Question Paper 2008 Delhi Set-3

Class-12 Chemistry

Time Allowed: 3 Hours, Maximum Marks: 70

General Instructions

1. All questions are compulsory.
2. Marks for each question are indicated against it.
3. Question numbers 1 to 8 are very short-answer questions, carrying 1 mark each. Answer these in one word or about one sentence each.
4. Question numbers 9 to 18 are short-answer questions, carrying 2 marks each. Answer these in about 30 words each.
5. Question numbers 19 to 27 are short-answer questions of 3 marks each. Answer these in about 40 words each.
6. Question numbers 28 to 30 are long-answer questions of 5 marks each. Answer these in about 70 words each.
7. Use Log Tables, if necessary Use of calculators is not permitted.

1. What type of substances exhibits antiferomagnetism. [1]

Ans. In which the alignment of domains (moments) is in a compensatory way to give zero net moment.

2. Express the relation between conductivity and molar conductivity of a Solution. [1]

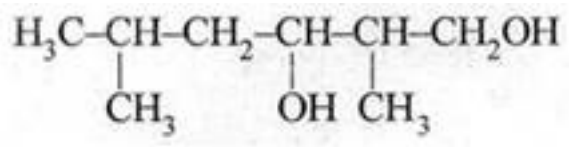
Ans. $\Lambda_m = \frac{\kappa}{c}$

where Λ_m is molar conductivity, κ is conductivity, c is concentration in $mol\ L^{-1}$.

3. Which has a higher enthalpy of adsorption, physisorption of chemisorption. [1]

Ans. Chemisorption.

4. Write the IUPAC name of the following compound:



Ans. 2,5-Dimethylhexane -1,3-diol.

5. In Which one of the two structures, NO_2^+ and NO_2^-, the bond angle has a higher value? [1]

Ans. NO_2^+

6. Name a substance that can be used as an antiseptic as well as a disinfectant. [1]

Ans. Phenol (or any other correct one)

7. Arrange the following compounds in an increasing order of their acid Strengths. [1]

$(CH_3)_2 CHCOOH,\ CH_3CH_2CH(Br)COOH,\ CH_3CH(Br)CH_2COOH$

Ans. $(CH_3)_2 CHCOOH < CH_3CH(Br)CH_2COOH < CH_3CH_2CH(Br)COOH$

8. Write a chemical reaction in which the iodide ion replaces the diazonium group in a diazonium salt. [1]

Ans. $C_6H_5N_2^+Cl^- + KI \rightarrow C_6H_5I + KCl + N_2$

9. Formulate the galvanic cell in which the following reaction takes place: [2]

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

State:

(i) Which one of its electrodes is negatively charged.

(ii) The reaction taking place at each of its electrode.

(iii) The carriers of current within this cell,

Ans. The galvanic cell is depicted as:

$Zn(s)|Zn^{2+}(aq)||Ag^{+}(aq)|Ag(s)$

(i) Zinc electrode is negatively charged

(ii) The ions formed i.e Zn^{2+} and Ag^{+} in the solution are the carriers of the current within the cell.

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

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

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10. The resistance of a conductivity cell containing $0.001M\ KCl$ Solution at $298\ K\ is\ 1500\pi$. What is the cell constant if the conductivity of $0.001M\ KCl$ solution at $298\ K\ is\ 0.146\times10^{-3}\ S\ cm^{-1}$? [2]

Ans. $R=\rho(1/A)$

Cell constant, $1/A=R/\rho=R\kappa$ = Resistance × Conductivity

$=(1500\ \Omega)\times(0.146\times10^{-3}\ S\ cm^{-1})$

$=0.219\ cm^{-1}$

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11. State Raoult's law for solutions of volatile liquids. Taking suitable examples explain the meaning of positive and negative deviations from Raoult's law. [2]

Or

Define the term osmotic pressure. Describe how the molecular mass of a substance can be determined by a method based on measurement of Osmotic pressure.

Ans. Raoult's law states that for a solution of volatile liquids, the partial vapour pressure of each component in the solution is directly proprtional to its mole fraction.

When the solute-solvent interaction is weaker than those between the solute-solute and solvent-solvent molecules than solution shows positive deviation from Raoults law because the partial pressure of each component is greater.

ex. mixture of ethanol and acetone or carbon-disulphide and acetone behave in this manner.

When the solute-solvent interaction is stronger than those between the solute-solute and solvent-solvent molecules than solution shows negative deviation from Raoults law and the partial vapour pressure of each component is lower.
ex. mixture of chloroform and acetone behave in this manner.

(Note: Explanation with suitable example of any one of the two.)

OR

The extra pressure applied on the solution side that just stops the flow of solvent to solution through semi-permeable membrane is called osmotic pressure of the solution.
Here π is the osmotic pressure and R is the gas constant.

$$\pi = (n_2 / V)RT$$

$$\pi V = \frac{w_2 RT}{M_2}$$

$$or\ M_2 = \frac{w_2 RT}{\pi V}$$

Thus, knowing the quantities $w_2,\ T,\ \pi and\ V$ we can calculate the molar mass of the solute

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12. Assign a reason for each of the following statements: [2]
(i) Ammonia is a stronger base than phosphine.
(ii) Sulphur in vapour state exhibits a paramagnetic behavior.

Ans. (i) The lone pair of electrons on N atom in NH_3 is directed and not diffused / delocalized as it is in PH_3 due to larger size of P/ or due to availability of d-orbitals in P.
(ii) S_2 molecule like O_2, has two unpaired electrons in antibonding π^* orbitals.

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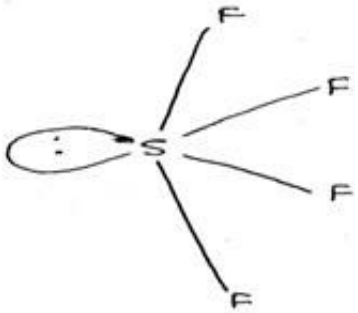
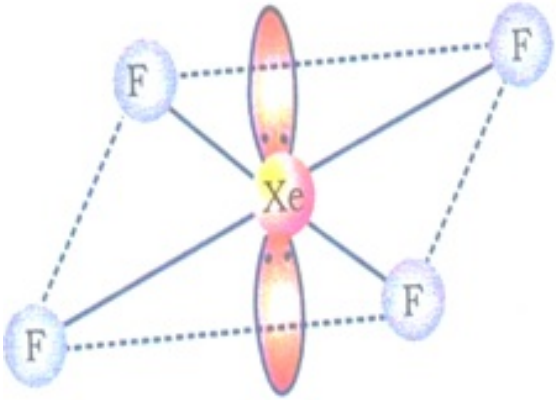
13. Draw the structures of the following molecules: [2]
(i) SF_4
(ii) XeF_4

Ans. (i) SF_4



(ii) XeF_4



14. Explain as to why haloarenes are much less reactive than haloalkanes towards nucleophilic substitution reactions. [2]

OR

Which compound in each of the following pairs will react faster in S_N2 reaction with $-OH$? Why?

(i) CH_3Br *or* CH_3I

(ii) $(CH_3)_3CCl$ *or* CH_3Cl

Ans. Aryl halides are less reactive towards nucleophilic substitution because of any of the following reasons with correct explanation:

(i) Resonance effect stabilization

(ii) sp^2 hybridization in haloarenes being more electronegative than sp^3 in haloalkanes.

(iii) Instability of phenyl cation which is not stabilized by resonance.

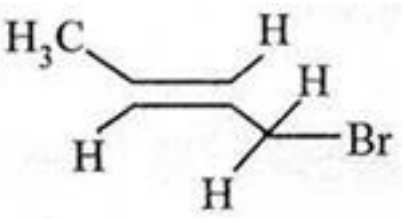
(iv) possible repulsion between electron rich nucleophile and electron rich arene. (at least two reasons to be given)

OR

(i) CH_3I, because iodine is a better leaving group due to its larger size.

(ii) CH_3Cl, the presence of bulky group on the carbon atom in $(CH_3)_2CCl$ has an inhibiting effect.

15. (a) State the IUPAC name of the following compound: [2]



(b) Complete the following chemical equation.

$$CH_3CH_2CH=CH_2 + HBr \xrightarrow{peroxide} \ldots$$

Ans. (a) 1-Bromobut-2-ene

(b) $CH_3CH_2CH_2CH_2Br$

16. What are biodegradable and non-biodegradable detergents. Give one example of each class. [2]

Ans. Biodegradable detergents are those detergents which are easily degraded by the microorganisms and hence are pollution free.
ex. Soap / Sodium laurylsulphate / any other unbranched chain detergent. (any one)

Non-Biodegradable Detergents are those detergents which cannot be degraded by the bacteria easily and hence create pollution. [example not essential]

17. Define the following terms in relation to proteins: [2].
(i) Peptide linkage
(ii) Denaturation

Ans. (i) Peptide linkage: Peptide linkage is an amide $(-CO-NH-)$ bond formed between $-COOH$ and $-NH_2$ group in protein formation.

(ii) Denaturation: When a protein in its native form, is subjected to physical change like change in temperature or chemical change like change in pH, protein loses its biological activity. This is called denaturation of protein.

18. List the reactions of glucose which cannot be explained by its open chain structure. [2]

Ans. (i) Despite having the aldehyde group, glucose does not give 2,4-DNP test or Schiff's test.
(ii) It does not form the hydrogen sulphite addition product with $NaHSO_3$.
(iii) The pentaacetate of glucose does not react with hydroxylamine indicating the absence of free -CHO group. (any two)

19. How Would you account for the following? [3]
(i) Frenkel defects are not found in alkali metal halides.
(ii) Schottky defects lower the density of related solids.
(iii) Impurity doped Silicon is a semiconductor,

Or

Explain the following properties giving suitable examples:
(i) Ferromagnetism
(ii) Paramagnetism
(iii) Ferrimagnetism

Ans. (i) Due to larger size of alkali metal ions.
(ii) Due to the presence of holes or vacancies.
(iii) Due to the presence of extra electrons or holes in impurity doped silicon.

Or

(i) Ferromagnetism: The substance which are attracted very strongly by a magnetic field and show magnetism even when the magnetic field is removed.
Ex. Iron, cobalt, nickel, CrO_2. (any one example)
(ii) Paramagnetism: The substances which are weakly attracted by magnetic field and loose their magnetism in the absence of magnetic field.

Ex. $O_2, Cu^{2+}, Fe^{3+}, Cr^{3+}$. (any one example)

(iii) Ferrimagnetism: When the magnetic moments of the domains in the substance are aligned in parallel and anti-parallel directions in unequal numbers then substance shows ferrimagnetism.
Ex. $Fe_3O_4\,(magnetite), MgFe_2O_4, ZnFe_2O_4$. (any one example).

20. Calculate the temperature at which a solution containing $54\ g$ of glucose, $(C_6H_{12}O_6)$, $in\ 250\ g$ of water will freeze. $(K_f\ for\ water = 1.86\ K\ mol^{-1}\ kg)$. [3]

Ans. $\Delta T_f = K_f m$

No. of moles of glucose $= \dfrac{54\ g}{180\ g\ mol^{-1}}$

Molality of Glucose solution $= \dfrac{54\ mol}{180} \times \dfrac{1000}{250\ kg} = 1.20\ mol\ kg^{-1}$

$$\Delta T_f = K_f m$$
$$= 1.86\ K\ kg\ mol^{-1} \times 1.20\ mol\ kg^{-1}$$
$$= 2.23\ K$$

Temperature at which solution freezes

$$= (273.15 - 2.23)\ K = 270.77\ K\ or\ -2.23^\circ C$$
$$Or\ (273.000 - 2.23)K = 2270.7\ K$$

21. Explain the basic principles of following metallurgical operations: [3]

(i) Zone refining
(ii) Vapour phase refining
(iii) Electrolytic refining

Ans. (i) Zone refining: This method is based on the principle that the impurities are more soluble in the melt than in the solid state of metal.

(ii) Vapour phase refining: In this method, the metal is converted into its volatile compound and collected elsewhere. It is then decomposed to give pure metal.

(iii) Electrolytic refining: In this method, the impure metal is made to act as anode. A strip of the same metal in pure form is used as cathode. They are put in a suitable electrolytic bath containing soluble salt of the same metal. The more basic metal remains in the solution and the less basic ones go to the anode mud.

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22. Explain What is observed when: [3]

(i) an electrolyte, KC, is added to hydrated ferric oxide solution
(ii) an electric current is passed through a colloidal Solution
(iii) a beam of strong light is passed through a colloidal solution

Ans. (i) Ferric hydroxide sol is positively charged. By adding potassium chloride, the excess chloride ions neutralize its positive charge and cause it to coagulate.

(ii) The dispersed phase and dispersion medium migrate towards oppositely charged electrodes (electrophoresis).

(iii) The beam of light is scattered by colloidal particles (Tyndall effect).

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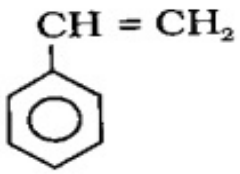
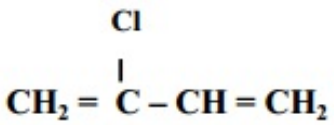
23. Write the names and structures of the monomers of the following polymers: [3]

(i) Buna-S
(ii) Neoprene
(iii) Nylon-6

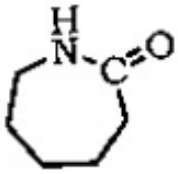
Ans. (i) Buna-S: 1,3- Butadiene and Styrene

$CH_2 = CH - CH = CH_2$ and 

(ii) Neoprene: Chloroprene



(iii) Nylon-6: Caprolactum



24. Account for the following observations: [3]

(i) pK_b **for aniline is more than that for methylamine,**
(ii) Methylamine solution in water reacts with ferric chloride solution to give a recipitate of ferric hydroxide,
(iii) Aniline does not undergo Friedel-Crafts reaction.

Ans. (i) It is because in aniline the $-NH_2$ group is attached directly to the benzene ring. It results in the unshared electron pair on nitrogen atom to be in conjugation with the benzene ring and thus making it less available for protonation. (or any other suitable reason)
(ii) Methyl amine in water gives OH^- ions which react with $FeCl_3$ to give precipitate of ferric hydroxide/ or

$$CH_3NH_2 + H_2O \rightarrow CH_3\overset{+}{N}H_3OH^- \rightarrow CH_3NH_3^+ + OH^-$$
$$Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3$$

(iii) Aniline does not undergo Friedel-Crafts reaction due to salt formation with aluminium chloride, the Lewis acid.

25. (a) What is a ligand? Give an example of a bidentate ligand. [3]
(b) Explain as to how the two complexes of nickel, $\left[Ni(CN)_4\right]^{2-}$ *and* $Ni(CO)_4$, **have different structures but do not differ in their magnetic behaviour. (Ni = 28)**

Ans. (a) Ligand: The ions or molecules bound to the central atom/ion in the coordination entity are called ligands.
ex. of bidentate ligand- ethane-1,2-diamine or oxalate ion (or any other)

(b) * *In* $\left[Ni(CN)_4\right]^{2-}$, nickel is $Ni^{2+}, (3d^8)$, with strong Ligand like CN^-, all the electrons are paired up in four d-orbitals resulting into dsp^2 hybridization giving square

planar structure and diamagnetic character.

In $Ni(CO)_4$:, nickel is in zero valence state, $(3d^8 4s^2)$, with strong Ligand like CO, $4s^2$, electrons are pushed to the d-orbitals resulting into sp^3 hybridization giving tetrahedral shape and diamagnetic in nature.

(or this can be explained by drawing orbital configurations too.)

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26. Name the reagents which are used in the following conversions: [3]

(i) A primary alcohol to an aldehyde

(ii) Butan-2-one to butan-2-ol

(iii) Phenol to 2, 4, 6-tribromophenol

Ans. (i) PCC, $KMnO_4$, CrO_3 (*any one*)

(*ii*) $LiAlH_4$, $NaBH_4$ (*any one*)

(*iii*) *aqueous* Br_2

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27. Write chemical equations for the following processes: [3]

(i) Chlorine reacts with a hot concentrated solution of sodium hydroxide

(ii) Orthophosphorous acid is heated

(iii) PtF_6, **and Xenon are mixed together**

Ans.

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

(ii) $4H_3PO_3 \rightarrow 3H_3PO_4 + PH_3$

(iii) $Xe^+[PtF_6]^-$

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28. Assign reasons for the following: [5]

(i) The enthalpies of atomisation of transition elements are high,

(ii) The transition metals and many of their compounds act as good catalyst.

(iii). From element to element the actinoid contraction is greater than the lanthanoid

contraction.

(iv) The E° value for the Mn^{3+} / Mn^{2+} couple is much more positive than that for Cr^{3+} / Cr^{2+}.

(v). Scandium (Z = 21) does not exhibit variable oxidation states and yet it is regarded as a transition element.

OR

(a) What may be the possible oxidation states of the transition metals with the following d electronic configurations in the ground state of their atoms: $3d^3 4s^2$, $3d^5 4s^2$ and $3d^6 4s^2$. Indicate relative stability of oxidation states in each case.

(b) Write steps involved in the preparation of

(i) Na_2CrO_4 from chromite ore and

(ii) K_2MnO_4 from pyrolusite ore. [3, 2]

Ans. (i) Because of larger number of unpaired electrons in their atoms they have stronger interatomic interaction and hence stronger bonding between atoms resulting in higher enthalpies of atomisation.

(ii) Because of their ability to adopt multiple oxidation states and to form complexes.

(iii) Because of poorer shielding by $5f$ electrons than that by $4f$, actinoid contraction is greater than the lanthanoid contraction.

(iv) Much larger third inonisation energy of Mn (where the required change is d^5 *to* d^4) is mainly responsible for this.

(v) Because of the presence of incomplete $d-orbital\left(3d^1 4s^2\right)$ in its ground state.

Or

$3d^3 4s^2$ (Vanadium): Oxidation states $+2, +3, +4, +5$

Stable oxidation state: $+4$ *as* VO^{2+}, $+5$ *as* VO_4^{3-}

$3d^5 4s^2$ (Manganese): Oxidation states $+2, +3, +4, +5, +6, +7$

Stable oxidation states: $+2$ *as* Mn^{2+}, $+7$ *as* MnO_4^-

$3d^6 4s^2$ (Iron): Oxidation states $+2, +3$

Stable oxidation state: +2 in acidic medium, +3 in neutral or in alkaline medium.

(b) (i) $4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$

(ii) $2MnO_2 + 4KOH + O_2 \rightarrow 2K_2MnO_4 + 2H_2O$

29. (a) Derive the general form of the expression for the half-life of a first Order reaction.

(b) The decomposition of NH on platinum surface is a zero-order reaction. What are the rates of production of N_2 and H_2 if $k = 2.5 \times 10^{-4}\ mol^{-1}\ Ls^{-1}$? [2, 3]

Or

(a) List the factors that affect the Tate of a chemical reaction.

(b) The half-life of radioactive decay of ^{14}C is $5730\ years$. An archaeological artefact containing wood had only 80% of ^{14}C activity found in living tree. Estimate the age of the artefact. [2, 3]

Ans. (a) Half-life of a First order reaction:

$$k = \frac{2.303}{t}\log\frac{[R]_0}{[R]}$$

at $t_{1/2}$ $\quad [R] = \frac{[R]_0}{2}$

So, the above equation becomes

$$k = \frac{2.303}{t_{1/2}}\log\frac{[R]_0}{[R]_0/2}$$

or $\quad t_{1/2} = \frac{2.303}{k}\log 2$

$$t_{1/2} = \frac{2.303}{k} \times 0.301$$

$$t_{1/2} = \frac{0.693}{k}$$

(b) $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$

$$Rate = \frac{-d[NH_3]}{dt} = k[NH_3]^\circ = 2.5 \times 10^{-4}\ Ms^{-1}$$

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

Rate of production of $N_2=+\frac{d[N_2]}{dt}=-\frac{1}{2}\frac{[NH_3]}{dt}$

$$=\frac{1}{2}\times\left(2.5\times10^{-4}Ms^{-1}\right)=1.25\times10^{-4}Ms^{-1}$$

Rate of production of hydrogen $=\frac{d[H_2]}{dt}=-\frac{3}{2}\frac{[NH_3]}{dt}$

$$=\frac{3}{2}\times\left(2.5\times10^{-4}\,Ms^{-1}\right)$$

$$=3.75\times10^{-4}\,Ms^{-1}$$

Or

$$\text{Rate}=-d[NH_3]=k[NH_3]^0=2.5\times10^{-4}Ms^{-1}$$

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

Rate of production of $N_2=+\frac{d[N_2]}{dt}=Rate=2.5\times10^{-4}Ms^{-1}$

Rate of production of hydrogen $=\frac{d[H_2]}{dt}=3\times Rate$

$$=3\times(2.5\times10^{-4}\,Ms^{-1})$$

$$=7.5\times10^{-4}\,Ms^{-1}$$

(Note: No marks to be deducted for wrong unit in this question, as there is a misprint in the question in units of k)

OR

(a) Factors affecting rate of chemical reaction are:

(i) Concentration of reactants
(ii) Temperature
(iii) Presence of catalyst
(iv) Surface Area
(v) Activation energy

(b) $k=\frac{0.693}{t_{1/2}}$

$k=\frac{0.693}{5730\ y}$

$K=1.21\times10^{-4}\ y^{-1}$

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

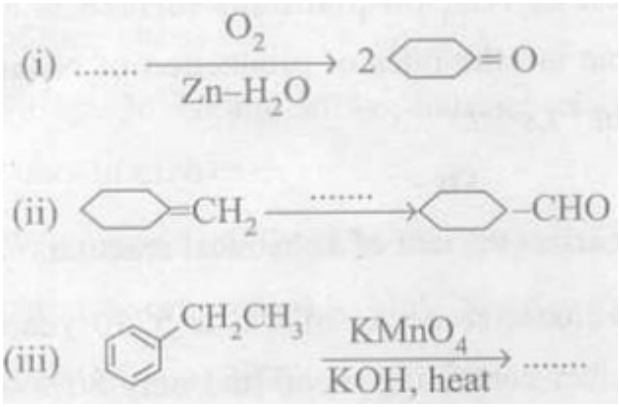
$k=\frac{2.303}{1.21\times10^{-4}y^{-1}}\frac{\log\ 100}{80}$

$k=\frac{2.303}{1.21\times10^{-4}y^{-1}}\log\ 1.25$

$k=\frac{2.303}{1.21\times10^{-4}y^{-1}}\times0.0969$

$=1845$ years

30. (a) Complete the following reaction statements by giving the missing starting material, reagent or product as required: [3, 2]



(b) Describe the following reactions:

(i) Cannizaro reaction

(ii) Cross aldol condensation

OR

(a) How would you account for the following: [3, 2]

(i) Aldehydes are more reactive than ketones towards nucleophiles.

(ii) The boiling points of aldehydes and ketones are lower than of the corresponding

acids.

(iii) The aldehydes and ketones undergo a number of addition reactions.

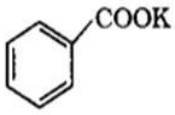
(b) Give chemical tests to distinguish between:

(i) Acetaldehyde and benzaldehyde

(ii) Propanone and propanol

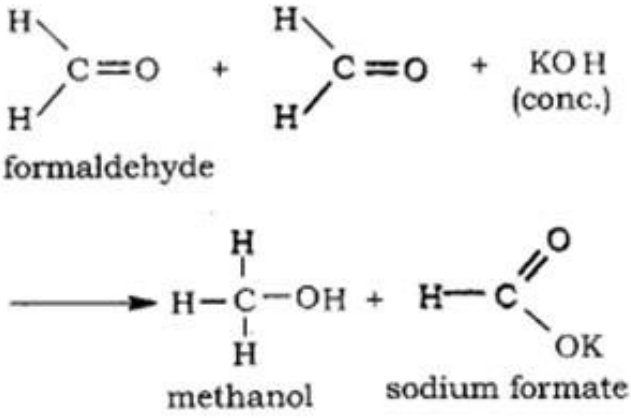
Ans. (a) (i)

(ii) $BH_3, H_2O_2 / OH^+, PCC\ (any\ one)$

(iii) 

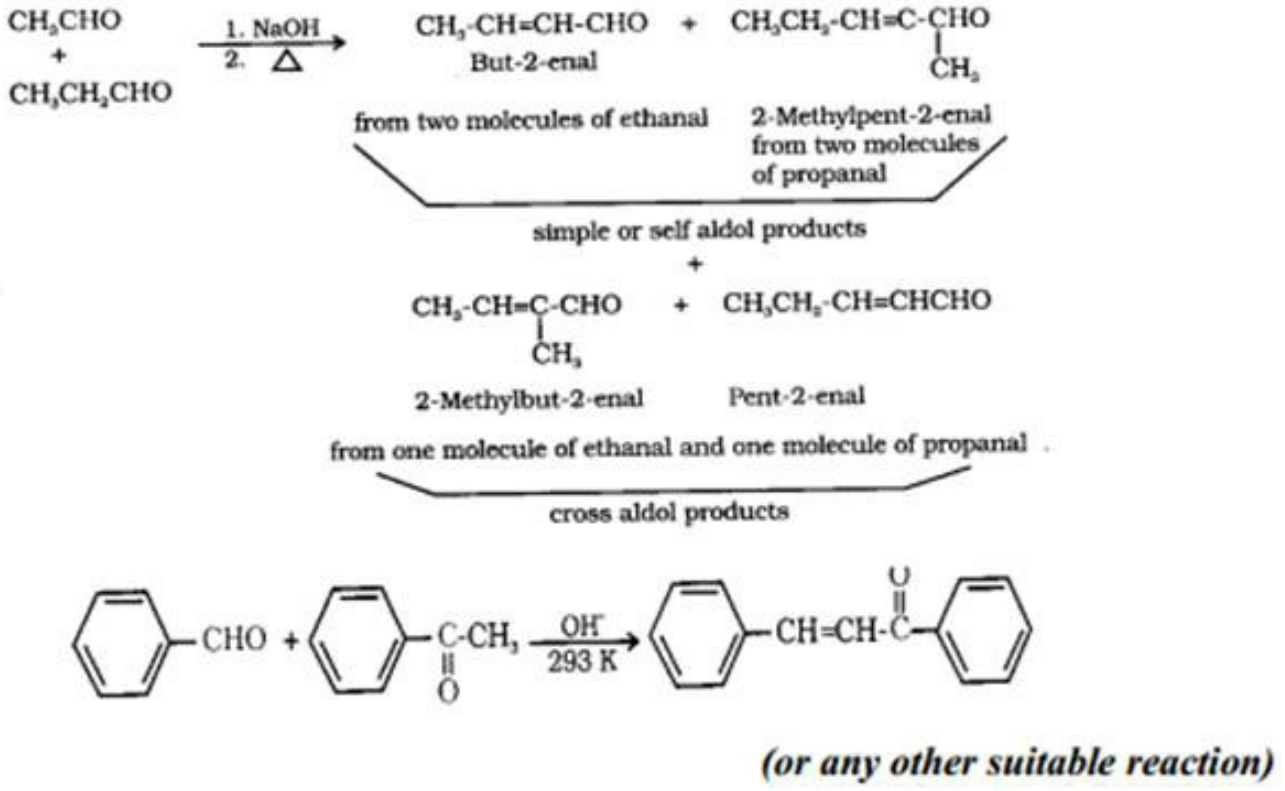
(NOTE: any two correct answers to be evaluated and 1½ marks for each to be awarded)

(b) (i) Cannizzaro reaction: Aldehydes which do not have an $\alpha - hydrogen\ atom,$ uhdergo self-oxidation and reduction reaction on treament with concentrated alkali.



(or any other suitable reaction)

(ii) Cross aldol condensation: When aldol condensation is carried out between two different aldehydes and /or ketones, it is called Cross aldol condensation.



(or any other suitable reaction)

(Note: Award full marks for correct chemical equation; award ½ mark if only statement is written)

OR

(i) Because two alkyl groups in ketones reduce the positive charge on carbon atom of the carbonyl group more effectivelythan in aldehydes. / or sterically, the presence of two relatively large substituents in ketones hinders the approach of nucleophile to carbonyl carbon than in aldehydes having only one such substituents.

(ii) Beacuase of the absence of hydrogen bonding in aldehydes and ketones.

(iii) Because of the presence of the sp^2 hybridised orbitals(or π-bond) of carbonyl carbon.

(b) (i) Acetaldehyde and benzaldehyde: Acetaldehyde gives yellow ppt of Iodoform (CHl_3) on addition of $NaOH/I_2$ whereas benzaldehyde does not give this test.

(or any other suitable test)

(ii) Propanone and propanol: Propanone gives yellow ppt of Iodoform (CHl_3) on addition of $NaOH/I_2$ whereas propanol does not give this test. Or / Propanol gives brisk effervesence on adding a piece of Sodium metal whereas Propanone does not give this test.

(or any other suitable test)