the following chemical equations :

(i) 

(ii) 

(iii) $C_6H_5CONH_2 \xrightarrow{H_2O/Heat}$

Answer : (a) (i) Propanal on treatment with Fehlings solution gives a red ppt. of cuprous oxide while propanone does not responds to this test.

$CH_2CH_2CHO + 2Cu^{2+} + 5OH^- -$

Fehling solution

$CH_3CH_2COONa + Cu_2O\downarrow + 3H_2O$

Red ppt.

(ii) Acetophenone on treatment with I_2/NaOH undergoes iodoform test to give yellow ppt. of iodoform that benzaldehyde does not

$C_6H_5COCH_3 + 4NaOH + 3I_2 \rightarrow$

$C_6H_5COONa + CHI_3\downarrow + 2H_2O + 3NaI$

Sod. benzoate Iodoform (yellow ppt)

$C_6H_5CHO \xrightarrow[NaOH + I_2]{} \text{No reaction}$

(b) (i)

$2CH_3CHO \xrightarrow[2.\Delta]{1.NAOH} CH_3-CH(OH)-CH_2-CHO \xrightarrow{H^+} H_2O$

Ethanal (Aldol condensation) $CH_3-CH=CH-CHO + H_2O$

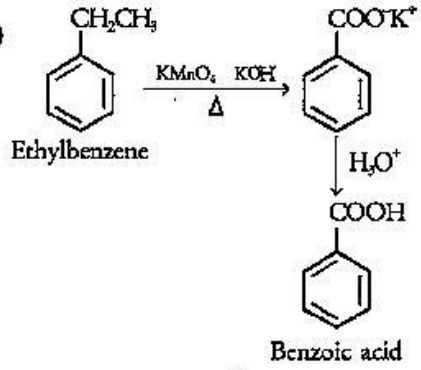
But–2–enal

(ii)

$CH_3CH_2CH_2CH_2OH \xrightarrow[dil.H_2SO_4]{alk.KMnO_4} CH_3CH_2CH_2COOH + H_2O$

Butanol Butanoic acid

(iii)

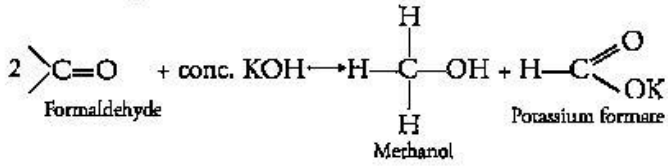


Ethylbenzene

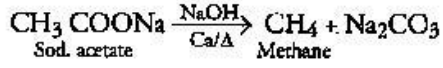
Benzoic acid

OR

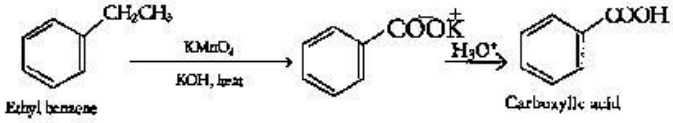
(a) (i) An aldehyde with no α-hydrogen atom undergoes self-reduction and oxidation in presence of conc. alkali to form alcohol and carboxylic acid salt.



(ii) Sodium acetate undergoes decarboxylation (removal of CO_2) in presence of soda lime to give hydrocarbon.



(b) (i)



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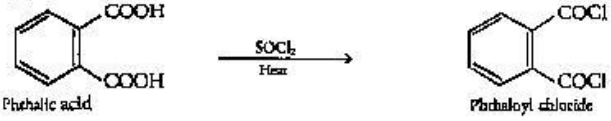

(iii) $C_6H_5CONH_2 \xrightarrow[\text{Heat}]{H_3O^+} C_6H_5COOH + NH_3$

Benzamide — Benzoic acid

30. (a) Explain the following : [5]

(i) NF_3 is an exothermic compound whereas NCl_3 is not.**

(ii) F_2 is most reactive of all the four common halogens.

(b) Complete the following chemical equations :

(i) $C + H_2SO_4(conc) \rightarrow$

(ii) $P_4 + NaOH + H_2O \rightarrow$

(iii) $Cl_2 + F_2 \rightarrow$

OR

(a) Account for the following :

(i) The acidic strength decreases in the order $HCl > H_2S > PH_3$

(ii) Tendency to form pentahalides decreases down the group in group 15 of the periodic table.**

(b) Complete the following chemical equations :

(i) $P_4 + SO_2Cl_2 \rightarrow$

(ii) $XeF_2 + H_2O \rightarrow$

(iii) $I_2 + HNO_3$ (conc.) $\rightarrow$

Answer : (a) (ii) Fluorine is most reactive of all the four common halogens because of its low bond dissociation energy due to which it readily dissociates into atoms and reacts with other substances readily.

(b) (i) $C + 2H_2SO_4 \rightarrow CO_2 + 2H_2O + 2SO_2$ (Conc.)

(ii) $P_4 + 3NaOH + 3H_2O \rightarrow PH_3 + 3NaH_2PO_2$

(iii) $Cl_2 + \underset{\text{(excess)}}{3F_2} \xrightarrow{473K} 2ClF_3$

OR

(a) (i) Because of decrease in electronegativity from chlorine to phosphorus, the dissociation enthalpy from HCl to HP increases, and their tendency to release H^+ ion decreases and thus acidic strength decreases.

(b) (i) $P_4 + 10SO_2Cl_2 \rightarrow \underset{\text{Phosphorus Pentachloride}}{4PCl_5} + 10SO_2$

(ii) $2XeF_2 + 2H_2O \rightarrow 2Xe + 4HF + O_2$

(iii) $I_2 + 10HNO_3(Conc.) \rightarrow 2HIO_3 + 4H_2O + 10NO_2$

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Chemistry 2011 (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.

1. Which stoichiometric defect in crystals decreases the density of a solid ?** **[1]**

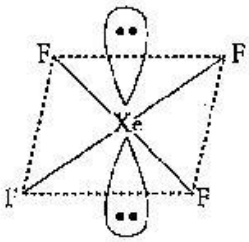
3. What is meant by shape-selective catalysis of reactions ? **[1]**

Answer : The reaction that depends for shape selective catalysts uses zeolites as catalyst for reaction on the shape and size of pores and of reactants and products.

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

4. **Draw the structure of XeF_4 molecule** [1]

Answer :



9. **Explain what is meant by (i) a peptide linkage, (ii) a glycosidic linkage ?** [2]

Answer : (i) Peptide linkage is present in proteins to bind together amino acids. The linkage involves the carboxyl group of one amino acid and amine group of another amino acids.

(ii) Glycosidic linkage is the (–C–O–C–) linkage present between two molecules of a monosaccharide to form a disaccharide.

10. **Name the bases present in RNA. Which one of these is not present in DNA.** [2]

Answer : Four bases present in RNA are Adenine, Guanine, Cytosine and Uracil. Uracil is not present in DNA.

22. **Explain the role of each the following in the extraction of metals from their ores :** [3]

(i) CO in the extraction of nickel.

(ii) Zinc in the extraction of silver.

(iii) Silica in the extraction of copper.

Answer : (i) CO is used in the vapour phase refining of nickel.

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

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

(ii) Zinc acts as a reducing agent which reduces cyanide complex of silver into pure silver.

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

Dicyano silver (I) ion Silver (aq)

(iii) Silica is used to remove impurities in the form of metal oxides as slag.

$$FeO + SiO_2 \rightarrow \underset{(slag)}{FeSiO_3}$$

24. **For the complex $[Fe(en)_2Cl_2]Cl$, identify the following :** [3]

(i) Oxidation number of iron.

(ii) Hybrid orbitals and shape of the complex.

(iii) Magnetic behaviour of the complex.

(iv) Number of its geometrical isomers.

(v) Whether there may be optical isomer also.

(vi) Name of the complex.

Answer : (i) +3

(ii) d^2sp^3 octahedral shape.

(iii) paramagnetic

(iv) 2 geometrical isomers, cis and trans.

(v) Only cis-isomers shows optical isomerism

(vi) Dichloridobis (ethylenediamine) iron(III) chloride

27. **Explain the following terms with one suitable example for each :** [3]

(i) A sweetening agent for diabetic patients

(ii) Enzymes

(iii) Analgesics

Answer : (i) Artificial Sweetening agents are chemicals that sweeten food. However, unlike natural sweetners, they do not add calories to the body, not harmful to diabtic patients. *e.g.* Saccharin, aspartame.

(ii) Enzymes are biocatalysts which are structurally globular proteins. They are sensitive to substrate, pH and temperature changes. *e.g.*, Trypsin

(iii) Analgesics are chemical substances which reduces pain without causing impairment of consciousness, mental confusion, in coordination of paralysis or some other disturbance of nervous system. *e.g.*, Aspirin, (non-narcotic analgesic) and Morphine (narcotic analgesic)

28. **(a) State the following :** [5]

(i) Henry's law about partial pressure of a gas in a mixture.

(ii) Raoult's law in its general form in reference to solutions.

(b) A solution prepared by dissolving 8.95 mg of a gene fragment in 35.0 mL of water has an osmotic pressure of 0.335 torr at 25°C. Assuming the gene fragment is non-electrolyte, find its molar mass.

OR

(a) Difference between molarity and molality in a solution. What is the effect of tempe-

rature change on molarity and molality in a solution?

(b) What would be the molar mass of a compound if 6.21 g of it dissolved in 24.0 g of chloroform form a solution that has a boiling point of 68.04°C ? The boiling point of pure chloroform is 61.7°C and the boiling point elevation constant, K_b for chloroform is 3.63°C/m.

Answer : (a)(i) Henry's law states that the partial pressure of gas in vapour phase is directly proportional to its mole fraction in the solution.

(ii) Raoult's law states that for a solution with volatile components, the partial vapour pressure of each component present in the solution is proportional to its mole fraction in the solution.

or $M_2 = \frac{W_2RT}{\pi V}$

$\therefore$ Molar mass, $M_2 = 1.42 \times 10^4$ g mol^{-1}

(b) Given : $W_2 = 8.95$ mg $= 8.95 \times 10^{-3}$ g

$V = 35$ mL $\quad\quad \pi = 0.335$ torr

$T = 25°C = 298$ K $\quad\quad M_2 = ?$

Substituting all the values in the given formula

$\pi = CRT$

$\pi = \frac{W_2RT}{M_2V}$

OR

(a) Molarity is defined as the number of moles of solute present in 1 litre of solution, while molality is defined as the number of moles of solute present in 1 kg of solvent. Molality does not have any effect of change in temperature because mass does not changes with temperature, whereas molarity changes with temperature.

(b) Given : $W_2 = 6.21$ g

$W_1 = 24$ g

$K_b = 3.63°C/m$

$\Delta T_b = T_b - T_b^\circ = 68.04 - 61.7 = 6.34°C$

$M_2 = ?$

From the formula,

$M_2 = \frac{100 \times K_b \times W_2}{\Delta T_b \times W_1}$

$= \frac{1000 \times 3.63 \times 6.21}{6.34 \times 24}$

$= 148.14$ g mol^{-1}

$\therefore$ Molar mass of the compound, M = 148.14 g mol^{-1}

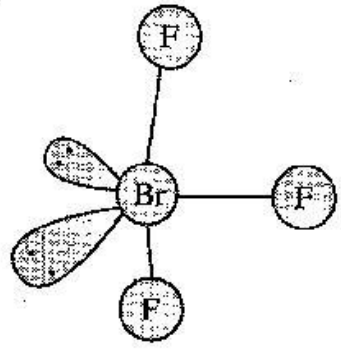
Chemistry 2011 (Delhi) SET III

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

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

4. Draw the structure of BrF_3 molecule [1]

Answer :



8. In nylon 6, 6 what does the designation '6, 6' mean ? [1]

Answer : 6, 6-refers to the number of carbon atoms in each of its monomer, adipic acid and hexamethyldiamine

9. What type of a battery is lead storage battery ? Write the anode and the cathode reactions and the overall reactions occurring in a lead storage battery. [2]

Answer : The lead storage battery is a secondary cell which is rechargeable. During discharging, the electrode reaction occurs as follows :

At anode :

$Pb(s) + SO_4^{-2}(aq) \rightarrow PbSO_4(s) + 2e^-$

At cathode :

$PbO_2(s) + SO_4^{2-}(aq) - 4H^+ + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$

Net reaction :

$Pb(s) + PbO_2(s) + 4H^+(aq) + 2SO_4^{-2}(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$

10. Two half-reaction of an electrochemical cell are given below :

$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O(l)$, $E^\circ = +1.51V$

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

Construct the redox equation from the standard potential of the cell and predict it the reaction is reactant favoured or product favoured. [2]

Answer : The redox reactions at anode and cathode can be represented as :

At anode (oxidation) :

$Sn^{2+}(aq) \rightarrow Sn^{4+}(aq) + Sn^{4+}(aq) + 2e^- \times 5E^\circ = +0.15\ V$

At cathode (reduction) :

$[MnO_4^{-2}(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O(l)] \times 2E^\circ = +1.51V$

The Net

$R \times M = 2MnO_4^- + 16H^+ + 5Sn^{2+} \rightarrow 2Mn^{2+} + 5Sn^{4+} + 8H_2O$

Now,

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

$\therefore$ The positive value of E°_{cell} favours formation of product.

13. Assign reasons for each of the following : [2]

(i) Transition metals generally form coloured compounds.

(ii) Manganese exhibits the highest oxidation state of +7 among the 3d series of transition elements.

Answer : (i) Due to presence of unpaired electrons and d-d transition, the transition metals are generally coloured.

(ii) Manganese (Z = 25), has the maximum number of unpaired electrons. Thus, it shows oxidation states from +2 to +7 which is maximum in number as compared to other elements of transition series.

18. Name the sub-groups into which polymers are classified on the basis of magnitude of intermolecular forces. [2]

Answer : Elastomers : They have weakest intermolecular forces of attraction.

Fibres : They have strong intermolecular forces of attraction among its molecules.

Thermoplastics Polymers : They are semifluid substances having low molecular weight.

Thermosetting Polymers – They have intermolecular forces intermediate between those of elastomers and fibres.

19. The density of lead is 11.35 g cm^{-3} and the metal crystallizes with *fcc* unit cell. Estimate the radius of lead atom. (At. mass of lead = 207 g mol^{-1} and $N_A = 6.02 \times 10^{23}$ mol^{-1})** [3]

26. Complete the following chemical equations : [3]

(i)

$$CH_3CH_2Cl \xrightarrow{NaCN} (A) \xrightarrow[Ni/H_2]{\text{reduction}} (B)$$

(ii) $C_6H_5N_2Cl + H_3PO_2 + H_2O \longrightarrow$

(iii)

$$R-\overset{\overset{O}{\|}}{C}-NH_2 \xrightarrow[H_2O]{LiAlH_4}$$

Answer :

(i)

$$CH_3CH_2Cl \xrightarrow{NaCN} CH_3-CH_2-C\equiv N$$

Chloroethane — Propanenitrile

$\xrightarrow{\text{Reduction}}$ $CH_3-CH_2-CH_2-NH_2$ Propan-1-amine

(ii)

$$\underset{\text{Benzene diazonium chloride}}{C_6H_5N_2Cl} + H_3PO_2 + H_2O \longrightarrow \underset{\text{Benzene}}{C_6H_6} + N_2 + H_3PO_3 + HCl$$

(iii)

$$R-\overset{\overset{O}{\|}}{C}-NH_2 \xrightarrow[H_2O]{LiAlH_4} R-CH_2-NH_2$$

Alkanamide → Alkanamine

27. Answer the following questions : [3]

(i) Why do soaps not work in hard water ?

(ii) What are the main constituents of dettol ?

(iii) How do antiseptics differ from disinfectants ?

Answer : (i) Hard water contains insoluble chloride of calcium and magnesium which forms insoluble ppt. (scum) with soap and thus cannot be rinsed off easily.

(ii) The main constituents of dettol are chloroxylenol and α-terpine.

(iii) Antiseptics : These are chemical substances which either kill or prevent the growth of micro-organism but do not cause harm to the living tissues.

Disinfectants : These are chemical substances which kill the microbes. They are toxic in nature and thus causes harm to the tissues of the skin.

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