# CREATIVE EDUCATION FOUNDATION, KARKALA
## SECOND PU ANNUAL EXAMINATION APRIL – 2023
## CHEMISTRY DETAILED SOLUTION

### PART - A

**I. Select the correct option from the given choices:** **15 × 1 = 15**

**1. Which kind of defect is introduced by doping intrinsic semiconductors?**

**A)** Dislocation defect **B) Electronic defect**

**C)** Interstitial defect D) Schottky defect

**Ans: B) Electronic defect (Page No. 28)**

**2. A binary liquid mixture that forms maximum boiling azeotrope at a specific composition is**

A) Ethanol + Water B) n – Hexane + n- Heptane

C) Benzene + Toluene **D) Nitric acid + Water**

**Ans: D) Nitric acid + Water (Page No. 49)**

**3. The value of Van't Hoff factor (i) for ethanoic acid in benzene is nearly**

A) 2 B) 1

C) **0.5** D) 0

**Ans: C) 0.5 (Page No. 58)**

**4. On charging the Lead storage battery, $PbSO_4$ on cathode is converted into**

**A) $PbO_2$** B) Pb

C) PbO D) No change

**Ans: A) $PbO_2$ (Page No. 89)**

**5. In the Arrhenius equation the factor $e^{\frac{-Ea}{RT}}$ corresponds to**

A) Collision frequency B) Proper orientation

**C) The fraction of molecules with kinetic energy > $E_a$**

D) Threshold energy

**Ans: C) The fraction of molecules with kinetic energy > $E_a$ (Page No. 114)**

**6. Which one of the following is not applicable to the phenomenon of absorption?**

A) $\Delta G = -Ve$ B) $\Delta S = -Ve$

C) $\Delta H = -Ve$ **D) $\Delta H = +Ve$**

**Ans: D) $\Delta H = +Ve$ (Page No. 125)**

**7. What is the role of NaCN in the separation of ZnS and PbS by froth floatation method?**

**A) depressant** B) froth stabilizer

C) collector D) reductant

**Ans: A) depressant (Page No. 154)**

**8. On complete hydrolysis of $XeF_6$ with water, the product formed is**

A) $XeF_4$ **B) $XeO_3$**

C) $XeO_2F_2$ D) $XeOF_4$

**Ans: B) $XeO_3$ (Page No. 210)**

**9. Which of the following element is not regarded as transition element?**

A) Fe B) Mn

C) Sc **D) Zn**

**Ans: D)** Zn **(Page No. 217)**

**10.** $M-C$ **bond in metal carbonyls possesses _____**

A) Ionic character **B) Both $\sigma$ and $\pi$ characters**

C) $\pi$ – character only D) Ion-dipole forces

**Ans: B) Both $\sigma$ and $\pi$ characters (Page No. 262)**

**11. Identify chiral molecule in the following compounds.**

A) **2- Bromobutane** B) 1-Bromobutane

C) 2- Bromopropane D) 2-Bromo-2-methyl-Propane

**Ans: A) 2-Bromobutane (Page No. 307)**

**12. When** $CH_3ONa$ **reacts with** $(CH_3)_3$ **CBr, it gives exclusively**

A) t- Butylmethyl ether B) 2,2-Dimethyl propane

**C) 2- Methyl propene** D) 2-Methyl Propan -2-ol

**Ans: C) 2- Methylpropene (Page No. 346)**

**13. Iodoform reaction with** NaOI **can be used for the detection of the compound**

A) $C_2H_5COC_2H_5$ **B) $CH_3CHO$**

C) $CH_3CH_2CH_2OH$ D) $(CH_3)_3COH$

**Ans: B) $CH_3CHO$ (Page No. 370)**

**14. Nitration of aniline in the strongly acidic medium at 288 K yields**

A) 2,4,6 – Trinitroaniline B) o and p – Nitroanilines

C) m- Nitroaniline **D) o, m and p – Nitroanilines**

**Ans: D) o, m and p – Nitroanilines (Page No. 403)**

**15. Which hormone is an iodinated derivative of amino acid tyrosine?**

A) Insulin B) Epinephrine

**C) Thyroxin** D) Glucagon

**Ans: C) Thyroxin (Page No. 430)**

**II. Fill in the blanks by choosing the appropriate word from those given in the brackets: [Radium -226, Anoxia, Norethindrone, Pseudo first order, Diphenyl] ( 5 × 1 = 5)**

**16. Because of low concentration of** $O_2$ **in the blood and tissues of people living at high altitudes, suffer from a disease called** Anoxia

**17. Inversion of cane sugar is an example of** Pseudo first order **reaction.**

**18. Radon is obtained as a decay product of** Radium -226**.**

**19. When Chlorobenzene is treated with sodium in dry ether** Diphenyl **is formed.**

**20.** Norethindrone **is a synthetic progesteron derivative, most widely used as an antifertility drug.**

## PART-B

**III. Answer ANY FOUR of the following. Each question carries 2 marks : (4 × 2 = 8)**

**21. Give any two differences between Frenkel defect and Schottky defect.**

| Frenkel defect | Schottky defect |
|---|---|
| 1. It is due to the missing of ions (usually cations) from the lattice sites and these occupy the interstitial sites. | 1. It is due to the missing of equal number of cations and anions from the lattice sites. |
| 2. It has no effect on density of the crystal | 2. This results in the decrease in the density of the crystal |

**22. $\Lambda^0$m for NaCl, HCl and NaAc (Sodium acetate) are 126.4 $Scm^2mol^{-1}$, 425.9 $Scm^2mol^{-1}$ and 91.0 $Scm^2mol^{-1}$ respectively. Calculate $\Lambda^0$m for HAc (acetic acid).**

**Ans:**

$$\Lambda^0_{m(CH_3COOH)} = \Lambda^0_{m(HCl)} + \Lambda^0_{m(CH_3COONa)} - \Lambda^0_{m(NaCl)}$$

$$\Lambda^0_{m(CH_3COOH)} = (425.9 + 91.0 - 126.4)\,S\,cm^2mol^{-1}$$

$$\Lambda^0_{m(CH_3COOH)} = 390.5\,S\,cm^2mol^{-1}$$

**23. What are the two criteria for the effective collisions between molecules in a chemical reaction?**

**Ans:** Colliding molecules should have i) sufficient kinetic energy (called threshold energy) and
ii) Proper orientation

**24. Give reason:**

**a) Actinoids exhibit a greater range of oxidation states.**

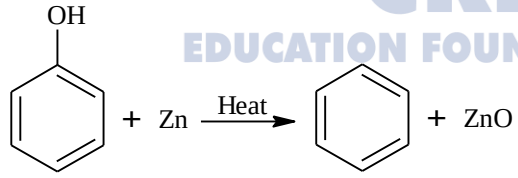
**b) Zr and Hf have the almost identical atomic radii.**

**Ans:** a) Due to very small energy gap between 5f, 6d and 7s subshells.

b) Due to lanthanoid contraction

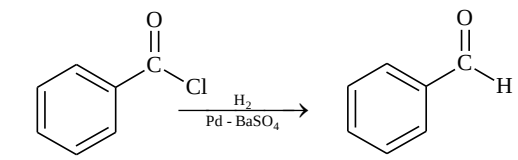
**25. What happens when Phenol is heated with Zinc dust? Write equation.**

**Ans:** phenol is converted to benzene on heating with zinc dust




**26. How is Benzoyl chloride converted into Benzaldehyde? Name the reaction.**

**Ans:** Rosenmund reduction.




Benzoyl chloride Benzaldehyde

**27. What is the role of following chemicals in food?**

**a) Sodium benzoate**

**b) Butylated Hydroxy Anisole (BHA).**

**Ans:** a) Food preservative

b) Antioxidant.

**28. Why do soaps not work in hard water?**

**Ans:** Hard water contains calcium and magnesium ions. These ions form insoluble calcium and magnesium soaps respectively when sodium or potassium soaps are dissolved in hard water. These insoluble soaps separate as scum in water and are useless as cleansing agent.

$2C_{17}H_{35}COONa + CaCl_2 \longrightarrow 2NaCl + (C_{17}H_{35}COO)_2Ca$

Soap — Insoluble calcium stearate.(soap)

## PART C

**IV. Answer ANY FOUR of the following question. Each question carries 3 marks** **4 × 3 = 12**

**29. Explain the extraction of 'blister copper' from copper matte. Write the balanced equations for the reactions taking place in then convertor.**

**Ans:** Copper matte is then charged into silica lined convertor. Some silica is also added and hot air blast is blown to convert $Cu_2S$ and $Cu_2O$ to the metallic copper.

Following reactions take place:

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

$FeO + SiO_2 \longrightarrow FeSiO_3$

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

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

The solidified copper obtained has blistered appearance due to the evolution of $SO_2$ and so it is called blister copper

**30. Write the balanced chemical equations with reaction conditions involved in the manufacture of nitric acid by Ostwald's process.**

**Ans:**

$4NH_3(g) + 5O_2(g) \xrightarrow[500K,\ 9\ bar]{Pt\ /Rh\ gauge\ catalyst} 4NO(g) + 6H_2O(g)$

(from air)

$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

$3NO_2(g) + H_2O(l) \longrightarrow 2HNO_3(aq) + NO(g)$



**31. Complete the following chemical equations:**

a) $PbS + 4O_3 \longrightarrow$ _____ $+ 4O_2$

b) $5SO_2 + 2MnO_4^- + 2H_2O \longrightarrow 5SO_4^{2-} + 4H^+ +$ _____

c) $C_{12}H_{22}O_{11} \xrightarrow{Conc.\ H_2SO_4}$ _____ $+ 11H_2O$

Ans:

a) $PbSO_4$

b) $2Mn^{2+}$

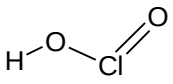
c) $12C$

**32. a) How is chlorine manufactured by Deacon's process? Give equation.**

**b) Write the structure of Chlorous acid.**

a) Oxidation of hydrogen chloride gas by atmospheric oxygen in the presence of $CuCl_2$ (catalyst) at 723 K gives Chlorine.

$$4HCl + O_2 \xrightarrow{CuCl_2} 2Cl_2 + 2H_2O$$

b) 

**33. a) The transition metals and their compounds are known for their catalytic activity. Give two reasons.**

**b) What is Mischmetall?**

a) (i) due to their ability to adopt multiple oxidation states.

(ii) due to their ability to form complexes

b) It is alloy consists of Lanthanoid metal (95%), iron (5%) and traces of S, C, Ca and Al.

**34. Explain the preparation of Potassium permanganate from $MnO_2$ with equations.**

**Ans:** Potassium permanganate is prepared by fusion of $MnO_2$ with an alkali metal hydroxide and an oxidising agent like $KNO_3$. This produces the dark green $K_2MnO_4$ which disproportionates in a neutral or acidic solution to give permanganate.

$$2MnO_2 + 4KOH + O_2 \longrightarrow 2K_2MnO_4 + 2H_2O$$

$$3MnO_4^{2-} + 4H^+ \longrightarrow 2MnO_4^- + MnO_2 + 2H_2O$$

**35. Out of the following two coordination entities; $cis-[PtCl_2(en)_2]^{2+}$ and $trans-[PtCl_2(en)_2]^{2+}$**

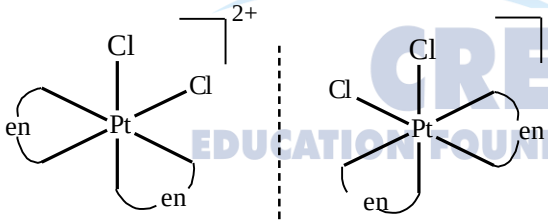
**a) Which is Chiral (optically active)?**

**b) Draw the structures of its enantiomers.**

**Ans:**

a) cis-$[PtCl_2(en)_2]^{2+}$

b)




**36. According to Valence Bond Theory (VBT), explain hybridization, geometry and magnetic property of $[CoF_6]^{3-}$ ion. (Atomic No. of Co = 27)**

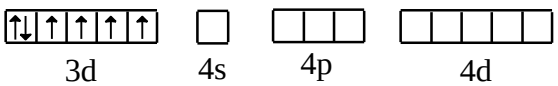
**Ans:**

$[CoF_6]^{3-}$

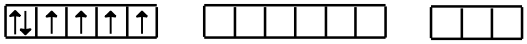
Central metal ion : $Co^{3+}$

Electronic configuration of $Co^{3+}$: [Ar] $3d^6$

Orbitals of $Co^{3+}$ ion

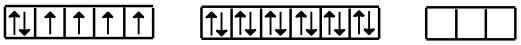


$sp^3d^2$ hybridised Orbitals of $Co^{3+}$ ion




$[CoF_6]^{3-}$

outer orbital complex or high spin complex




Magnetic property : Paramagnetic
Hybridisation : $sp^3d^2$
Geometry : Octahedral
Nature of complex : Outer orbital complex or high spin complex or spin free complex

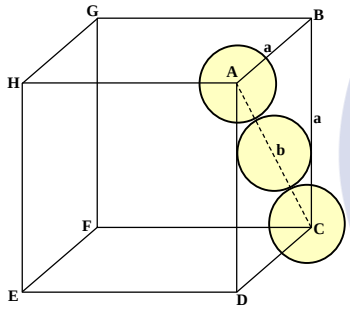
## PART – D

**V. Answer any three of the following. Each question carries 5 marks :**

**37. a) Calculate the packing efficiency in Face centred Cubic (FCC) Lattice.**

**b) potassium metal crystallises in a bcc unit cell with edge length 542 pm. Calculate the density of potassium metal. [Atomic mass of K =** $39\,g\,mol^{-1}$, $N_A = 6.022\times10^{23}mol^{-1}$]

**Ans:** Let the unit cell edge length be 'a' and face diagonal AC = b.




In Δ ABC

$AC^2 = b^2 = BC^2 + AB^2 = a^2+a^2 = 2a^2$ $\quad b^2 = 2a^2$ or $b = \sqrt{2}\,a$

If *r* is the radius of the sphere,

$b = 4r = \sqrt{2}\,a$ or $a = \frac{4r}{\sqrt{2}} = 2\sqrt{2}\,r$

Each unit cell in ccp structure has 4 spheres.

Total volume of four spheres = $4 \times \left(\frac{4}{3}\right)\pi r^3$

volume of the cube = $a^3$ or $(2\sqrt{2}\,r)^3$.

Therefore,

$$\text{Packing efficiency} = \frac{\text{Volume occupied by four spheres in the unit cell}\times100}{\text{Total volume of the unit cell}}\,\%$$

$$= \frac{4\times\left(\frac{4}{3}\right)\pi r^3\times100}{(2\sqrt{2}r)^3}\,\% = \frac{\frac{16}{3}\pi r^3\times100}{16\sqrt{2}r^3}\,\% = 74\%$$

b)

$$d = \frac{zM}{a^3N_A} \qquad d = \frac{2\times39\,g\,mol^{-1}}{\left(5.42\times10^{-8}cm\right)^3\left(6.022\times10^{23}mol^{-1}\right)} = 0.813\ g\ cm^{-3}$$

**38. a)** $450\,cm^3$ **of an aqueous solution of a protein contains 1.0 g of the protein. The osmotic pressure of such a solution at 310 K is found to be** $3.1\times10^{-4}$ **bar. Calculate the molar mass of the protein.** $\left(R = 0.083\,L\,bar\,mol^{-1}K^{-1}\right)$.

**b) State Raoult's law of relative lowering of vapour pressure. Write its mathematical form.**

**a) Ans:**

$$M_2 = \frac{W_2 \times R \times T}{\pi \times V}$$

$$M_2 = \frac{1\,g \times 0.083\,L\,bar\,mol^{-1}\,K^{-1} \times 310\,K}{3.1\times10^{-4}\,bar \times 450 \times 10^{-3}\,L} = 1,84,444.44\,g\,mol^{-1}$$

**b)** For a solution containing non volatile solute, the relative lowering of vapor pressure is equal to the mole fraction of the solute.

$$\frac{p_1^0 - p_1}{p_1^0} = \frac{n_2}{n_1 + n_2}$$

**39. a) Calculate the standard Gibb's energy** $\left(\Delta_r G^0\right)$ **for the reaction at 298 K:**

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

**[Given :** $E^0_{Zn^{2+}/Zn} = -0.76V$, $E^0_{Ag^+/Ag} = +0.80\,V$, $F = 96,500\,C\,mol^{-1}$**].**

**b) Write the balanced equations for the reactions taking place at anode and cathode during rusting of iron.**

**Ans:**

a)

$$E^0_{Cell} = E^0_{Ag^+/Ag} - E^0_{Zn^{2+}/Zn} = 0.80 - (-0.76) = 1.56V$$

$$\Delta_r G^0 = -nFE^0$$

$$\Delta_r G^0 = -2 \times 96500\ C\ mol^{-1} \times 1.56\ V = -301080\,J mol^{-1} = -301.080\,kJ mol^{-1}$$

b)

**Ans:** Anode: $2Fe\,(s) \longrightarrow 2Fe^{2+}\,(aq) + 4e^-$

Cathode: $O_2(g) + 4H^+(aq) + 4e^- \longrightarrow 2H_2O(l)$

**40. a) Derive an integrated rate equation for the rate constant of a first order reaction.**

**b) Draw a graph of potential energy v/s reaction coordinate showing the effect of catalyst on the rate of a reaction.**

**Ans:**

a)

A first order reaction is one in which, the rate of the reaction is proportional to the first power of the concentration of reactant R.

Consider the first order reaction, $R \longrightarrow P$

$$\text{Rate} = -\frac{d[R]}{dt} = k[R]$$

$$\frac{d[R]}{[R]} = -kdt$$

Integrating this equation, we get

$$\ln [R] = -kt + I \text{----(1)}$$

Where, I is the constant of integration.

When t = 0, $R = [R]_0$, Where $[R]_0$ is the initial concentration of the reactant.

Equation (1) can be written as

$$\ln [R]_0 = -k \times 0 + I$$

$$I = \ln [R]_0$$

Substituting value of I in equation (1)

$$\ln [R] = -kt + \ln [R]_0 \quad ----(2)$$

Rearranging equation (2)

$$kt = \ln [R]_0 - \ln [R]$$

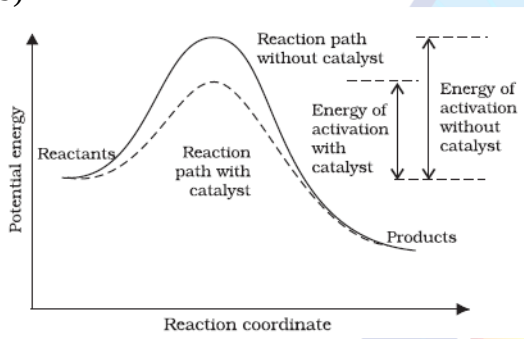
$$\ln \frac{[R]_0}{[R]} = kt \quad ----(3)$$

$$k = \frac{1}{t} \ln \frac{[R]_0}{[R]}$$

$$k = \frac{2.303}{t} \log \frac{[R]_0}{[R]} \quad ----(4)$$

Equation (4) is the integrated rate equation for first order reaction.

b)

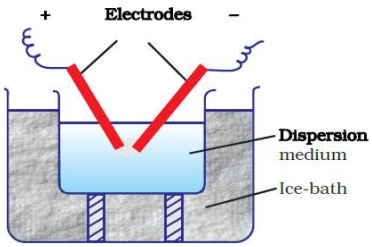



**41. a) Explain Bredig's Arc method for the preparation of metal sols.**

**b) Write two steps involved in the mechanism of enzyme catalysed reaction.**

**Ans:**

**a)**




This process involves dispersion as well as condensation.

Colloidal sols of metals such as gold, silver, platinum, etc., can be prepared by this method.

In this method, electric arc is struck between electrodes of the metal immersed in the dispersion medium.

The intense heat produced vapourises the metal, which then condenses to form particles of colloidal size.

**b)**

**Step 1:** Binding of enzyme to substrate to form an activated complex.

$$E + S \longrightarrow ES^*$$

**Step 2:** Decomposition of the activated complex to form product.

$$ES^* \longrightarrow E + P$$

**VI. Answer any three of the following. Each question carries 5 marks:**

**42. a) Explain $S_N1$ mechanism of conversion of tert-butyl bromide to tert-butyl alcohol.** **(3)**

**b) Give any two reasons for the less reactivity of aryl halides towards nucleophilic substitution reactions.**

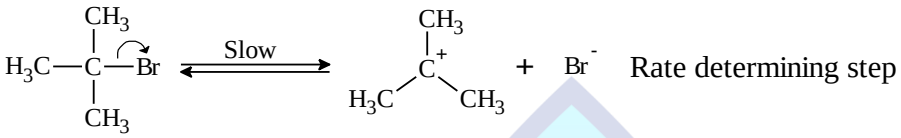
**Ans:** **(2)**

**a)** $S_N1$ reactions are generally carried out in polar protic solvents.

It follows first order kinetics.

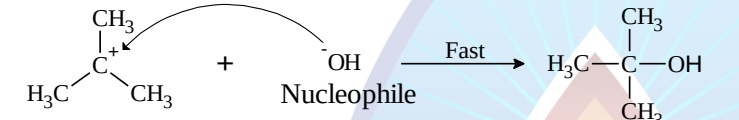
It occurs in two steps.

**step I:** the polarised C—Br bond undergoes slow cleavage to produce a carbocation and a bromide ion.




tert-Butyl bromide tert-Butyl carbocation

**step II:** The carbocation thus formed is then attacked by nucleophile to complete the substitution reaction.




tert-Butyl carbocation




tert-Butyl alcohol

**b)** i) Resonance effect: Due to resonance C-X bond in aryl halides acquires partial double bond character, consequently C-X bond in aryl halides is little stronger than in alkyl halides, and hence cannot be easily broken.

ii) Hybridisation: Carbon which is bonded to halogen in aryl halide is $sp^2$ hybridised which has more s-character and can hold the electron pair of C-X bond more tightly than $sp^3$ hybridised carbon in alkyl halide.

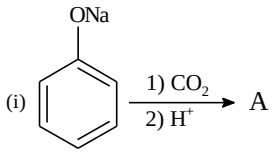
iii) Instability of phenyl cation: phenyl cation is not resonance stabilised.

iv) Possible repulsion between electron rich nucleophile and electron rich arenes.

**43. a) Write the mechanism of the following reaction:** **(3)**

$$C_2H_5OH \xrightarrow[443K]{Conc.H_2SO_4} CH_2=CH_2 + H_2O$$

**b) Identify 'A' and 'B' in the following equations:** **(1+1)**

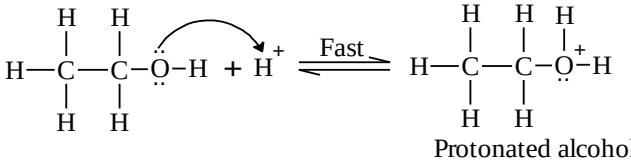



(ii) $(CH_3)_3C\text{-}O\text{-}C_2H_5 \xrightarrow{HI} C_2H_5OH + B$

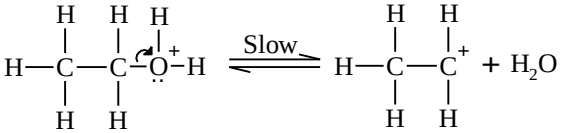
**Ans:**

**a) Mechanism**

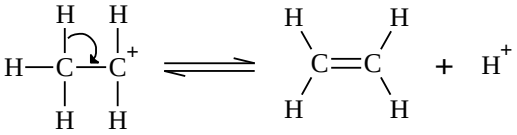
**Step 1:** Formation of protonated alcohol.



**Step 2:** Formation of carbocation: It is the slowest step and hence, the rate determining step of the reaction.

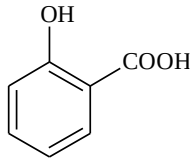



**Step 3:** Formation of ethene by elimination of a proton.



Ethene

b)



Orthohydroxybenzoic aci

A = Salicylic acid

B = $(CH_3)_3CI$

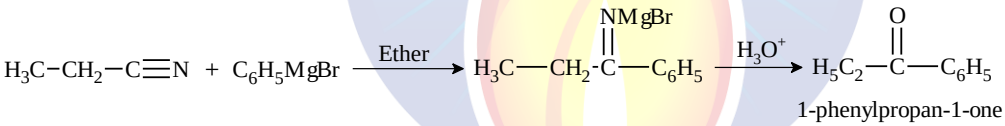
**44. a) How is ketone prepared from Grignard reagent and nitrile? Explain with an example. (2)**

**b) Explain Hell – Volhard – Zelinsky reaction. Give equation. (2)**

**c) What is the role of dry HCl gas in the addition of alcohols to aldehydes? (1)**

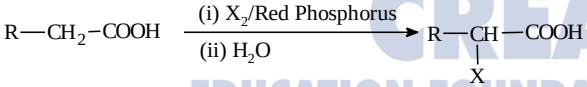
**Ans:**

**a)** Treating a nitrile with Grignard reagent followed by hydrolysis yields a ketone.




1-phenylpropan-1-one

**b) Hell-Volhard-Zelinsky reaction:** Carboxylic acids having a α-hydrogen are halogenated at the α-position on treatment with chlorine or bromine in the presence of small amount of red phosphorus to give α-halocarboxylic acids.




X = Cl, Br

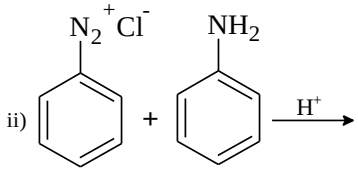
α-Halocarboxylic acid

**c)** Dry HCl protonates the oxygen of the carbonyl compounds and therefore increases the electrophilicity of the carbonyl carbon.

**45. a) Write the equations of reactions involved in the Gabriel Phthalimide synthesis of a primary amine. (3)**

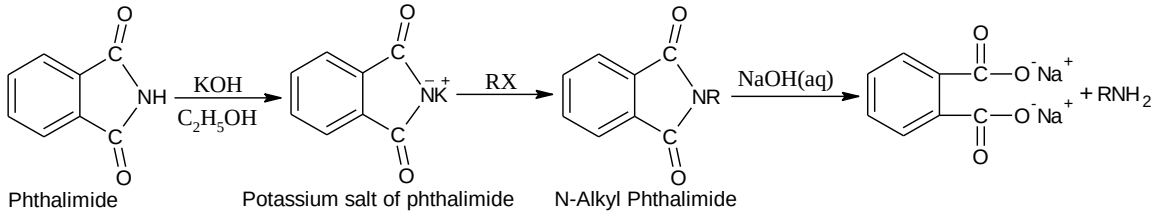
**b) Complete the following reactions by giving major products.**

i) $C_6H_5NH_2 \xrightarrow[273K\text{-}278K]{NaNO_2 + 2HCl}$



**Ans:**

a)

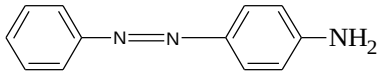



Phthalimide — Potassium salt of phthalimide — N-Alkyl Phthalimide

b)

i) $C_6H_5N_2^+Cl^-$

ii)



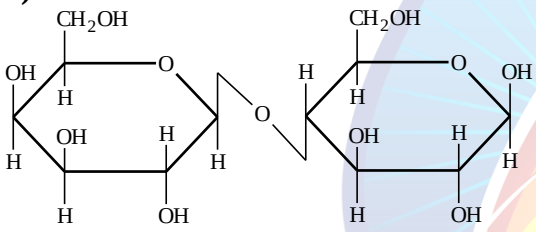

**46. a) Write the Haworth's structure of lactose. (2)**

**b) What is denaturation of proteins? Which level of structure remains intact during denaturation of globular proteins? (2)**

**c) Name the sugar moiety present in DNA. (1)**

**Ans:**

**a)**



Lactose

b) When a protein in its native form, is subjected to physical change like change in temperature or chemical change like change in pH, the hydrogen bonds are disturbed. Due to this, globules unfold and helix get uncoiled and protein loses its biological activity. This is called **denaturation** of protein.

During denaturation Primary structure remains intact.

c) β–D-2-deoxyribose

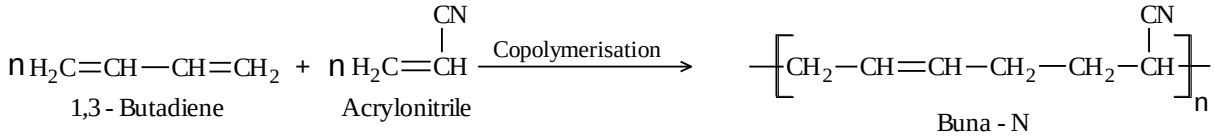
**47. a) How is Buna – N prepared? Give equation. (2)**

**b) Name the monomers of the biodegradable polymer Nylon -2-nylon-6. (2)**

**c) Write the partial structure of Dacron. (1)**

**Ans:**

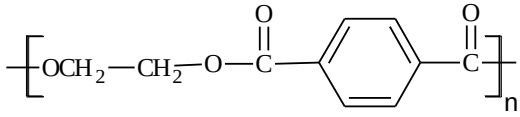
a) Buna–N is obtained by the copolymerisation of 1,3–butadiene and acrylonitrile in the presence of a peroxide catalyst.




1,3 - Butadiene — Acrylonitrile — Buna - N

b) Glycine and Aminocaproic acid

c)



Terylene or Dacron

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