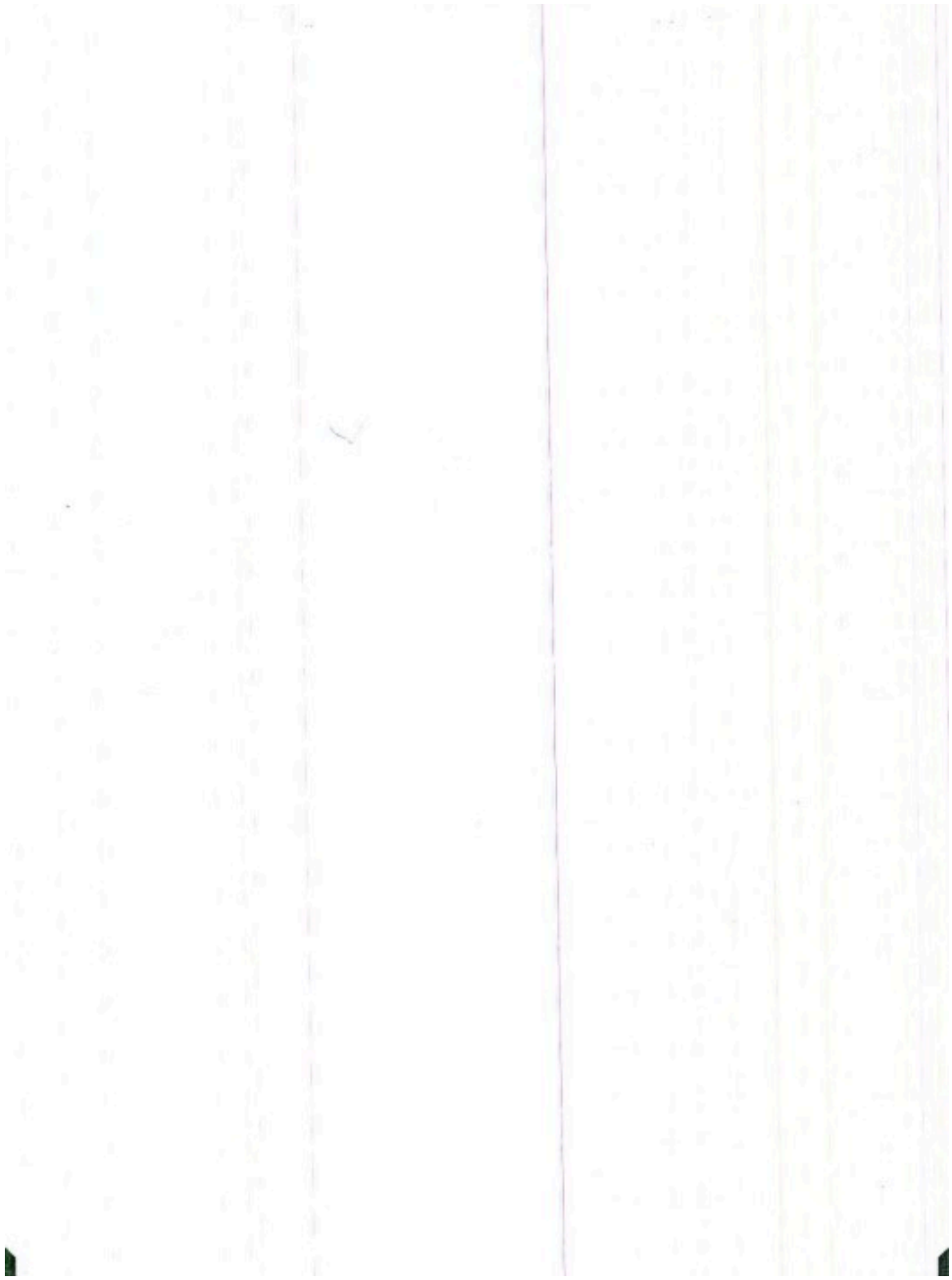






(Section B)

Q. No. 2 Part (i) Feasibility of Fe / Pb^{+2} reaction

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

Step 1 → Determination of oxidation and reduction

$$\overset{\text{oxidation}}{Fe} + \overset{\text{reduction}}{Pb^{+2}} \longrightarrow Fe^{+2} + Pb$$

From the data above, Fe undergoes oxidation while Pb^{+2} undergoes reduction.

Step2 → Determination of feasibility

By the cell potential formula

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

The more negative value indicates that the element undergoes oxidation

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

$$E^\circ_{cell} = +0.31V \longrightarrow \text{Reaction is feasible.}$$

Q. No. 2 Part (ii) Occurence of Oxidation & Reduction

Reaction → $NH_3 \longrightarrow NO_2$

Step 1 → Label the oxidation state

N has -3 in NH_3 while N in NO_2 has +4

$$\overset{-3}{NH_3} \longrightarrow \overset{+4}{NO_2}$$

Results → The reaction undergoes oxidation as the oxidation state of N increases by -3 to +4.

(Section B)

Q. No. 2 Part (iii) Given:

mol of CH_3COOH 'n_1' = 1

mol of CH_3COONa 'n_2' = 1

Acid constant 'K_a' of CH_3COOH = 1.8×10^{-5}

Required:- pH = ?

Solution:- As we know that;

$$pH = pK_a + \log\left(\frac{salt}{acid}\right)$$

first we find pKa value by:

$$pK_a = -\log(K_a)$$

$$pK_a = -\log(1.8 \times 10^{-5})$$

$$\boxed{pK_a = 4.744}$$

putting the values in the equation

$$pH = 4.744 + \log\left[\frac{1}{1}\right]$$

$$\boxed{pH = 4.744}$$

$\because \log\left[\frac{1}{1}\right] = 0$

The pH is acidic (less than pH=7)

Q. No. 2 Part (iv) Shape of $[Ag(CNH_3)_2]^+$

→ The shape is linear as ~~the~~ silver (Ag) is bonded to two ligands of NH_3 which is quite unstable.

$$[NH_3 — Ag — NH_3]^+$$

Bond Angle → 180° (linear)

Coordination no. → 2 since there are two ligands bonded to Ag through dative bonds.

(Section B)

Q. No. 2 Part (v) Elements with d^{10} configuration

→ Elements with d^{10} configuration such as Zn and Cu shows colourless compounds as they have full d- orbital shells.

→ Elements with full d-orbitals tend to reflect light after the light strikes it since there is no d-d transition. $Zn \rightarrow [Ar]\,4s^2 3d^{10}$ → full d-orbital

→ The elements are generally stable, ~~Therefore~~ Therefore, they do not participate in d-d transition, Hence they show colourless compounds.

.....

Q. No. 2 Part (vi) Optical activity of 1,2-bromoethanol

Compound :-

$CH_3 - \overset{OH}{\overset{|}{C}}H - Br \Rightarrow CH_3 - \overset{OH}{\overset{|}{C}} - Br$ (H)

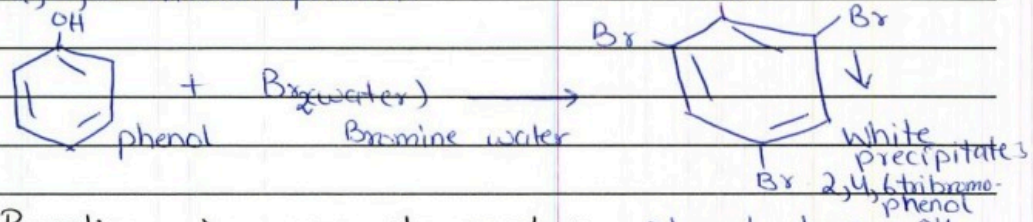
2-bromoethan-2-ol

Answer:- Yes, the compound 2-bromoethanol shows optical activity due to the chiral carbon in C2 where it is bonded to four different groups (CH_3, H, OH and Br). Therefore, it is optically active. ~~and~~ Moreover, ~~assymetrical~~ the compound is assymmetrical in which there is no symmetry ~~and~~ which it also affects the optical activity.

(Section B)

Q. No. 2 Part (vii) Phenol with Br water

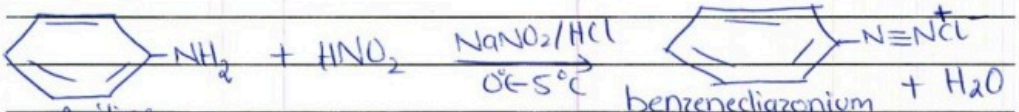
→ When phenol is treated with bromine water at room temperature, then it forms a white precipitates of 2,4,6-tribromophenol.



Reaction in room temperature → phenol has -OH group which is an electron-donating group that activates the benzene ring through inductive and resonance effect which ultimately draws incoming ~~electrophiles~~ nucleophiles in ortho and para-position unlike benzene.

Q. No. 2 Part (viii) Formation of benzenediazonium chloride

→ When phenylamine (aniline) reacts with HNO_2 in the presence of $NaNO_2$ and HCl under 0°C to 5°C, then it forms benzenediazonium chloride.

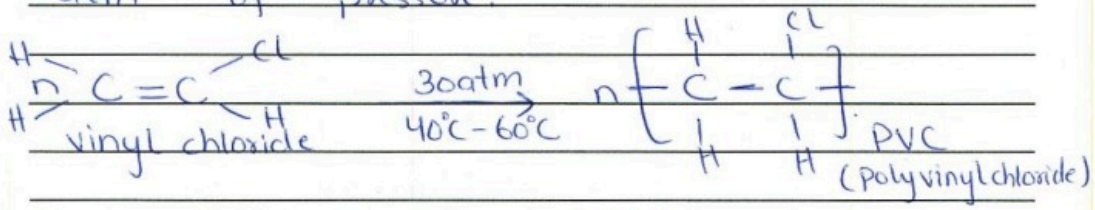


Reaction below 5°C → The reaction occurs below 5°C as the diazonium salt is stable at that temperature. If the reaction proceeds in higher temperature than 5°C, it will decompose rapidly.

(Section B)

Q. No. 2 Part (ix) Polymerization of PVC from vinyl chloride

→ PVC (polyvinyl chloride) is formed by a monomer of vinyl chloride under 40°C - 60°C temperature and 30-60 atm of pressure.



Type of Polymerization → Addition polymerization as there is no elimination of small molecules.

Q. No. 2 Part (x) Factors affecting Enzymes

→ ~~Temperature~~ Temperature → Temperature affects the enzyme activity as high temperature can cause denaturation of enzymes by affecting the peptide bonds. The specific range of temperature in which enzymes can operate is the optimal temperature. In humans, the optimal temperature is 37°C while in plants, it's 60°C.

→ pH → pH also affects the enzyme activity as the pH for pepsin operates in pH 2 in stomach while the pH of trypsin operates in pH 8 or 9 in intestines.

→ Substrate Concentration → Substrate concentration also affects the enzyme activity as there will no available enzymes to bind to.

(Section B)

Q. No. 2 Part (xi) Classification of lipids

Simple lipids → These lipids are formed by fatty acids and glycerol. Examples:

Triglyceride → It contains a glycerol and three fatty acid units. It stores energy in adipose tissues.

$$\begin{array}{l} CH_2-OH \\ | \\ CH_2-OH \\ | \\ CH_2-OH \end{array} + 3\,R-COOH \longrightarrow \begin{array}{l} CH_2-OOCR \\ | \\ CH_2-OOCR \\ | \\ CH_2-OOCR \end{array} + 3H_2O$$

glycerol fatty acids

Phospholipids → They are a part of the cell membrane integrity. Example → Glycolipids → They take part in cell signaling and recognition.

Derivative Simple lipids → These lipids are derived from simple lipids

Steriods → They aid in physiological process such as estrogen and progesterone.

Q. No. 2 Part (xii) No. of carbons atoms

Given:

A mass spectrum shows M^+ peak = 100% and (M+1) = 5.5%. As we know

Required: → As we know that,

$$\text{No. of C-atoms} = \frac{100\,\% \times \%\text{ in } [M+1]}{1.1\,\% \times \%\text{ in } [M^+]}$$

Putting the values

$$\text{No. of C-atoms} = \frac{100\,\% \times 5.5\,\%}{1.1\,\% \times 100\,\%}$$

$$\text{No. of C-atoms} = \frac{5.5\,\%}{1.1\,\%} \Rightarrow \frac{5.5}{1.1} \Rightarrow 5$$

(There are no. of 5 C-atoms)

(Section B)

Q. No. 2 Part (xiii) Description of Stationary phase & solvent front

a) Stationary phase → A stationary phase does not move at all as it remains static.

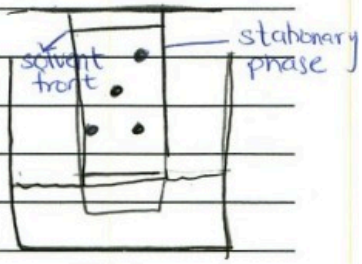
→ It can be a solid or a liquid

→ It allows the individual components to separate depending upon the polarity.

b) Solvent front

→ It is the top line on the chromatogram which measures the distance covered by the solute

→ ~~The~~ It is the end-point of the chromatogram



Q. No. 2 Part (xiv) Pesticides

→ Pesticides are chemicals that gets rid of pests (insects, rodents or fungi).

→ It is a useful chemical as it can ward off any pests or varmints.

Negative Aspects

Presence of Toxic chemicals → Toxic chemicals such as carcinogen or neurotoxic chemicals are primarily present in pesticides that could critically affect the health of consumers.

Resistant to Pesticides → Overusing the pesticides can develop a resistant in pests through adaptability and resilience in which it results in more usage of pesticides that would aggravate the environment

(Section C)

Q. No. 3 (Page 1) Given:- Current 'I' = 3.0A

Time 't' = 45 min = 2700s

Required → Charge 'Q' = ?

Mass of Cu 'M' = ?

(a) Reaction at cathode

At cathode: $Cu^{+2} + 2e^- \longrightarrow Cu$ (reduction)

Cu metal is obtained from cathode

(b) Total charge 'Q' = ?

As we know that,

$$I = \frac{q}{t} \Rightarrow It = q$$

$$q = (3.0A)(2700s)$$

$$\boxed{q = 8100C}$$

(c) Mass of Cu = ?

First we compute faraday's value,

we know that $1C = 96500f$

$$f = \frac{8100}{96500}$$

$$f = 0.08393F$$

from the above equation

$$Cu^{+2} + 2e^- \longrightarrow Cu$$

We use the molar ratio to compute the moles of Cu

F : mol

2 : 1

0.08393 : X

X = 0.04196 moles of Cu

(Section C)

Q. No. 3 (Page 2) finally, we can compute the mass of Cu by using the stiochiometric formula of mass.

M = moles × molar mass

M = 0.04196 × 63.5g/mol

M = 2.65g

From the above data, 2.61g of Cu is deposited at cathode.

(Section C)

Q. No. 3 (Page 3)

(Section C)

Q. No. 4 (Page 1) Basicity of Amines

Factors Affecting basicity

→ The ease of accepting protons

→ The stability of conjugate acid

Order of conjugate acid

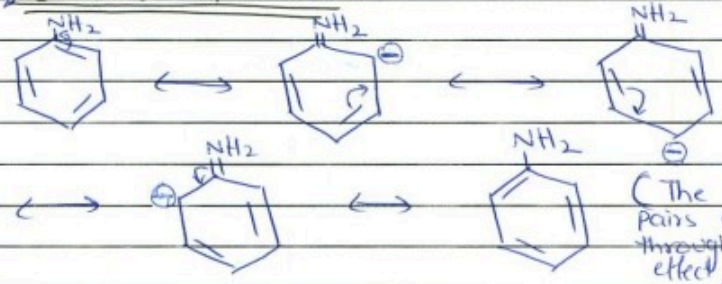
Phenylamine > Ammonia > Ethylamine

The order shows the increasing basicity.

Reason → Phenylamine shows less basicity due to the presence of $-NH_2$ which is the electron-donating group which activates the benzene ring.

→ However, the lone pairs of N-atom is delocalized across the membrane which makes the N-atom incapable of accepting protons since there is less availability.

Resonance in Aniline



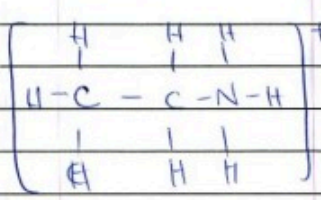
(The lone pairs are delocalized through resonance effect and inductive effect)

→ Ethylamine is more basic than ammonia and aniline as it has an ethyl group which is an electron-donating group

→ It increases the charge density of lone pairs of N-atom that draws

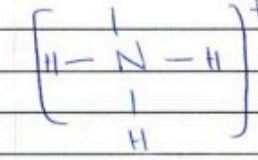
(Section C)

Q. No. 4 (Page 2) more proton, making it more likely to accept proton and it becomes stable



The lone pairs are increased through inductive effect

→ Ammonia is a weak base as compared to ethylamine as it does not have any electron-donating and can accept protons as compared to aniline.



pKb values

The less pK_b value, the more basic the compound is

Ethyl amine	pKa → 3.26
Ammonia	pKa → 4.97
Aniline	pKa → 9.36

Order of conjugate acid

Phenylamine > Ammonia > Ethylamine

→ This order shows the strength of conjugate acid after the base accepted the protons.

(Section C)

Q. No. 4 (Page 3) Order of Basicity

Ethylamine > Ammonia > phenylamine

→ Ethylamine is more basic

→ phenylamine is less basic

(Section C)

Q. No. 5 (Page 1) Alkylation of Benzene.

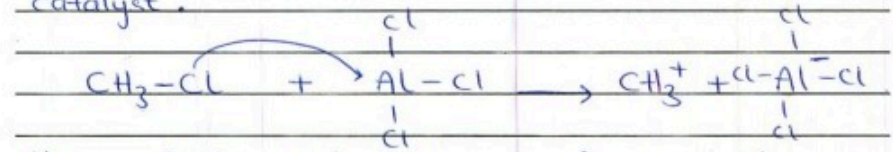
→ The process in which the proton of benzene is replaced with a methyl group ($-CH_3$) to form a compound known as Toulene or methyl-benzene.

→ It is carried out by a catalyst such as $AlCl_3$ which temporarily dissociate a part of benzene ring through an active cation of $-CH_3$ group (CH_3^+).

Mechanism of Alkylation of Benzene

Step 1 → formation of Electrophile

→ An electrophile (CH_3^+) is formed by losing the Cl^- atom to the $AlCl_3$ catalyst.



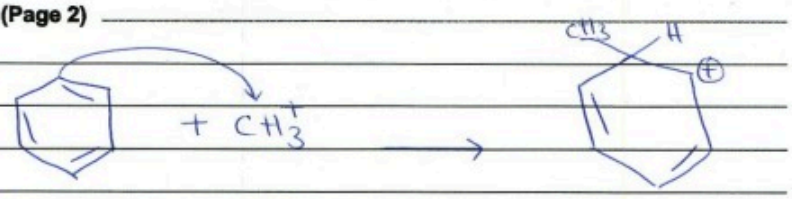
Here, $AlCl_3$ act as a lewis acid while CH_3-Cl act as a lewis base.

Step 2 → formation of Arenium ion

→ The cation / electrophile attacks the partial part of benzene ring in which it temporarily lose the aromacity to form an intermediate known as Arenium ion or phenonium ion.

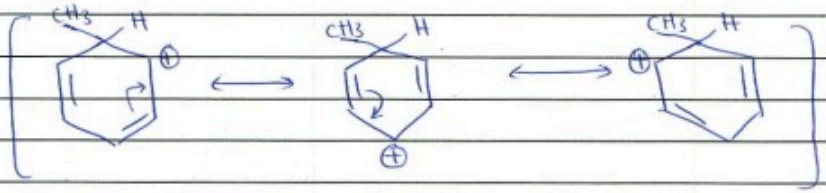
(Section C)

Q. No. 5 (Page 2)



Benzene Methyl cation Arenium ion

The arenium ion undergoes resonance to maintain the ~~stabilized~~ stability.

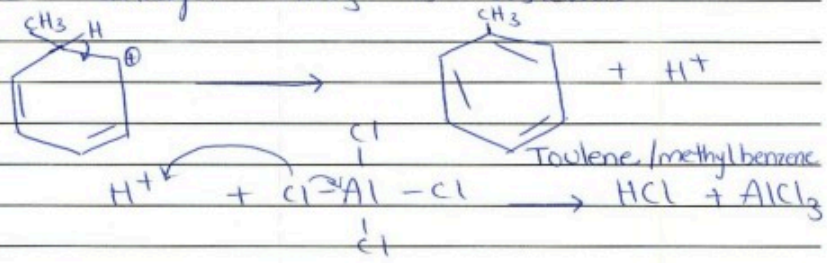


Resonance - stability of arenium ion

Step 3 → Deprotonation of Arenium ion

→ The proton is removed from the arenium ion, which regains the aromaticity of the benzene ring.

→ The proton bonds with the Cl atom from $AlCl_4^-$ to form HCl and the catalyst $AlCl_3$ is restored.



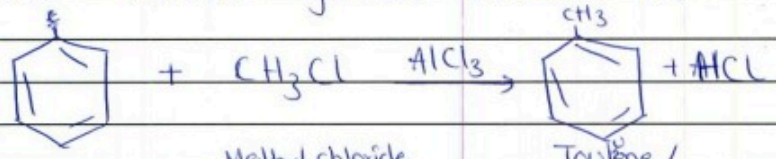
Toulene / methylbenzene

$$H^+ + Cl-Al(Cl)_2-Cl \longrightarrow HCl + AlCl_3$$

(Section C)

Q. No. 5 (Page 3) Conclusion

The overall general reaction is:



Benzene. Methyl chloride. Toluene / methylbenzene.

(Section C)

Q. No. 6 (Page 1) Acidic Strength

Phenol > Water > Ethanol

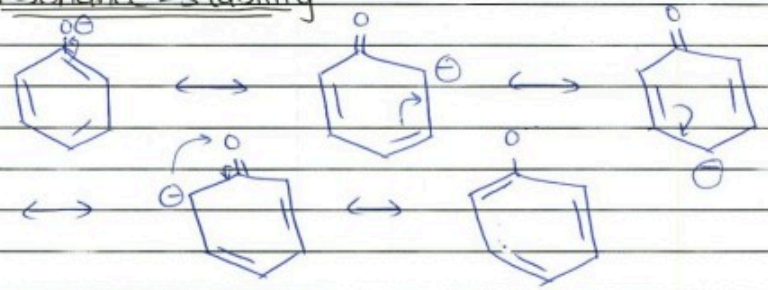
Reason:→ Acidity refers to the stability of the conjugate base

→ Water is both basic and acid and it possess the capability in autoionization

→ However, it is a weak acid as compared to phenol as it possess the K_a value of 1.6×10^{-16}

Phenol → Phenol is more acidic than ethanol as it forms a stable conjugate base of phenoxide ion after losing a proton. The negative charge, it possess is delocalized across the ion which stabilizes the ion through resonance and inductive effects.

Resonance - Stability



Ethanol → Ethanol is less acidic than phenol and water as it has localized electrons in its conjugate base. Th

→ When ethanol loses a proton, it forms an ethanoxide ion which has

(Section C)

Q. No. 6 (Page 2) a localized electrons that tightly bond the proton (H-atom) which makes it hardly acidic as it is less likely to lose a proton.

$CH_3CH_2OH \rightarrow CH_3CH_2O^- + H^+$

ethanol → ethanoxide ion

Ka values

The more Ka value it is, the more acidic the compound is

phenol Ka → 1.3×10^{-15}

ethanol Ka → 1.6×10^{-16}

water Ka → 1.93×10^{-16}

(Section C)

Q. No. 6 (Page 3)