CHEMISTRY (043) CLASS- XII

Section-A

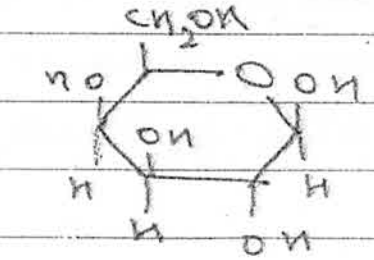
1. In emulsion : physical state of dispersed phase :- liquid
physical state of dispersion medium :- liquid
(e.g. milk, hair cream etc)
but, In gel : physical state of dispersed phase :- liquid
physical state of dispersion medium :- solid
(e.g. cheese, jellies etc).
So, these colloids differ in physical states of their dispersion medium.

2. Increasing order of basic strength (gas phase)
$C_2H_5NH_2 < (C_2H_5)_2NH < (C_2H_5)_3N$

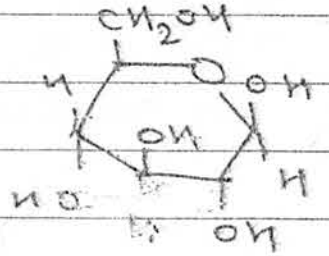
3. Phosphorus is a pentavalent element. Therefore, when Silicon is doped with phosphorus, one of the electrons remains unbonded and is delocalised in the lattice. This electron can be easily excited to conduction band and move in the presence of external electric field. This way, doping Si with P increases the number of charge carriers and hence its conductivity.

The semi-conductor thus formed is an extrinsic one (n-type).

4. Products of hydrolysis of lactose :- β-D-galactose, β-D-glucose.

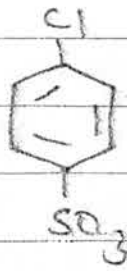


β-D-galactopyranose



β-D-glucopyranose.

5. IUPAC name : 4-Chlorobenzene sulphonic acid

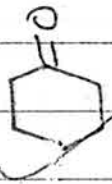
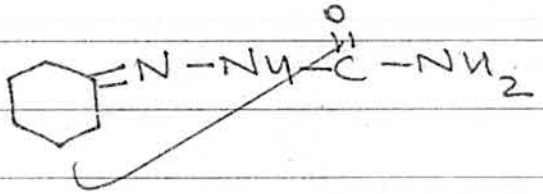


Section-B

6. (i)

A –  , B – 

(ii)

A –  , B – 

7. (i) Rate law for the reaction

$$\text{Rate} = k[H_2O_2][I^-]$$, where k is the rate constant for the given reaction.

(ii) Overall order of reaction = 1+1 = 2

(iii) Step (1) is the rate determining step because it is the slowest step (elementary reaction) in the proposed mechanism. Hence, the rate of reaction is determined by this reaction (step).

8.

Ideal Solution	Non-Ideal Solution
(a) The solution obeys Raoult's law over the entire range of concentration. The vapour pressure of solution is nearly equal to that predicted by Raoult's law.	(a) The solution does not obeys Raoult's law. The vapour pressure of the solution is either higher or lower than that predicted by Raoult's law.
(b) The intermolecular interactions between solute-solvent particles are of similar order to that of solute-solute particles and solvent-solvent particles. i.e. $\Delta_{mix}H = 0$ & $\Delta_{mix}V = 0$	(b) The intermolecular interactions between solute-solvent particles is either stronger or weaker than that existing between solute-solute particles & solvent-solvent particles. i.e. $\Delta_{mix}H > 0$, $\Delta_{mix}V > 0$ (+ve deviation) OR $\Delta_{mix}H < 0$, $\Delta_{mix}V < 0$ (-ve deviation)
e.g. Solution of n-hexane & n-heptane	e.g. Solution of ethanol & acetone — ion

9. A – K_2MnO_4

Potassium manganate.

B – $KMnO_4$

Potassium permanganate

C – KIO_3 (or $IO_3^{\ominus}$)

Potassium iodate

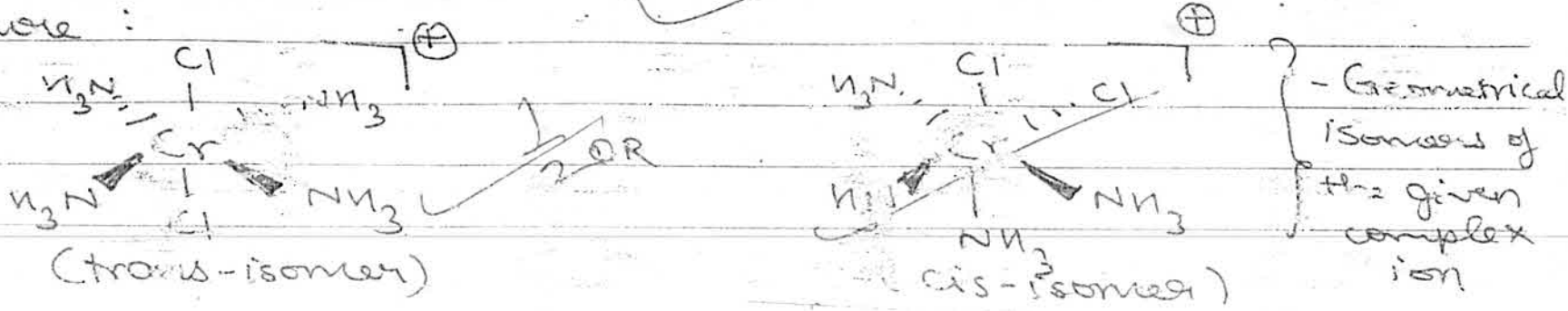
D – I_2

Iodine

10. IUPAC name of $[Cr(NH_3)_4Cl_2]^+$:–

Tetraamminedichloridochromium(III) ion

Structure :



11. (i) Diamagnetic complex :- $[Co(C_2O_4)_3]^{3-}$
(ii) More stable complex :- $[Co(C_2O_4)_3]^{3-}$ (Chelate effect)
(iii) Outer orbital complex :- $[CoF_6]^{3-}$
(iv) Low spin complex :- $[Co(C_2O_4)_3]^{3-}$

12. (i) Increasing acidic character
$H_2O < H_2S < H_2Se < H_2Te$
(ii) Decreasing bond enthalpy
$HF > HCl > HBr > HI$

Section-C

13. edge length of unit cell, $a = 300\ pm$
$= 3 \times 10^2 \times 10^{-10}\ cm$
$= 3 \times 10^{-8}\ cm$
Volume of 1 unit cell $= a^3 = 27 \times 10^{-24}\ cm^3$
Density of element $= \rho = 10.8\ g\ cm^{-3}$ (given)
Mass of 1 unit cell $= \rho a^3 = 10.8 \times 27 \times 10^{-24}\ g$

Given mass of element = 108 g

So, Total number of unit cells in this mass of element

$$N = \frac{108\,g}{\text{mass of 1 unit cell}} = \frac{108\,g}{10.8 \times 27 \times 10^{-24}\,g}$$

OR, $$N = \frac{10 \times 10^{24}}{27} \text{ unit cells}$$

Number of atoms present in one unit cell, $n = 4$ (fcc (atfico))

So, total number of atoms $= nN = 4 \times \frac{10}{27} \times 10^{24}$ atoms

$$= \frac{40}{27} \times 10^{24} \text{ atoms}$$

$$= 1.481481 \times 10^{24} \text{ atoms}$$

Hence, a total of $1.481\,481 \times 10^{24}$ atoms of element are present in 108 g of the given element.

14. Concentration of sucrose solution = 4% (w/w)

Considering 100g of solution,

Mass of sucrose = 4g (m_s)

Mass of water = 100 - 4 = 96g (m_w)

Molar mass of Sucrose, M_s = 342 g mol^{-1}

Moles of Sucrose molecules

$$n_s = \frac{m_s}{M_s} = \frac{4}{342} \text{ mol} = \frac{2}{171} \text{ mol}$$

Molality of Solution = $\frac{n_s}{m_w \text{(in kg)}}$

$$m = \frac{2\,(1000)}{171\,(96)} \text{ mol kg}^{-1}$$

$$m = \frac{2000}{171 \times 96} \text{ mol kg}^{-1}$$

Freezing point of solution = 271.15 K.

Depression in freezing point = (273.15 - 271.15) K

= 2K = ΔT_f

Now, $\Delta T_f = K_f \, m$

where K_f = molal depression constant of water.

Substituting values,

$$2 = K_f \times \frac{2000}{171 \times 96}$$

OR $$K_f = \frac{2 \times 171 \times 96}{2000} = \frac{171 \times 96}{1000} \text{ K kg mol}^{-1} \quad \text{—(1)}$$

Now, given 5% glucose solution.

Considering 100 g of solution.

Mass of glucose = 5g = m_g [Mass of water = 95g]

Molar mass of glucose = 180 g mol^{-1} = M_g

moles of glucose, $n_g = \frac{m_g}{M_g} = \frac{5}{180} \text{ mol} = \frac{1}{36} \text{ mol}$

Molality of solution = $\frac{n_g}{\text{mass of water (in kg)}}$

$$m = \frac{1}{36(95)} \times 1000 \text{ mol kg}^{-1} = \frac{1000}{3420} \text{ mol kg}^{-1}$$

Using : $\Delta T_f = K_f m$

$\Delta T_f = \frac{171 \times 96}{1000} \times \frac{1000}{36 \times 95}$ (from ①)

$\Delta T_f = \frac{171 \times 96}{36 \times 95} K = 4.8 K$

So, actual freezing point = 273.15K - 4.8K

$= 27\overset{6}{\cancel{3}}\overset{12}{\cancel{.}}15$

$\quad\quad 4.80$

$\quad\quad 268.35$

$= 268.35 K$

Hence, the freezing point of 5% glucose solution in water is 268.35 K.

15. Reaction : $NH_3(g) \rightleftharpoons \frac{1}{2} N_2(g) + \frac{3}{2} H_2(g)$

Rate of reaction $= -\frac{d[NH_3]}{dt} = k[NH_3]^0$

where, $k = 4 \times 10^{-3} MS^{-1}$ (given)

So, differential rate equation becomes,

$$-\frac{d[NH_3]}{dt} = R$$

$$\int d[NH_3] = -\int R\,dt$$

$$[NH_3] = -Rt + C \quad -(1)$$

At $t = 0$, $[NH_3] = [NH_3]_0$ (initial concentration)

So, $[NH_3]_0 = C$

$\therefore$ (1) becomes,

$$[NH_3] = [NH_3]_0 - Rt$$

Now, $[NH_3]_0 = 0.1\,M$

$[NH_3] = 0.064\,M$

and $R = 4 \times 10^{-3}\,M\,s^{-1}$

So,

$$0.064\,M = 0.100\,M - Rt$$

$$Rt = 0.036\,M$$

$$t = \frac{0.036\,M}{4 \times 10^{-3}\,M}\,s = \frac{36}{4}\,s = 9\,s$$

Hence, it will take 9s to reduce the initial concentration of NH_3 from 0.1M to 0.064M.

16. (i) Activated charcoal acts as an adsorbent in gas masks and adsorbs harmful and poisonous gases like SO_2 & fumes of As etc on itself, thus protecting the wearer of the mask from these gases.

(ii) The hydrated ferric oxide colloid is negatively charged in this case (because it adsorbs OH^- on ferric solution). Sol can be represented as $Fe_2O_3 \cdot xH_2O \,|\, OH^-$

OR $Fe(OH)_3 \,|\, OH^-$

(iii) The degree (or extent) of chemisorption increases with increasing temperature, as chemical bond formation between the adsorbate and adsorbent molecules takes place in this case. Therefore, an appreciable amount of activation energy (E_a) is present, which can be easily overcome at high temperatures (according to Arrhenius equation $[k = Ae^{-\frac{E_a}{RT}}]$). However, even very high temperature, the extent of chemisorption decreases

due to increasing thermal energy of gas particles (but that is very high temperature ∴ not much perceptible).

17. (i) CO acts as a complexing agent and combines with Nickel atoms to form $[Ni(CO)_4]$ complex (volatile) This compound thus formed is highly volatile in nature and is collected elsewhere and decomposed at higher temperature to give pure Ni, which allows us to separate pure Nickel from the impurities present in crude nickel. Hence, helps in refining of Nickel metal.

$$Ni + 4CO \xrightarrow{350K} [Ni(CO)_4] \text{ (volatile)}$$

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

↓ pure nickel metal.

(ii) Silica (SiO_2) acts as an acidic flux and combines with basic impurities (gangue – FeO) to form slag. The slag thus produced is a fusible component and immiscible with molten metal (Cu). Being lighter, slag can be easily removed from pure molten Cu and helps in further purification and reduction of Cu metal.

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

$$FeO(s) + SiO_2(s) \longrightarrow FeSiO_3(l)$$
(slag)

· Thus way, iron is removed from $CuFeS_2$ and other Cu ores containing iron.

(iii) Highly Electropositive elements such as Na, Mg, Al etc. are generally extracted through electrolytic method. This is so, because these metals are themselves the strongest reducing agent therefore, no other element, compound can reduce these metals from their salts to metal form. Hence, electrolytic principles have to be used and external voltage is used to drive the non-spontaneous chemical reaction.

e.g. Extraction of Aluminium (Hall-Heroult Process)

Q. (i) Transition metals have a large number of unpaired - d- electrons, of small size and (d-s-p) vacant orbitals present per bonding (metallic bond) this makes the metals to

homogeneously mix with one another (solid solution) leading to the formation of alloys. Also, in a period, the size of the elements are almost similar, and therefore, atoms of one element when present along with other elements do not interfere with corresponding metallic lattices and are able to fuse with one another quite effectively e.g. German Silver (Cu, Zn & Ni), Brass (Cu & Zn), Bronze (Cu & Sn).

(ii) In Mn_2O_3, Manganese is present in +3 oxidation state, whereas in Mn_2O_7, Manganese is present in +7 oxidation state. Since, higher the oxidation state, more is the polarising power of the metallic ion (Fajan's Rule), Mn–O bonds in Mn_2O_7 are more covalent as to those in Mn_2O_3. This increase in covalent nature and high oxidation state of Mn atom makes the solution of Mn_2O_7 in water more acidic as that of the solution of Mn_2O_3 in water. Hence, Mn_2O_7 is more acidic than Mn_2O_3

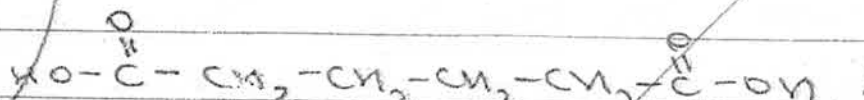
(iii) Eu (Europium) belongs to the 4f-series (lanthanoids) and has a more stable oxidation state of +3, (+3 oxidation state for all lanthanoids is the most stable).

Hence, Eu^{2+} ion has a strong tendency to go to Eu^{3+} state (+3 oxidation state), and thus acts as a strong reducing agent.

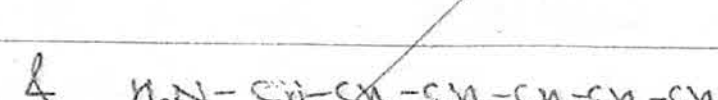
$$Eu^{2+}_{(aq)} \longrightarrow Eu^{3+}_{(aq)} + e^- \quad , E_{cell} > 0$$

Also, $E_{cell} > 0$ for this reaction making it much more favourable.

19. (i) Monomers of Nylon-6,6

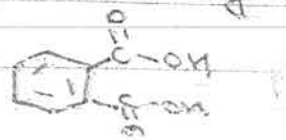


(Hexane-1,6-dioic acid) &

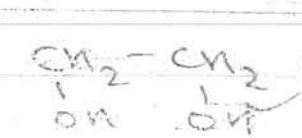


(Hexane-1,6-diamine)

(ii) Monomers of Glyptal

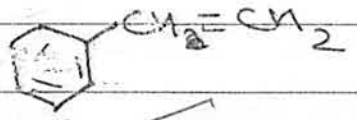


(Phthalic acid) &



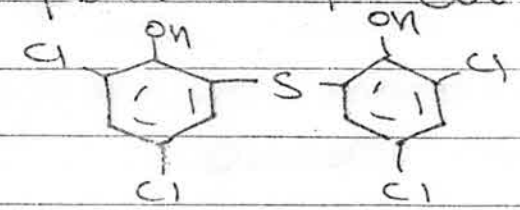
(ethylene glycol)

(iii) Monomers of Buna-S

$CH_2 = CH - CH = CH_2$ and 

(Buta-1,3-diene) (Styrene)

20. (i) Bithional is added to soap to impart antiseptic properties to it.

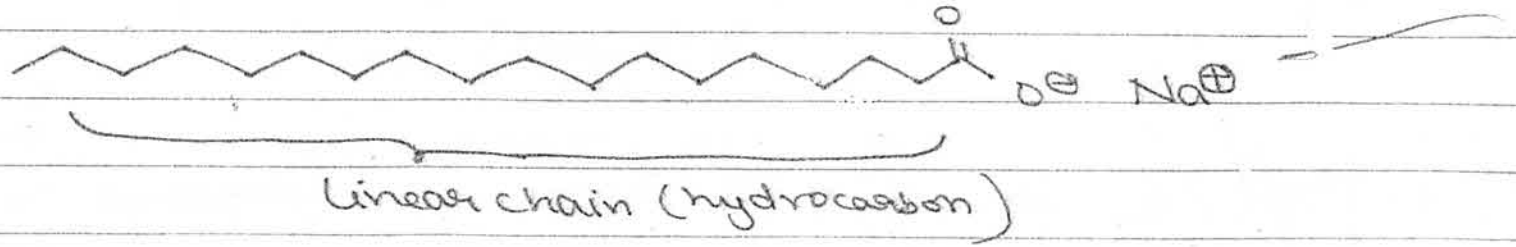


(Bithional)

(ii) $Mg(OH)_2$ is a mild base as compared to $NaHCO_3$. Therefore, if we use $NaHCO_3$, it will make the medium of our stomach alkaline, which will lead to even further secretion of HCl from the cells present in wall of our stomach (according to Le Chatelier's principle). This is undesirable. Therefore, $Mg(OH)_2$ is preferred

in place of $NaHCO_3$, as being a weaker base, it only neutralises the excess acid and relieves the person from symptoms of hyperacidity. It does not make the stomache medium alkaline and hence does not promote further secretions of acid.

(iii) Soaps are generally sodium salts of long chain fatty acids which are linear in structure and do not consist of extensive branching. for e.g. Sodium Stearate.

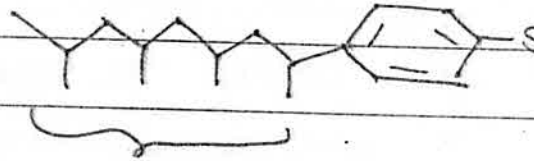


OR Sodium oleate, Sodium palmitate etc.

On the other hand, detergents are usually branched, which makes it difficult for microorganisms (like bacteria) to break them down (degrade them). Thus, they sustain themselves in the environment and cause pollution (in waters etc)

These, thus are generally non-biodegradable in nature.

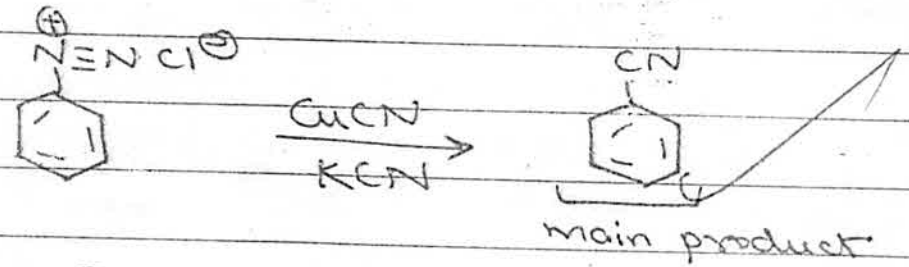
e.g. Sodium - 4 - (1,3,5,7-tetramethyl octyl) benzene sulphonate



branching
4 methyl group

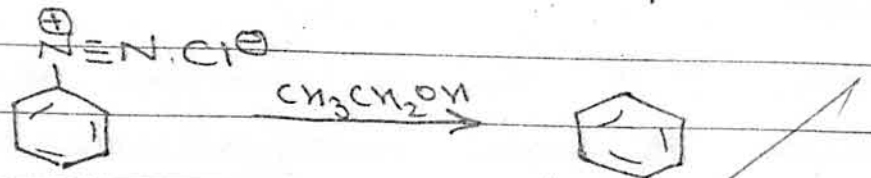
, many other ABS (alkyl benzene sulphonates) are heavily also branched and are hence, non-biodegradable.

21. (i)



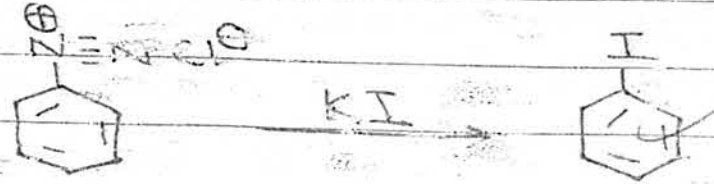
main product

(ii)



main product

(iii)



main product

22 (i) $(CH_3)_3C-I$ is more reactive than $(CH_3)_3C-Br$ towards S_N1 reaction, because $I^\ominus$ is a better leaving group than $Br^\ominus$. Because of its larger size as compared to $Br^\ominus$, $I^\ominus$ is able to effectively stabilise the negative charge on itself, therefore, making the cleavage step more favourable.
Also, C-I bond is weaker than C-Br bond (i.e. C-I bond is longer than C-Br bond due to large size of $I^\ominus$ ion)

$$(CH_3)_3C-I \underset{\text{polar protic solvent}}{\overset{H^\oplus}{\rightleftharpoons}} (CH_3)_3C^\oplus + I^\ominus$$

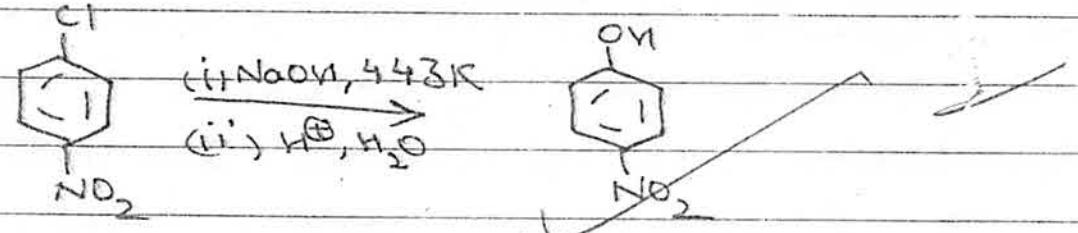
$I^\ominus$ is more stable and hence, cleavage takes easily

$$(CH_3)_3C-Br \underset{\text{polar protic solvent}}{\overset{H^\oplus}{\rightleftharpoons}} (CH_3)_3C^\oplus + Br^\ominus$$

Also, we know that H-I is a stronger acid than H-Br, because of low bond-dissociation enthalpy of H-I bond as compared to H-Br.
∴ by Bronsted theory of acids and bases, the conjugate base $I^\ominus$ should be a weaker base than $Br^\ominus$, and we know that a stronger base can displace a weaker base more easily in a nucleophilic substitution reaction. Hence, $I^\ominus$ is more

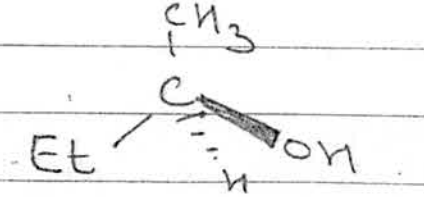
easily replaced by other nucleophiles as compared to $Br^{\ominus}$. Thus increasing the rate of reaction.

(ii)



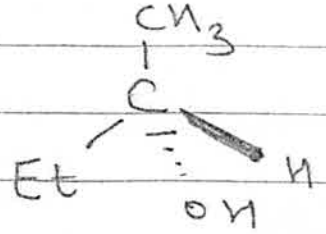
4-Nitrophenol

(iii) 'dextro' and 'laevo' rotatory forms of Butan-2-ol, mainly constitute the enantiomers of the same compound. i.e.



(R-configuration)

and



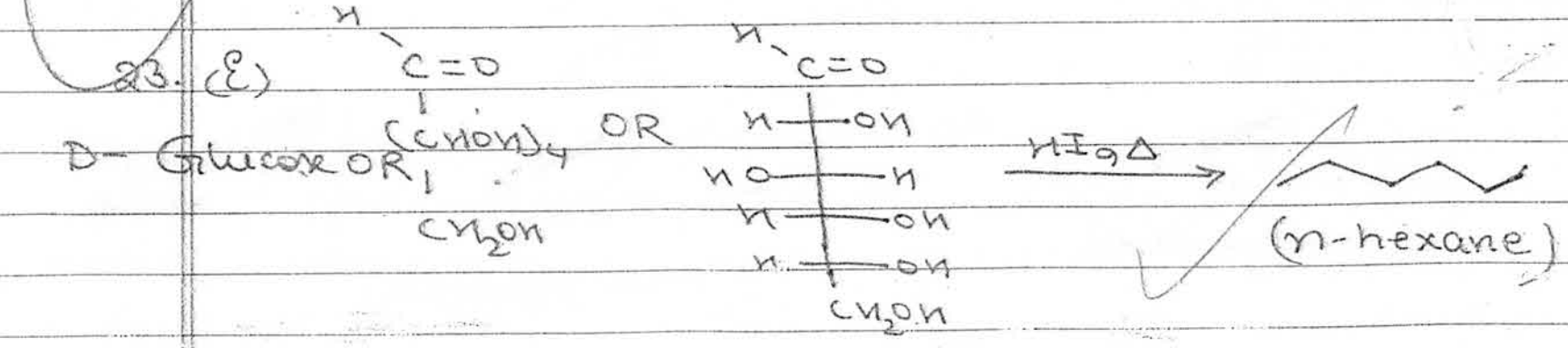
(S-configuration)

Key:
Et = ethyl group

These two forms of Butan-2-ol differ only in their spatial arrangement of molecules: Me, Et H, OH around the chiral carbon and therefore have the same

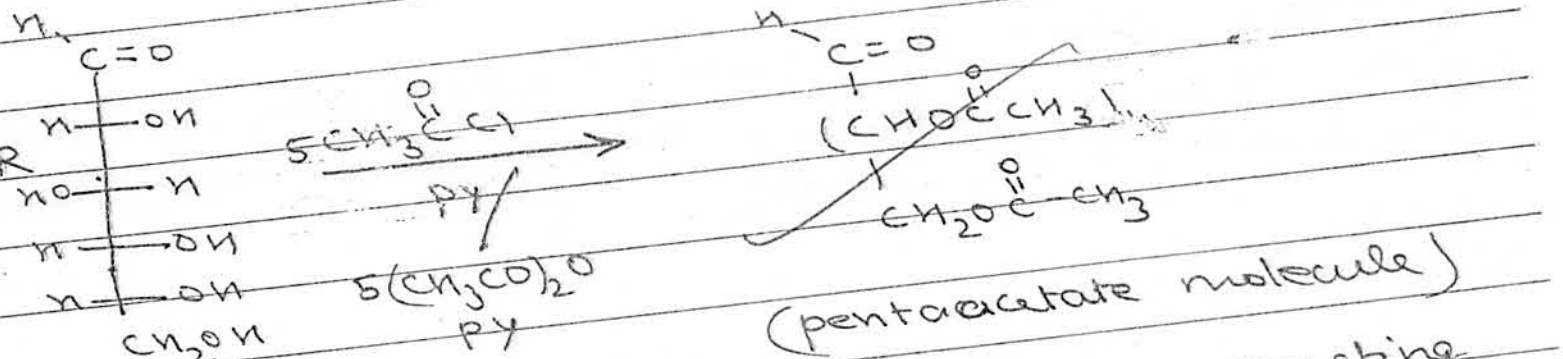
physical properties like - melting point, boiling point, electrical conductivity, solubility etc.
Hence, it is difficult to separate these two isomers (optical stereoisomers) of Butan-2-ol by fractional distillation, as fractional distillation makes use of difference in boiling point of two substances (which should be greater than 20-25°C). But in this case, both the isomers have identical boiling points and thus, these are not separable by this method.

23. (E)



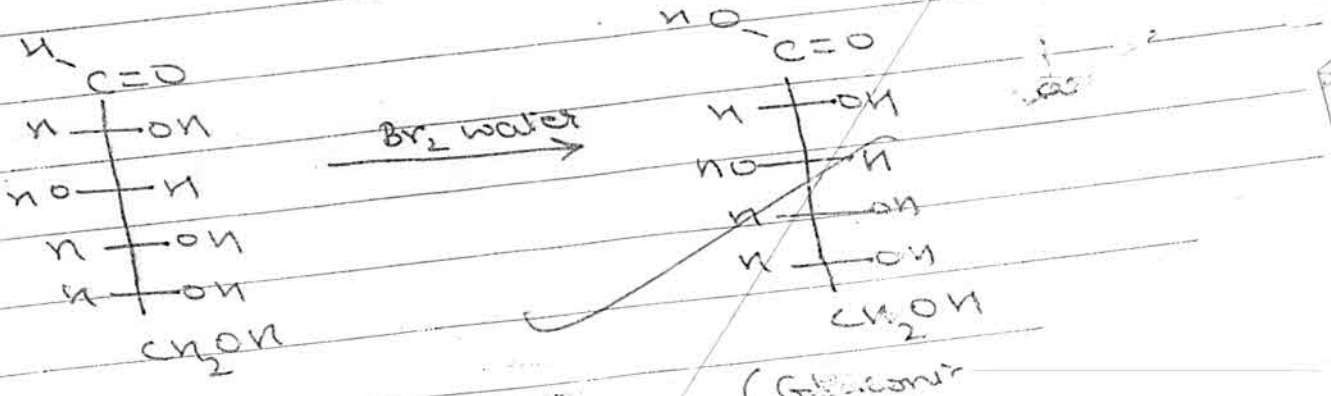
The prolonged heating of glucose molecule with HI to produce n-hexane, proved that the open structure of D-glucose contains a straight chain.

(ii) D-Glucose OR



This formation of pentaacetate molecule on reacting glucose with acetyl chloride in presence of pyridine proved that open structure of glucose contains five alcoholic groups (pentaacetate molecule)

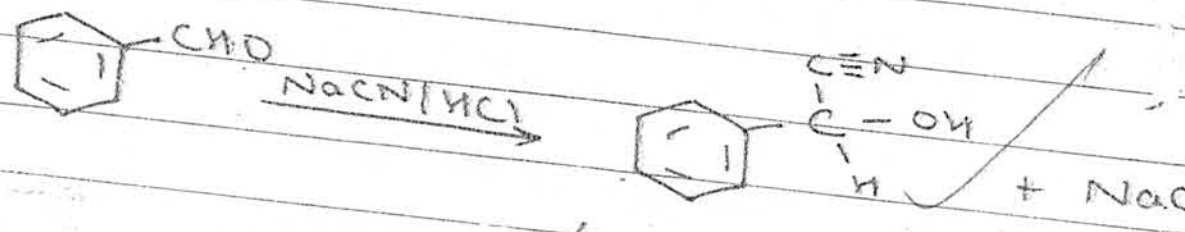
(iii) D-Glucose OR



D-Glucose on treatment with mild oxi... form gluconic ... (Gluconic ...

open structure of D-glucose contains an Aldehyde as carbonyl group (as ketone would not have been oxidised by Br_2 water).

24. (i)



(cyanohydrin)

25.

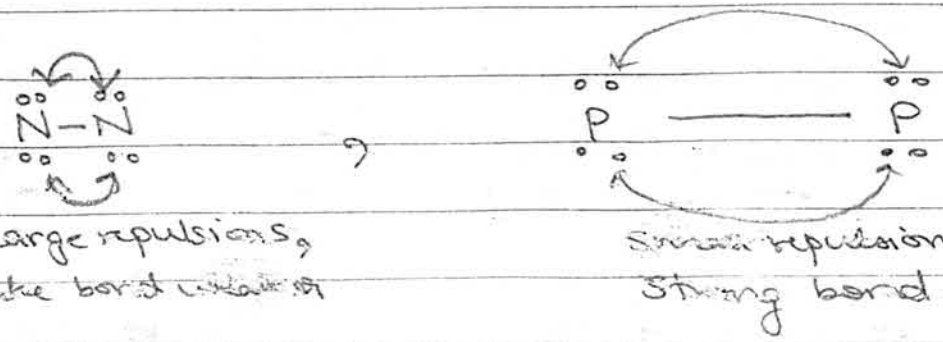
(ii) $(C_6H_5CH_2)_2Cd + 2\,CH_3COCl \longrightarrow CdCl_2 + 2\,CH_3\overset{O}{\overset{\|}{C}}-CH_2C_6H_5$

(iii) $CH_3-\underset{}{\overset{CH_3}{\underset{|}{CH}}}-COOH \xrightarrow[(ii)\ H_2O]{(i)\ Br_2/red\ P_4} CH_3-\overset{CH_3}{\underset{Br}{\overset{|}{\underset{|}{C}}}}-\overset{O}{\overset{\|}{C}}-OH$

Section-D

25. (a) (i) Sulphur in vapour state exists as S_2 molecules. In S_2 like O_2, unpaired electrons are present in $\pi^*_{3p_x}$ and $\pi^*_{3p_y}$ orbital respectively. These unpaired electrons impart S_2 gas paramagnetic behaviour.

(ii) N-N bond length is shorter than P-P bond length. (Because of smaller size of nitrogen as compared to phosphorus)
Due to this reason, the interelectronic repulsion between the non-bonding electrons in N-N is significantly higher as compared to that in P-P single bond. This makes the N-N bond weaker than P-P single bond.



(iii) Ozone is thermodynamically less stable than oxygen because for the reaction,

$$2O_3(g) \longrightarrow 3O_2(g)$$

change in enthalpy of reaction $\Delta_r H$ is highly negative as ozone has a high tendency to go to oxygen state (more stable).

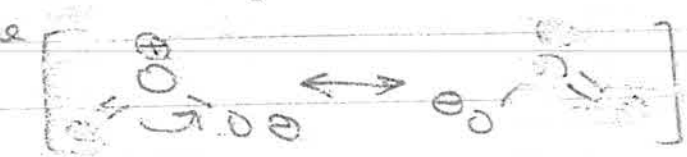
Also, $\Delta_r S$ for the reaction is positive, as from two moles of ozone (gas), we are getting three moles of oxygen (gas).

Therefore, in total,

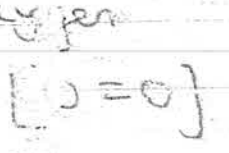
$\Delta_r G = \Delta H - T\Delta_r S$ is highly negative as $\Delta_r H < 0$ and $\Delta S > 0$, making the reaction highly favourable at all temperatures. Hence, O_3 is thermodynamically less stable than O_2.

Also, comparing structures.

Ozone



Oxygen



The bond order in ozone is nearly 1.5 due to two resonating structures, whereas it is 2 in oxygen. Since, more is the bond order, more stable is the compound, we can conclude again that O_2 is thermodynamically more stable than O_3.

(b) (i) Nitric oxide (NO)

$$3Cu + 8HNO_3(dil.) \longrightarrow 3Cu(NO_3)_2 + \underline{2NO}\uparrow + 4H_2O$$

(ii) Nitrogen dioxide (NO_2)

$$Cu + 4HNO_3(conc.) \longrightarrow Cu(NO_3)_2 + \underline{2NO_2}\uparrow + 2H_2O$$

26. Cell Reaction : $Mg(s) + Cu^{2+}(aq, 0.01\,M) \longrightarrow Mg^{2+}(aq, 0.001M) + Cu(s)$

Anode Reaction:

$$Mg(s) \longrightarrow Mg^{2+}(aq, 0.001M) + 2e^-$$

Cathode Reaction:

$$Cu^{2+}(aq, 0.01M) + 2e^- \longrightarrow Cu(s)$$

Total Electrons exchanged during redox reaction = $n = 2$ mol

Reaction quotient of the reaction, $Q = \frac{[Mg^{2+}]}{[Cu^{2+}]} = \frac{0.001\,M}{0.01\,M}$

$= \frac{1}{10} = 0.1$

Using Cell Representation:

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

Standard potential, $E^\circ_{cell} = 2.71\,V$ (given)

Using Nernst's equation,

$$E_{cell} = E^\circ_{cell} - \frac{0.059}{n} \log Q \quad (\text{at } T = 298K)$$

Substituting the values,

$$E_{cell} = 2.71 - \frac{0.059}{2} \log(10^{-1})$$

(i)

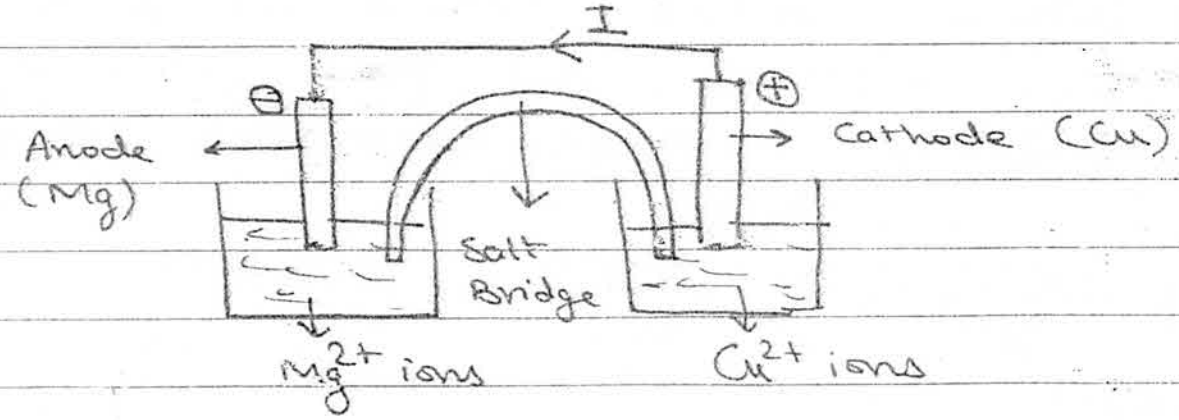
$$E_{cell} = 2.71 + \frac{0.059}{2}$$

$$E_{cell} = 2.71 + 0.0295$$

$$E_{cell} = 2.7395\ V$$

Hence, the E_{cell} for the reaction is 2.7395 V

Cell Construction:



When no external voltage is applied
(current flows from Cu cathode to Mg anode)

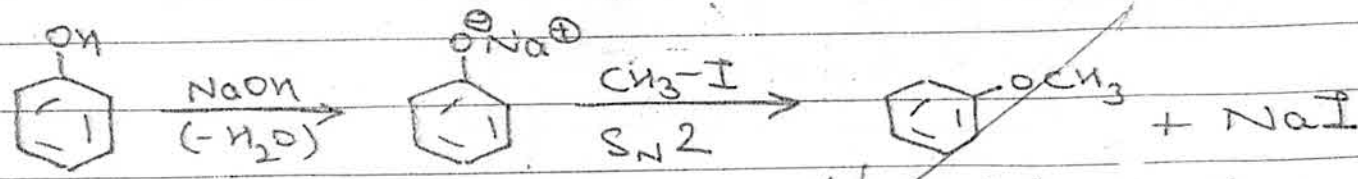
(i) In standard conditions as well as in the given conditions (E_{cell} 2.7395V), the current will flow from cathode (Cu) to anode (Mg) as long as external applied voltage is less than 2.71V

(ii) However, if external applied voltage exceeds 2.71 V, current will start flowing from Mg electrode to Cu electrode in standard conditions.
But in given conditions, the current will keep flowing from Cu electrode to Mg electrode as long as

$$2.71\,V < V_{external} < 2.7395\,V.$$

But, when external applied voltage exceeds even 2.7395 V, current will flow from Mg electrode to Cu electrode in given conditions as well.

2.7 (a) (i)



(phenol) (anisole)

Williamson's ether synthesis

We can convert phenol into anisole, by first converting it into phenoxide form by treating it with NaOH, and then carrying out Williamson's ether synthesis (S_N2 attack on CH_3-I in presence aprotic solvent like DMSO ($(CH_3)_2\overset{O}{\underset{}{S}}$))

0901

Fictitious Roll No.
(To be entered by Board)

अपना अनुक्रमाँक इस उत्तर-पुस्तिका पर न लिखें
Please do not write your Roll Number on this Answer-Book

अतिरिक्त उत्तर-पुस्तिका(ओं) की संख्या.....
Supplementary Answer-Book(S) No. 1

(i) CH_3-CH_2-OH (Ethanol) $\xrightarrow[[O]]{PCC}$ $CH_3-\overset{O}{\overset{\|}{C}}-H$ $\xrightarrow{CH_3MgBr}$ $CH_3-\underset{CH_3}{\overset{OMgBr}{\overset{|}{\underset{|}{C}}}}-H$ $\xrightarrow{H^+, H_2O}$ $CH_3-\underset{CH_3}{\overset{OH}{\overset{|}{\underset{|}{CH}}}}$ (Propan-2-ol) + $Mg(OH)Br$

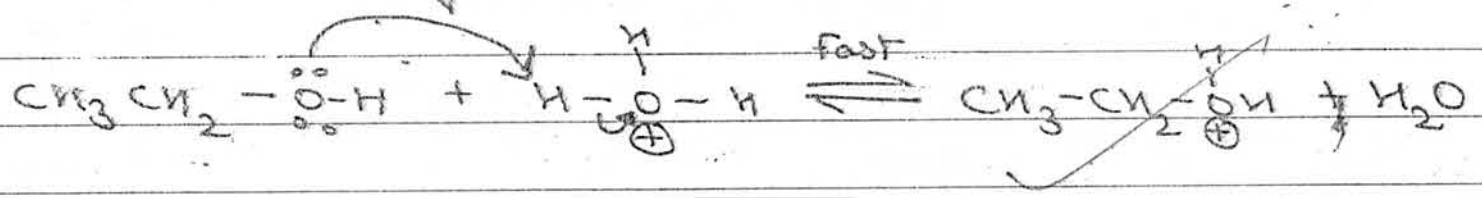
We can convert ethanol into isopropyl alcohol by first oxidising it into ethanal by reacting it with PCC (pyridinium chloro chromate). Then treating it with CH_3MgBr (grignard reagent) followed by hydrolysis.

(b) Mechanism of dehydration of alcohol in concentrated acid H_2SO_4 at 443 K.

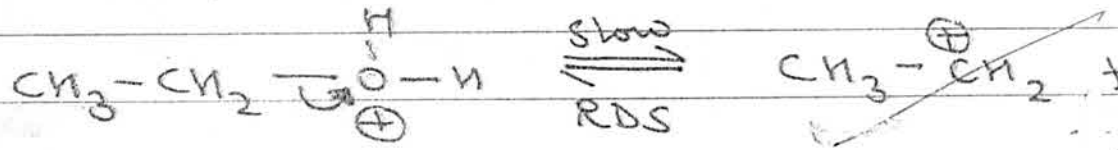
(I) Ionization of H_2SO_4

$H_2SO_4 + H_2O \longrightarrow H_3O^+ + HSO_4^-$

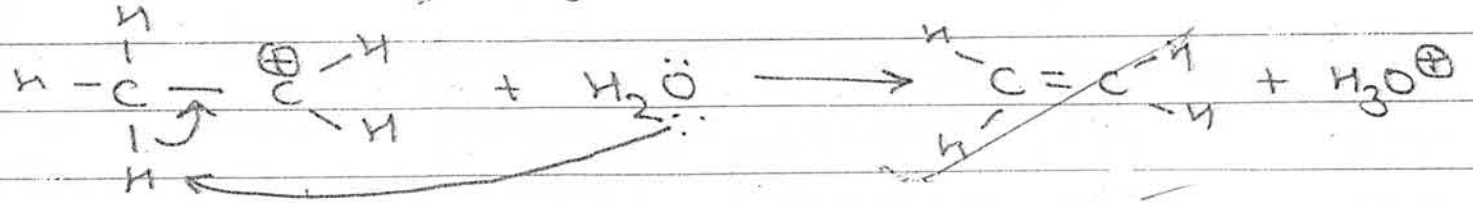
(II) Protonation of alcohol



(III) Loss of water molecule by cleavage of C-O bond



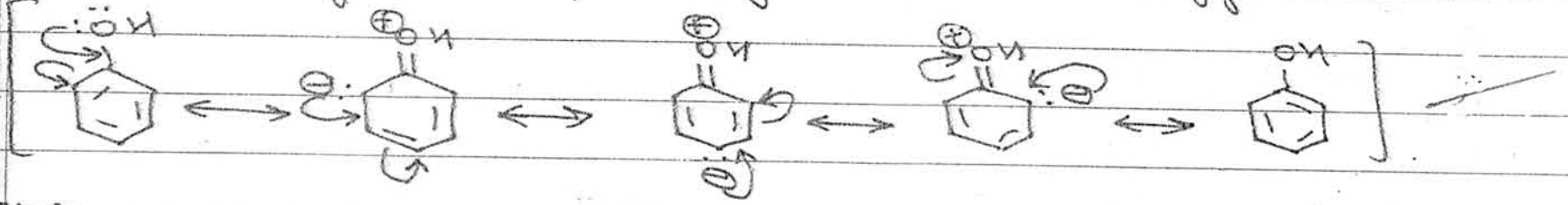
(IV) Elimination of β-hydrogen to form ethene.



So, in totality, a loss of water molecule from ethanol takes place and the reaction can be represented as :-



(c) Phenol consists of -OH group attached to benzene ring which increases the electron density of the benzene ring due to strong +R-effect of -OH group, by virtue of presence of lone pair of electron on Oxygen atom.



It is clear from the resonating structures, that the electron density is greatly increased at o, p-positions, and the ring is activated towards attack by an electrophile. Also, +R-effect of -OH group is more pronounced than its -I-effect, thus activating the ring.

In Benzene, no such activation of ring takes place, hence it is less reactive towards electrophilic substitution as compared to phenol.

