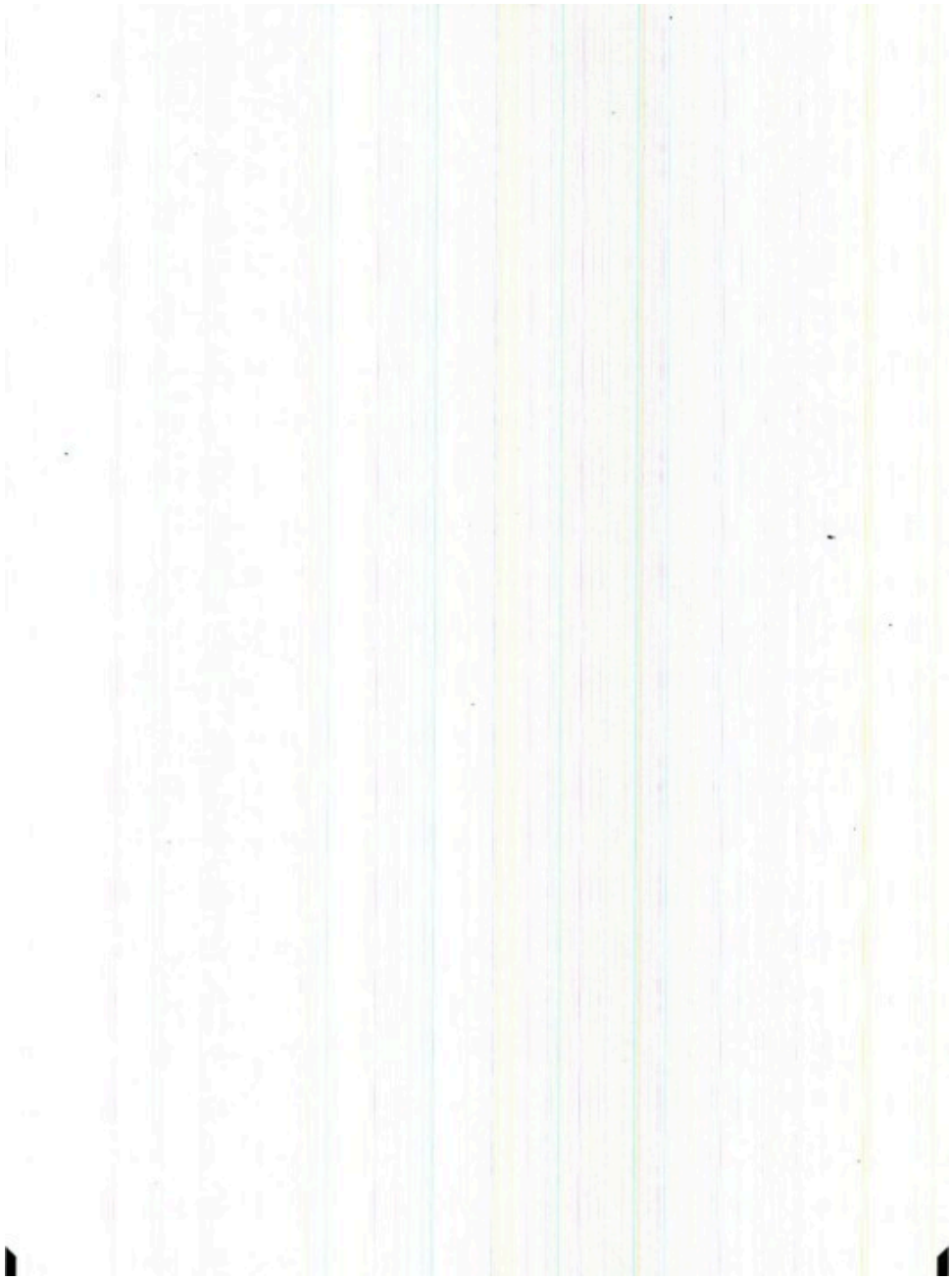
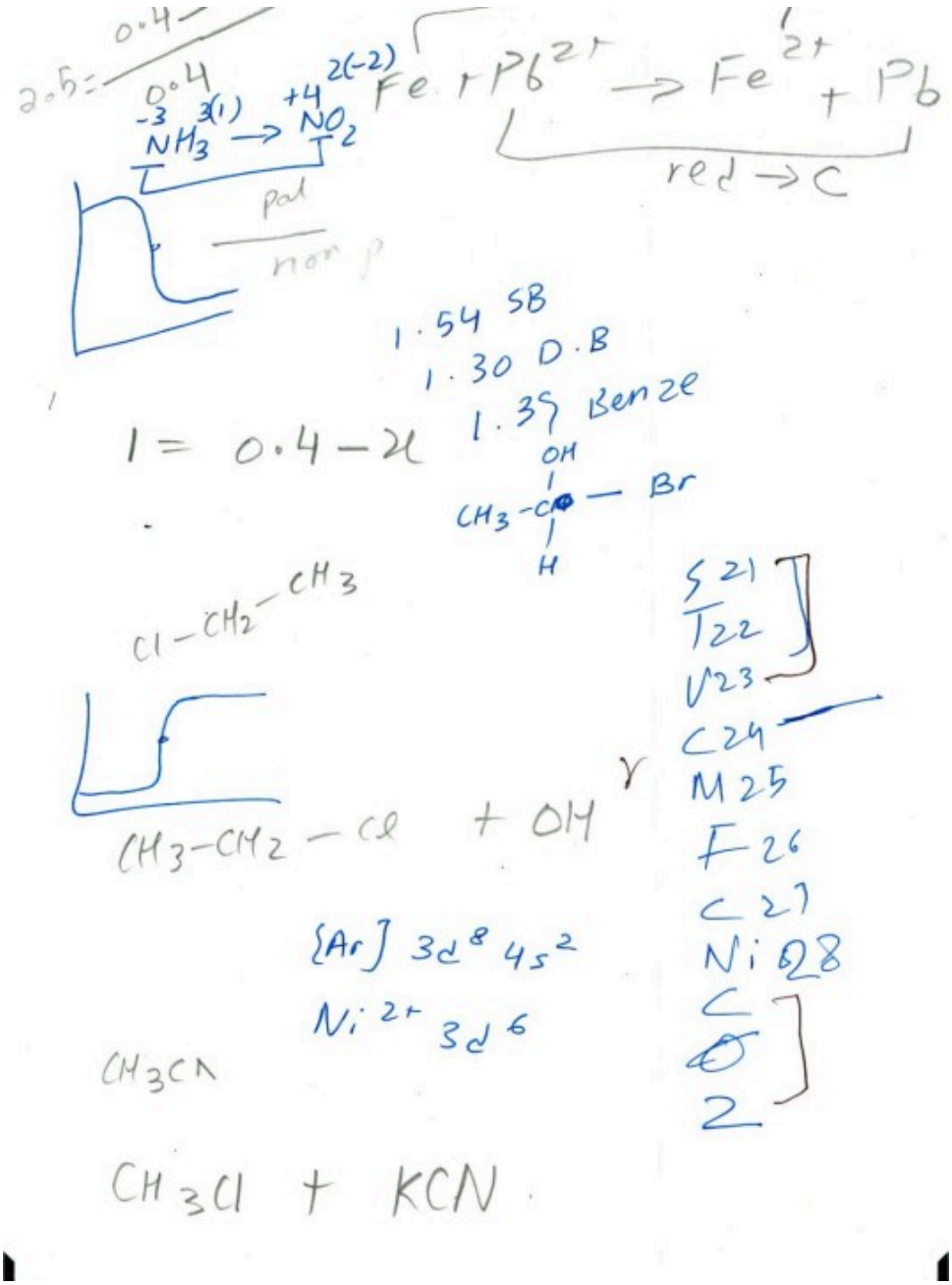



0.4
2.5 = 0.4
-3 3(1) +4 2(-2)
NH3 → NO2
Fe + Pb2+ → Fe2+ + Pb
red → C
pal
non p
1.54 SB
1.30 D.B
1.39 Benze
l = 0.4 − 2l
OH
CH3 − C − Br
H
Cl − CH2 − CH3
CH3 − CH2 − Cl + OH
S 21
T 22
V 23
C 24
M 25
F 26
C 27
Ni 28
C
O
2
[Ar] 3d8 4s2
Ni2+ 3d6
CH3CN
CH3Cl + KCN

(Section B)

Q. No. 2 Part (I) Feasability of Reaction.

→ reaction.

$Fe + Pb^{2+} \rightarrow Fe^{2+} + Pb$

⇒ Since Fe goes from oxidation no. 0 → 2, it is oxidized & act as anode.

⇒ Since Pb goes from oxidation no. 2 → 0, it is reduced & acts as cathode

Hence $E^\circ_{cathode} = -0.13V$ / $E^\circ_{Anode} = -0.44\ V$

⇒ From cell potential equation.

$$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{Anode}$$
$$= -0.13 - (-0.44)$$
$$= -0.13 + 0.44$$
$$= +0.31\ V$$

⇒ A positive value of cell potential suggests reaction is feasible.

.....

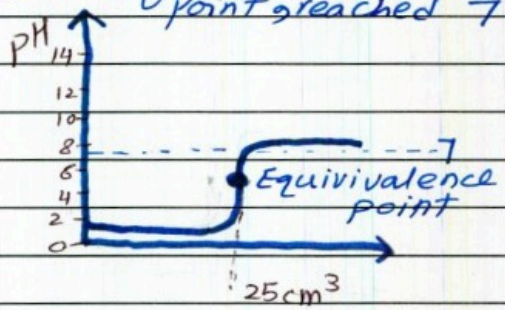
Q. No. 2 Part (II) Titration curve

Titrant = NH_3, added from burette.

Analyte = HCl, present in conical flask.

Initial pH = 1–2, Equivivalence point = 5.5, Final pH = 7

⇒ For H^+ ions in flask pH was low, with the addition of Base it increase & at equivivalence point, reached 7.



⇒ Equivivalence point is when equal moles of alkali & acid are reacting.

(Section B)

Q. No. 2 Part (iii)

pH calculation.

From equation

$$pH = pKa + \log \frac{salt}{acid}$$

$\therefore Ka = 1.8 \times 10^{-5}$.

$$pH = -\log(Ka) + \log \frac{[CH_3COONa]}{[CH_3COOH]}$$

$\therefore [CH_3COOH] = 1$

$\therefore [CH_3COONa] = 1$

$$= -\log(1.8 \times 10^{-5}) + \log \frac{1}{1}$$

$$= 4.74$$

Conclusion.

4.74 is the pH for the Buffer solution of sodium acetate and acetic acid.

.....

Q. No. 2 Part (iv)

Shape/Molecular Symmetry :-

Linear

$[H_3\ddot{N} - Ag - \ddot{N}H_3]^+$

Diammine silver (I) ion.

Bond Angle :-

The bond angle is 180°

Coordination No. :- 2

This is a transition metal complex framed with silver metal cation and 2 Ammine i.e ligand.

(Section B)

Q. No. 2 Part (v)

Colourless Transition Metal Complexes

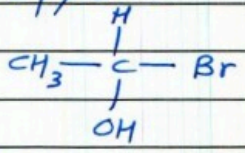
For the complex to appear coloured, it is a condition for it to have an incomplete d subshell. For an incomplete d-subshell like that of $Ni^{2+} \rightarrow [Ar]3d^8 4s^0$, The d-d splitting occurs & hence the excitation with the absorbence of light and showing of colour complementary to the light absorbed. However for a complete d-subshell like that of $Zn^{2+} \rightarrow [Ar]3d^{10} 4s^0$, no such phenomenon of d-d splitting occurs hence no absorption of light & the complex appears colourless.

Q. No. 2 Part (vi)

Optical Activity

optical activity is ensured by the presence of chiral carbon.

⇒For the following compound, the structure appears as.



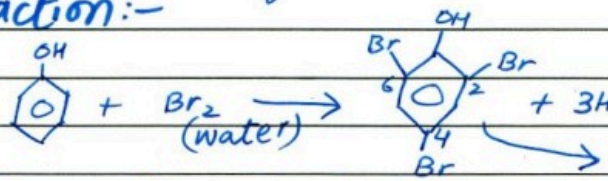
since carbon is bonded to 4 different groups, it is chiral and is optically active.

(Section B)

Q. No. 2 Part (vii) **Phenol reaction with Br_2 water.**

The reaction occurs at room temperature making benzene react with Bromine and forming 2,4,6 tribromo phenol.

reaction:-



The reaction decolorises the reddish brown colour of bromine water.

room temperature:- The reaction occurs at room temperature since presence of -OH group activates the benzene ring by resonance donating electron effect. ~~while benzene is less reactive.~~

.....

Q. No. 2 Part (viii) **Acidic strengths of carboxylic acid.**

⇒ Acidic strength is as followed.

$CH_2ClCOOH > CH_3COOH$

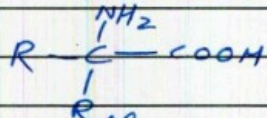
chloro acetic acid. Acetic Acid.

The acidic strength is dependant upon the stability of conjugate base. The conjugate base for chloro acetic acid is much more stable since -Cl group is electron withdrawing. It withdraws the electron density towards it self stabilizing the conjugate base. ~~[illegible]~~ Tri & di chloro acetic acid would be even more acidic.

(Section B)

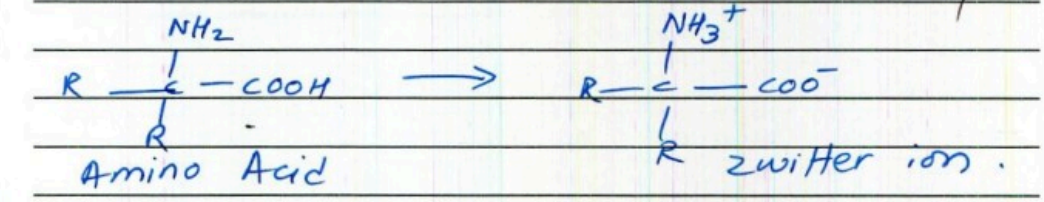
Q. No. 2 Part (ix) **Zwitter ion.**

The amino acid general structure is as fodlowed:



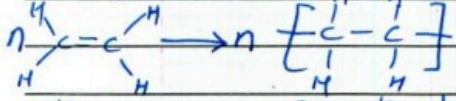
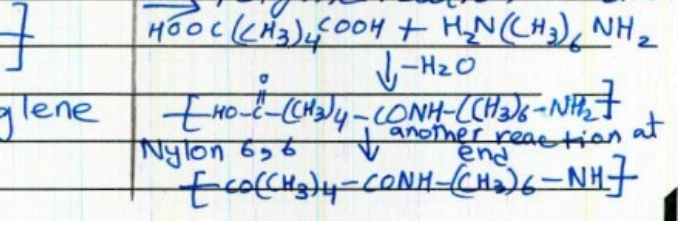
It has a $-COOH$ as well as $-NH_2$ group.

$\Rightarrow$ The proton shifts in the amino acid making it develop an acidic as well as basic site. The amino acid exists in this structure even is solid form.



Amino Acid — zwitter ion.

Q. No. 2 Part (x)

Addition Polymers	Condensation Polymers.
$\Rightarrow$ Polymers formed by the breaking of double bond while nothing is lost.	$\Rightarrow$ Polymers formed by the removal of simple molecules like HCl, H_2O.
$\Rightarrow$ e.g PVC i.e Polyvinylchloride Polyethylene	$\Rightarrow$ e.g Kevlar. Nylon 6,6.
$\Rightarrow$ Usually non-biodegradeable due to being non polar & saturated	$\Rightarrow$ Usually biodegradeable due to presence of hydrolysable amino or ester group.
$\Rightarrow$ Polymerization reaction  ethene — Polyethylene	$\Rightarrow$ Polymerization reaction  Nylon 6,6

(Section B)

Q. No. 2 Part (xi) **Molecular ion peak:-** It is the peak on mass spectrum ~~obtained by~~ due to the molecular ion, formed when the molecule is bombarded with electrons (70mV). **Importance & Symbol.**

⇒ It represents the intact molecule with the loss of $2e^-$

⇒ Used to derive structural formula of compound.

⇒ It is used to find the molecular mass of compound, its m/z value equals molecular mass of compound.

⇒ H_2^+ symbol is M^+.

.....

Q. No. 2 Part (xii)

Calculating no. of C atoms.

From formula:

$$\text{no. of C atoms} = \frac{\text{intensity at } M+1 \times 100}{\text{intensity at } M^+ \times 1.1}$$

$$= \frac{5.5 \times 100}{100 \times 1.1}$$

$$= \boxed{5}.$$

There are 5 no. of C atoms in the compound.

(Section B)

Q. No. 2 Part (xiii)

Deuterated Solvents.

Deuterated solvents are the ones that have H_2 replaced with H_1

⇒ e.g D_2O , $(CD_3)CO$

Importance in NMR

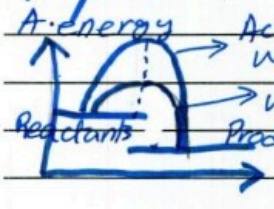
Used in NMR to avoid unnecessary hydrogen peaks from the compound and effectively analyse the remaining structure. Also, used to avoid H peaks by functional groups, in such cases F.G's have an exchangeable H_1 hence is replaced by H_2 when Deuterated solvents are used.

.....

Q. No. 2 Part (xiv) **Catalyst**:- catalysts are chemical compounds that speed up the chemical reactions and are obtained in their original form after the reaction.

Working:- They provide an alternative reaction pathway by lowering the activation energy i.e the energy needed to start a reaction.

Graph:-



Example Transition metals as catalysts.

$2Fe^{2+} + S_2O_8 \rightarrow 2Fe^{3+} + 2SO_4^{2-}$

$2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$

⇒ Transition metals do the job by change in O.state.

(Section C)

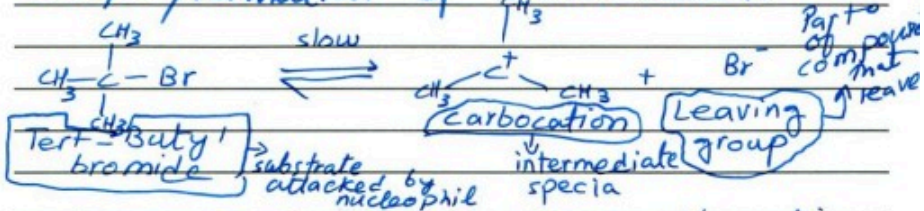
Q. No. 3 (Page 1)

SN_1 reaction.

- Unimolecular nucleophilic substitution reaction.
- occurs in 2 steps.
- Given by tertiary alkyl halides since the attacking nucleophile cannot directly attach to the substrate & the formation carbocation is necessary. This is because of the steric hinderance offered by bulky alkyl groups.
- Polar protic solvents are preferred for this reaction because they stabilize the carbocation i.e an unstable specie and anything stabilizing it increases the rate of reaction.

Mechanism

- Step 1 / Formation of carbocation.



substrate ionizes to give carbocation while leaving group leaves
This is the slow step & hence is the rate determining step.

(Section C)

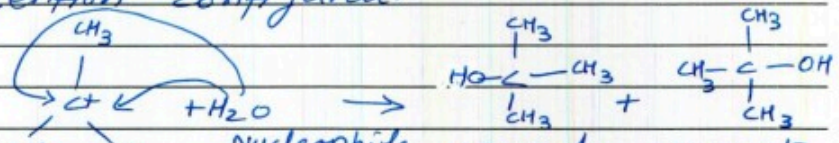
Q. No. 3 (Page 2)

Rate = $K[R-X]$

It is a first order reaction dependant upon substrate concenteration.

- **Step 2 / Attack of Nucleophile.**

Nucleophile attacks the carbocation forming 50% of inversion & 50% of retention configuration.



Carbocation.

[50% of inversion] Nucleophile attaches to the position opposite to where the L.G was present.

[50% of retention] Nu attaches to position where LG was present.

Inductive effect of Alkyl groups.

The more the alkyl groups the stable will be the carbocation. This is in accordance with the electron donating resonance effect of alkyl groups.

$3^\circ > 2^\circ > 1^\circ$

Conclusion:- The carbocation of tertiary alkyl halides are more stable ie in accordance with these compounds favouring SN_1 than SN_2. Similarly Primary ones favour SN_2 over SN_1.

(Section C)

Q. No. 3 (Page 3)

(Section C)

Q. No. 4 (Page 1)

Atomic Radi.

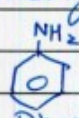
The atomic radi of transition elements doesn't show a constant tread. Instead is variable showing a decrease values then constant values and finally increase in values.

As it is concerned of the trend **from Ti to Cu**. The atomic radi.

- Decreases for Titanium & Vanadium
- Constant for Cu

Basicity strength order.

The following basic strength order

$CH_3-CH_2-NH_2 > NH_3 >$ 

Ethylamine. Ammonia Phenyl amine

Explaination

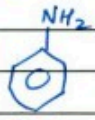
(i). $CH_3-CH_2-NH_2$ The alkyl group attached to amine is electron donating and through positive inductive effect, it increases electron density on the amine group allowing to readily accept protons.

(Section C)

Q. No. 4 (Page 2)

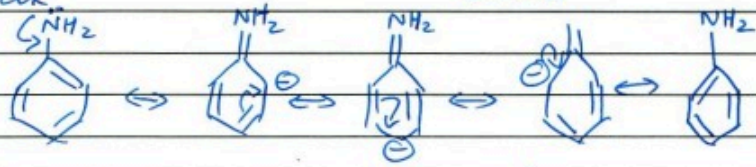


(ii) NH_3 Presence of lone pair on ammonia allows it to accept protons. However since it has no R (alkyl group) attached & hence has less electron density it is less basic than phenyl amine



(iii) The lone pair on amine group is delocalised over the benzene ring with a partial double bond developed between $C-NH_2$ making it the least reactive since it's harder to break.

$C-NH_2$



(b). Explaining on basis of K_b values.

Compound	K_b values
Ethyl Amine	5.6×10^{-5}
Ammonia	1.8×10^{-10}
Phenyl Amine	4.0×10^{-10}

Higher the value of Ka more basic it is.
Hence from values we say ethyl amine is most basic while phenyl

(Section C)

Q. No. 4 (Page 3)

amine is least basic.

(Section C)

Q. No. 5 (Page 1)

Thermal Stability.

Thermal stability is defined as the ability of a compound to resist decomposition when heated.

Thermal Decomposition

⟹ For carbonates

$$MCO_3 \longrightarrow \underset{\text{metal oxide}}{MO} + CO_2$$

⟹ For Nitrates

$$2M(NO_3)_2 \longrightarrow 4NO_2 + 2MO + O_2$$

Trend.

The trend for thermal stability is such that.

- Thermal stability increases down the group.

Reason.

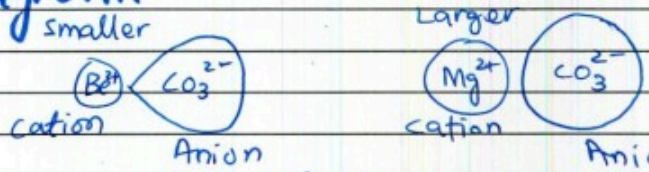
- It can be explained on basis of ion polarization.
- Ion polarization is ability of the cation to distort the anion electron cloud
- Ion polarization ability decreases down the group since it is dependant upon size & charge which are increasing down the group. This is in accordance with Fajan's rule.
- Since the ion polarization decreases,

(Section C)

Q. No. 5 (Page 2)

cation is able to make stronger bonds with the anions and carbonate anions which are harder to break. Hence, require increased temperatures.

Diagram.



Thermal Stability Trend.

$BeCO_3 < MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$

$Be(NO_3)_2 < Mg(NO_3)_2 < Ca(NO_3)_2 < Sr(NO_3)_2 < Ba(NO_3)_2$

Atomic Size trend.

Upon the basis of which Thermal stability trend is explained.

$Be^{2+} < Mg^{2+} < Ca^{2+} < Sr^{2+} < Ba^{2+}$

(Section C)

Q. No. 5 (Page 3)

(Section C)

Q. No. 6 (Page 1)

Hydrolysis

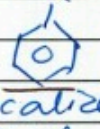
The given order of ease of hydrolysis.

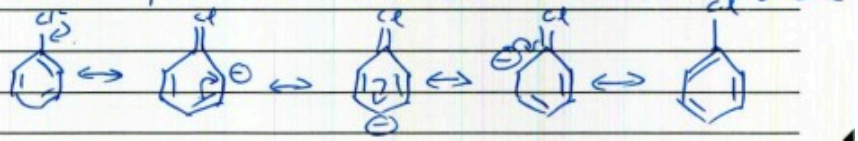
Acyl chloride > Alkyl chloride > Aryl chloride.

Explaination.

(i). $CH_3-\overset{O}{\overset{\|}{C}}-Cl$ These react with water most readily since presence of 2 electronegative atoms ~~with draw the electron density towards them~~ giving the carbon a positive charge allowing for stronger nucleophile attack by water.

(ii). CH_3-CH_2-Cl Presence of only one electronegative atom develops a less positive charge on the C atom making it less reactive to water, nucleophile.

(iii).  It is the least reactive of all since the chlorine lone pair is delocalized over the ring developing a C–Cl partial double bond (harder to break



(Section C)

Q. No. 6 (Page 2)

(Section C)

Q. No. 6 (Page 3)