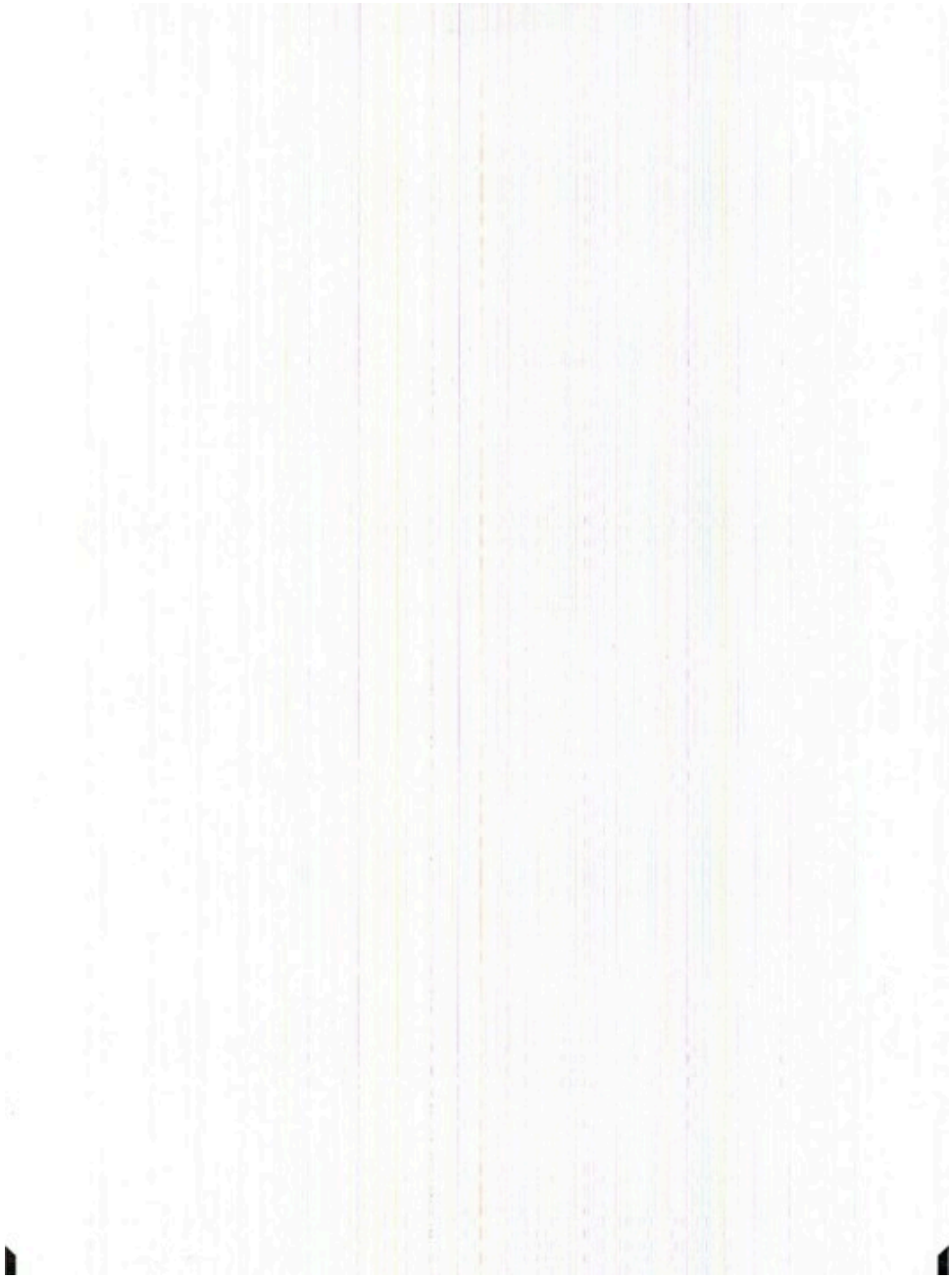
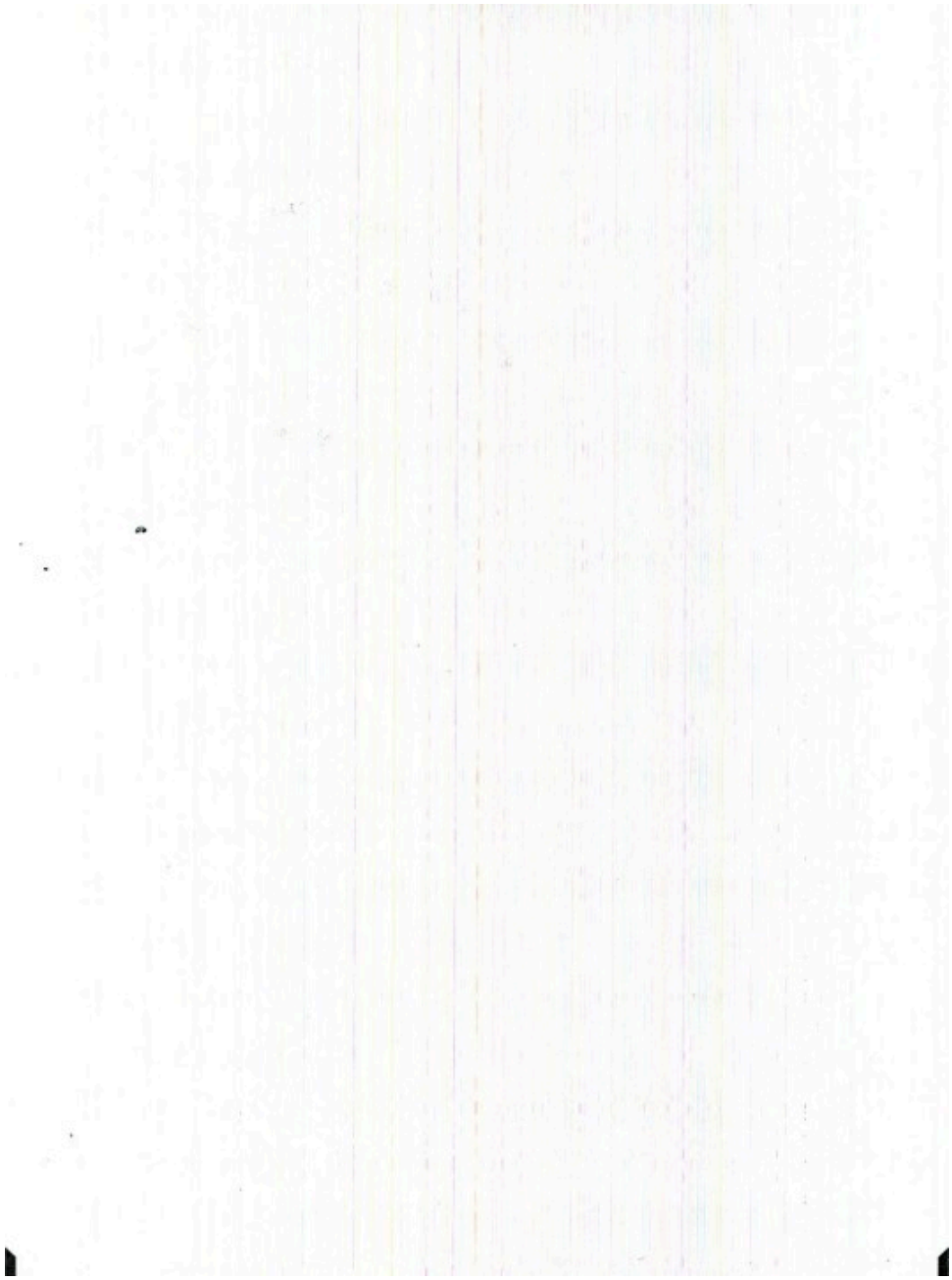




(Section B)

Q. No. 2 Part (i) Feasibility:-

- $Fe + Pb^{+2} \longrightarrow Fe^{+2} + Pb$

$E^\circ(Fe) = -0.44V$, $E^\circ(Pb) = -0.13V$.

- In the following reaction, Fe is undergoing oxidation and Pb is undergoing reduction, so Fe acts as the anode while Pb acts as the cathode.

To determine feasibility, we need to calculate E°_{cell}:-

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

$\Rightarrow E^\circ_{cell} = -0.13 - (-0.44)$

$E^\circ_{cell} = +0.31V$

- Since E°_{cell} is positive, this reaction will occur.

Q. No. 2 Part (ii) Oxidation or Reduction:-

- $NH_3 \longrightarrow NO_2$

↳ Determine the oxidation states:-

$\overset{-3}{N}\overset{(+1)3}{H_3} \longrightarrow \overset{+4}{N}\overset{(-2)2}{O_2}$

↳ Since their is an increase in the oxidation state of Nitrogen, oxidation has occured:-

oxidation

$\overset{-3}{N}\overset{+3}{H_3} \longrightarrow \overset{+4}{N}\overset{(-2)2}{O}$

(Section B)

Q. No. 2 Part (iii) — **PH calculation:-**

- Given:

$K_a = 1.8 \times 10^{-5}$

$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

- Calculation:

$\therefore K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$

$= K_a = \frac{[1][H^+]}{[1]}$

$= 1.8 \times 10^{-5} = \frac{[1][H^+]}{[1]}$

$= 1.8 \times 10^{-5} = H^+$

$\therefore pH = -\log[H^+] = -\log[1.8 \times 10^{-5}] =$ **4.744** Ans

---

Q. No. 2 Part (iv) — **Geometry:-**

- $[Ag(NH_3)_2]^+$

diaminesilver(I) ion

$[NH_3 — Ag — NH_3]^+$

- Shape: Linear
- Bond angle: 180°
- Coordination number: 2

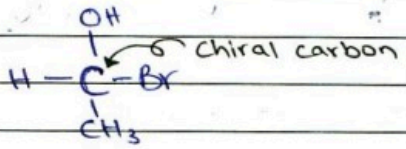
(Section B)

Q. No. 2 Part (v) Colorless compounds:-

- Compounds that have a configuration of d^{10} are usually colorless because compounds can ~~sty~~ only be colored if thier electrons can absorb light with a specific frequency and get excited to a higher energy level. But since d^{10} elements have a fully filled orbital, their electrons can not get excited to a higher energy level &, thus can't show color.

Q. No. 2 Part (vi) Optically active:-

- $CH_3-CH(OH)-Br$

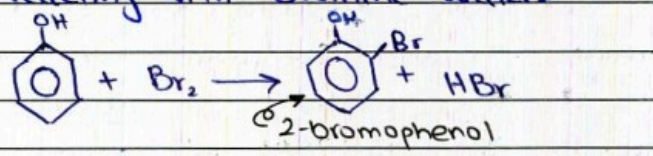


- Since this compound has a chiral carbon, it is a chiral compound. Thus it can rotate the plane of polarized light either clockwise or anticlockwise. This compound is therefore optically active.

(Section B)

Q. No. 2 Part (vii) **Phenol:-**

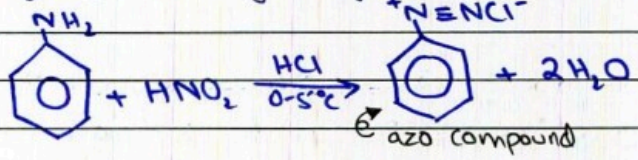
- Phenol reacting with bromine water:-



- This reaction can occur at room temprature unlike benzene molcule due to the presence of the ring activating -OH group. It increase the electron density of the benzene molcule & makes it more reactive.

Q. No. 2 Part (viii) **Benzene diazonium Chloride:-**

- Add ice-cooled solution of phenyl amine to ice-cooled solution of hydrogen nitrate (HNO_2) in the presence of HCl at temperatures below 5°C to get a solution containing yellow ~~orng~~ orange ppt ⇒ diazonium chloride.

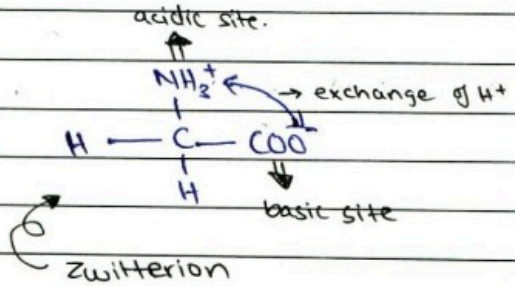


- Benzene diazonium chloride is an azo dye. It rapidly decomposes into phenol at temperatures below 10°C.

(Section B)

Q. No. 2 Part (ix) Zwitter ion:-

- Zwitterionic form of amino acid:-



Q. No. 2 Part (x) Enzyme activity:-

- Factors that effect enzymatic activity are:-
  - Substrate concentration.
  - Temprature = enzymes work best at their optimal temprature
  - pH = enzymes have their own optimal pH range.

(Section B)

Q. No. 2 Part (xi) Molecular ion peak:-

- Molecular ion peak:-

The peak that has the largest m/z ratio apart from any peaks formed by the presence of heavier isotopes is called as the molecular ion peak.

- Symbol: M^+

- Importance: It shows the molecular mass of a compound as it has the largest mass-to-charge ratio.

Q. No. 2 Part (xii) Number of C-atoms:-

- Given:-

M^+ peak = 100%

M+1 peak = 5.5%

- Solution:-

$$\therefore \text{C-atoms} = \frac{100 \times \text{abundance of M+1}}{1.1 \times \text{abundance of } M^+}$$

$$= \text{C-atoms} = \frac{100 \times 5.5}{1.1 \times 100}$$

$$= \text{C-atoms} = \frac{550}{110}$$

$$= \text{C-atoms} = \boxed{5} \text{ Ans}$$

(Section B)

Q. No. 2 Part (xiii) **Deuterated Solvents:-**

- Deuterated solvents are used in NMR spectroscopy because of the following reasons:-

↳ It does not interfere with the NMR signals.

↳ It does not make the solvent peaks overlap with the solute peaks.

↳ It provides no magnetic hinderence due to being NMR-inactive.

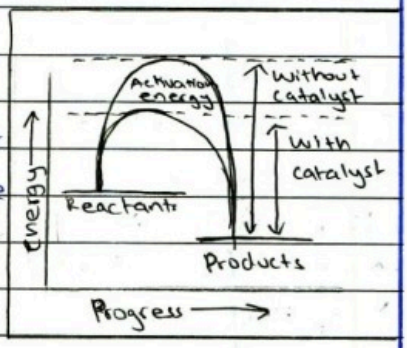
Q. No. 2 Part (xiv) **Catalyst:-**

- **Catalyst:**

A catalyst is a molecule that speeds up a chemical reaction by lowering the activation energy by providing an alternate pathway with low activation energy.

- **Action (Working):-**

A catalyst temporarily bonds with the reactants, bringing them closer & making them react faster, thereby lowering the activation energy needed to start a chemical reaction.



(Section C)

Q. No. 3 (Page 1) "SN-1 mechanism"

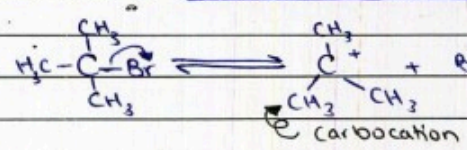
- Ter-butyl bromide undergoes S_N1 mechanism of nucleophillic substitution.

- **S_N1 mechanism:-**

S_N1 mechanism is a unimolecular nucleophilic substitution mechanism that involves 2-steps.

↳ **1st step:-**

In the first step, the ter-butyl bromide reversibly ionizes into a carbocation and bromide ion.



- The alkyl groups attached to the carbocation intermediate are electron donating groups. Because of this, they will stabalize the carbocation intermediate by their electron-donating inductive effect

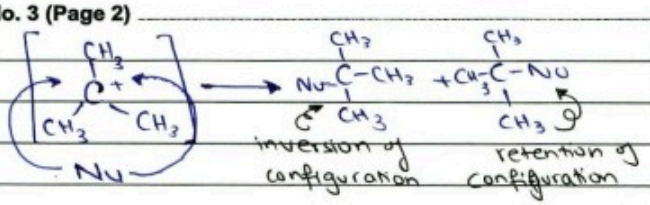
- This step is a slow & rate-determining step.

- **2nd step:-**

In the next step, the Nucleophile (Nu) will attack the electrophilic carbon atom of the carbocation either from the left or right forming retention of the configuration or inversion of configuration respectively.

(Section C)

Q. No. 3 (Page 2)



- Since two products can possibly form, this produces a racemic mixture.

- Studies have shown that the rate of the reaction solely depends upon the concentration of the alkyl halide & is not dependent upon the nucleophile. Therefore, the rate of reaction is a first order reaction.

$$\text{Rate} = K[R\text{-}X] \text{ (First order).}$$

(Section C)

Q. No. 3 (Page 3)

(Section C)

Q. No. 4 (Page 1)

Amines:-

- **Strength of a base:-**

Strength of a base can be differentiated ~~Extentated~~ by looking at their relative pk_b values.

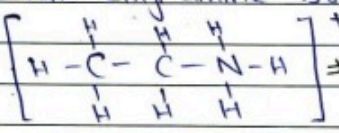
- The factors which affect the strength of a base are:
  - Ease with which they accept a proton
  - The relative stability of the specie formed after the acceptance of a proton.

- **Order of basicities:**

Phenyl amine < Ammonia < Ethyl amine.

- **Ethyl amine:-**

The structure of the ion formed after the acceptance of a base from ethyl amine is:-



→ ion

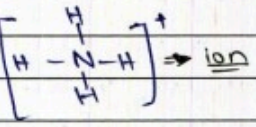
- Due to the presence of the electron-donating alkyl groups next to the nitrogen atom, they increase the electron cloud over the nitrogen atom, making it more attractive towards the hydrogen ion (H^+)

- These alkyl groups also decrease the positive charge by donating electrons, hence stabalizing the ion.

(Section C)

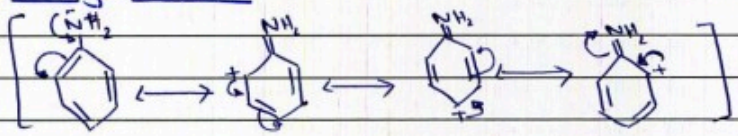
Q. No. 4 (Page 2)

- **Ammonia:-**



- The ammonium ion is less stable than ethyl ammine because it isn't attached to any electron donating groups & hence its positive charge is localized, giving it a little protonation ability, making it a weak base.

- **Phenyl ammine:-**



- The lone pair on the nitrogen atom is involved in resonance is is delocalized over the ring. Which makes it unavailable for bonding with hydrogen, making it a weaker base than ammonia & ethyl amine

- Based upon the above factors, ethyl ammine is the strongest base, then comes ammonia & the weakest base is phenyl amine.

Ethyl amine > Ammonia > phenyl amine

(Section C)

Q. No. 4 (Page 3)

(Section C)

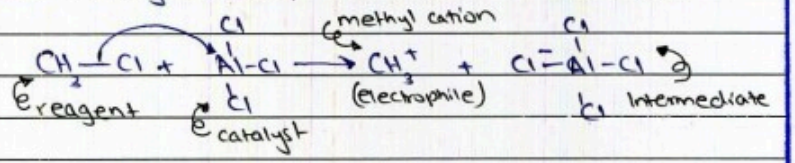
Q. No. 5 (Page 1) **Friedal-Crafts alkylation:-**

- **Mechanism:-**

This reaction involves the electrophilic substitution reaction where an electrophile will attack the benzene ring, temporarily breaking the resonance, followed by the removal of H^+ & reformation of stable ring.

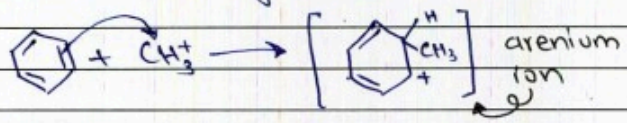
- **Generation of electrophile:-**

The heterolytic breaking of the alkyl halide (CH_3Cl) in the presence of the lewis acid catalyst $AlCl_3$ produces methyl cation, which is the electrophile:-

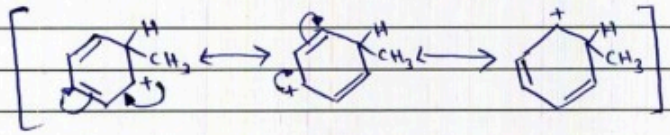


- **Attack of electrophile of benzene ring:-**

The generated electrophile gets attacked by the electrons of the benzene ring, breaking the stable ring structure & forming arenium ion:



Resonance:-

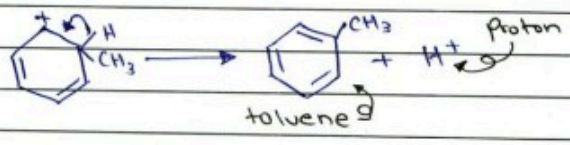


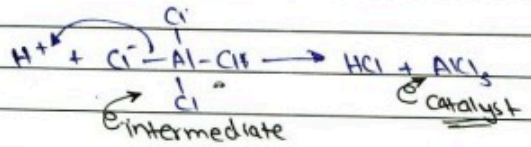
(Section C)

Q. No. 5 (Page 2)

- **Regeneration of catalyst:-**

In the final step, the arenium ion loses a proton, reforming its resonance-stabilized ring. The H^+ ion then reacts with the reaction intermediate to reform the catalyst.





(Section C)

Q. No. 5 (Page 3)

(Section C)

Q. No. 6 (Page 1)

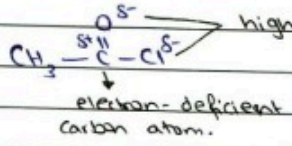
Hydrolysis:-

- **Hydrolysis of acyl, alkyl & aryl chlorides:-**

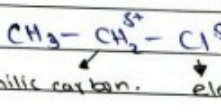
The hydrolysis of the following compounds can be explained on the basis of the relative strength of the C-Cl bond.

acyl chloride > alkyl chloride > aryl chloride.

- Acyl chlorides are the easiest to hydrolyse because the central carbon atom is attached to two electronegative atoms (Cl & O) & thus it is very electron-defient. Any ~~nu~~ ~~elec~~ nucleophile can come and replace the electronegative elements.



- On the other hand, alkyl chlorides are only attached to one chlorine atom as compared to the carbonyl carbon. This makes hydrolysis kind of difficult, making the presence of stronger nucleophiles than water necessary.

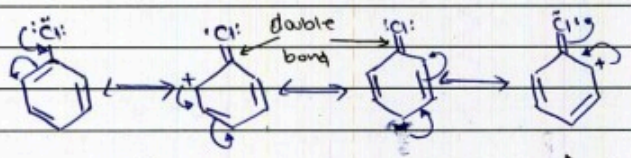


Continuation →→→→→→

(Section C)

Q. No. 6 (Page 2)

- Aryl chlorides has the chlorine atom attached to the benzene ring. The chlorine atom has its lone pair of electrons delocalized over the ring, participating in resonance. This makes the C-Cl bond have a partial double-bond characteristic, making hydrolysis impossible.



Resonance-stabalization

- Order of ease of hydrolysis is:-

acyl chlorides > alkyl chlorides > aryl chlorides

(Section C)

Q. No. 6 (Page 3)