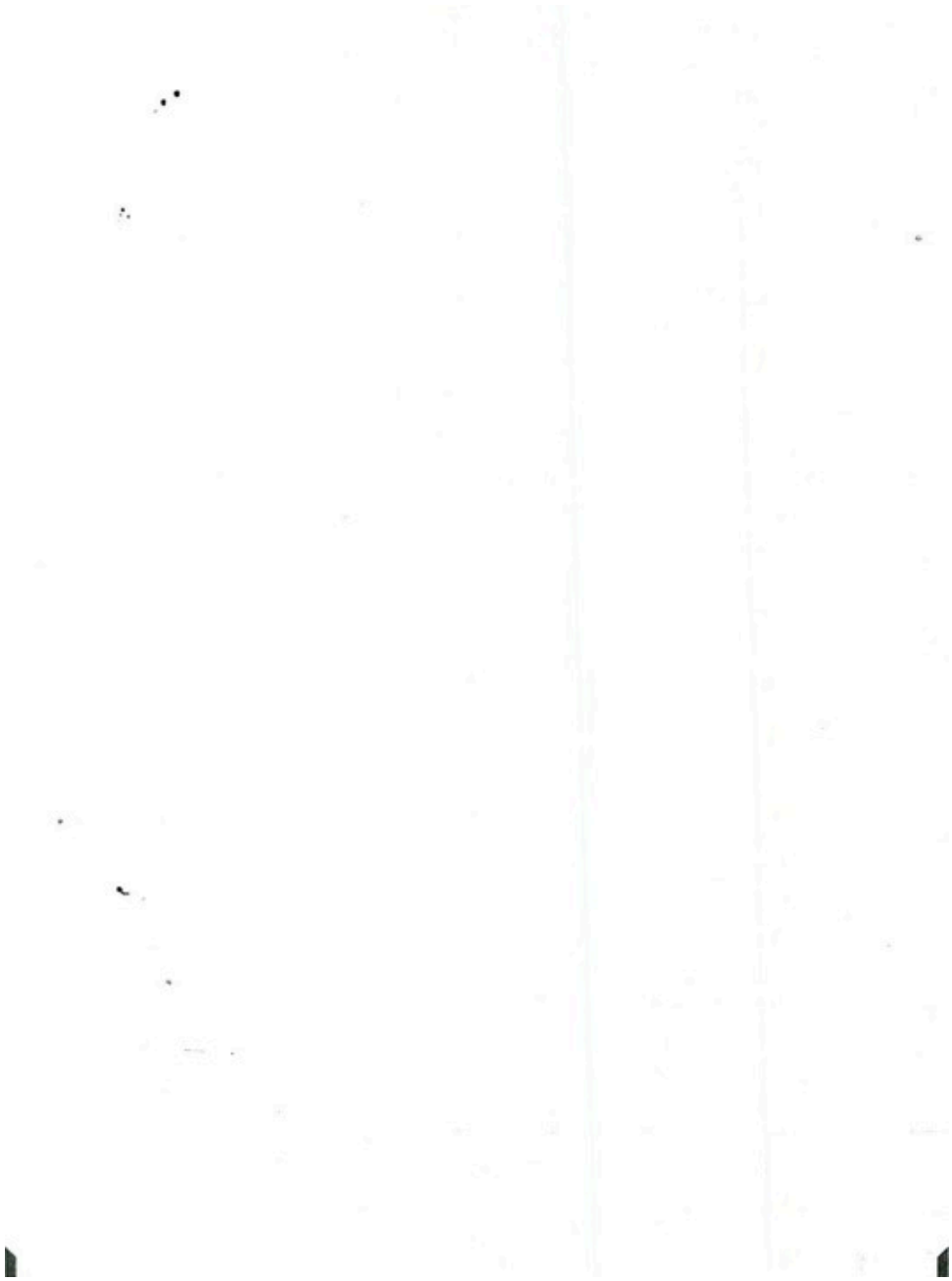




$CH_3 - Cl + KCN \rightarrow CH_3 - CN + KCl$

16.2
14.7
~~15.8~~
15.4

12.8
12.7
12.6
12.1
12.4
1.28
1.34

(Section B)

Q. No. 2 Part (i)

$\therefore$ $Fe \longrightarrow Fe^{2+} + 2e^-$ $\quad E^\circ = +0.44V$

$Pb^{2+} + 2e^- \rightarrow Pb$ $\quad E^\circ = -0.13V$

As reduction potential of "Fe" is smaller so it occurs at anode and ~~this equ~~ "Pb" has greater reduction potential so it occurs at cathode.

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

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

As this value is positive so the reaction is **feasible** and **spontaneous.**

Q. No. 2 Part (ii)

~~reduction~~

$NH_3 \longrightarrow NO_2$

oxidation

As "N" in NH_3 changes its oxidation state from -3 to $+4$ so oxidation has taken place.

Also, Hydrogen is lost and oxygen is gained which indicates that **Oxidation reaction** took place.

(Section B)

Q. No. 2 Part (iii)

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

1 Mol 1 mol 1 mol

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

as CH_3COOH and CH_3COO^- are 1 mol so,

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

We know that, $K_a = 1.8 \times 10^{-5}$

$[H^+] = K_a$

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

$\because pH = -\log[H^+]$

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

$pH = -(-4.744)$

$pH = 4.744$

Hence, pH of 1 mol of acetic acid / sodium acetate is 4.744

Q. No. 2 Part (iv) Group (II) elements also known as alkaline earth metals have ns^2 valence shell configuration due to which they have tendency to loose these two electrons. So, group II elements loose 2 electrons and gain **+2 charge** and they are **cations**.

Reactivity:

Group II elements are comparatively less reactive than group I elements because

1- Their size is smaller as compared to Group I elements

2- Their ionization energy is greater as compared to group I elements

3- Their nuclear charge is greater than group I elements

These reasons make them less reactive than group I element. $2Na + Cl_2 \rightarrow NaCl$ / $Ca + Cl_2 \rightarrow CaCl_2$

(Section B)

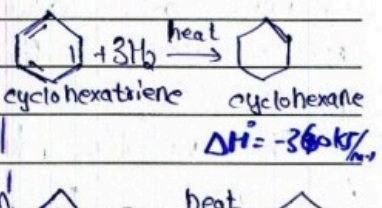
Q. No. 2 Part (v)

The transition elements with **d^{10} configuration** are colorless because they do not have any empty or half-filled d-shell and therefore they do not show d-d-orbital splitting or transition of electrons.

When electrons are transitioned into highier energy d-orbital they absorb specific wavelength of light and complementary light passed is observed but in d^{10} configuration as in zinc element, no transition occurs and so zinc element is colorless and very stable. Zinc is not even a transition metal.

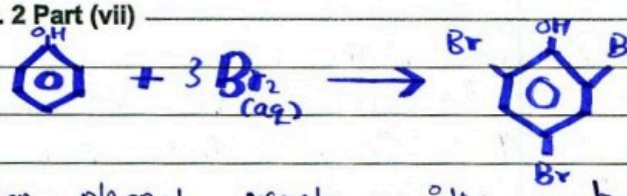
Q. No. 2 Part (vi) Enthalpy of hydrogenation of 1,3,5-cyclohexatriene is **-360 KJ/mol** and of benzene is **-208 KJ/mol**. The significant difference between them is due to following reason.

→ **Benzene** shows **resonance** and its electrons resonate in the ring due to which it has **low energy** and is **very stable**. So, in hydration low energy enthalpy is required and that's why its enthalpy of hydration is lower than 1,3,5-cyclohexatriene. There is **-152 KJ/mol** difference in it which is called resonance energy of benzene.



(Section B)

Q. No. 2 Part (vii)

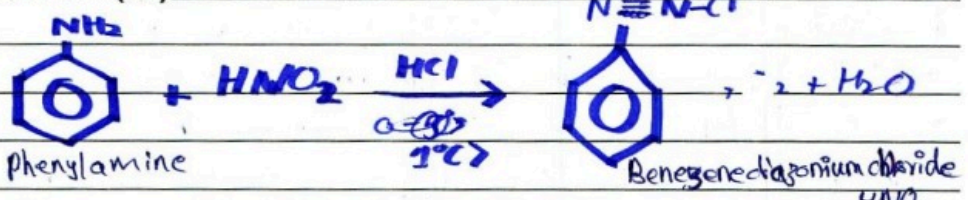


2,4,6-tribromo-Phenyl

when phenol reacts with bromine water we get 2,4,6-tribromophenyl.

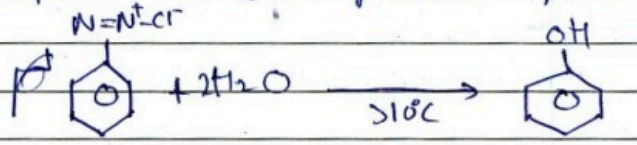
Phenol react at room temperature unlike benzene because it contains -OH group which is electron-donating group. It increases electron density at ortha (2,6) and para (4) positions and makes phenol very active thats why it can take place even at room temperature.

Q. No. 2 Part (viii)



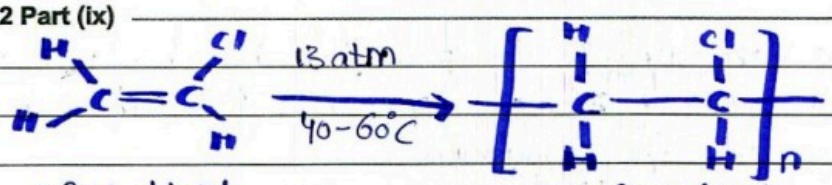
When cold solution of phenyl amine react with nitrous acid and HCl the benzene diazonium chloride is produced.

The reaction has to take place at temperature less than 1°C because it will otherwise decompose. It will produce phenol.



(Section B)

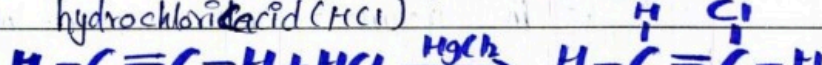
Q. No. 2 Part (ix)



Vinyl chloride ∴ Poly vinyl chloride.

This is addition polymerization where double bond is broken. It takes place at 40-60°C temperature 13 atm pressure.

Vinyl chloride is created by reaction of ~~ethylene~~ ethyne with hydrochloric acid (HCl)



ethyne. vinyl chloride

Q. No. 2 Part (x) **Factors affecting enzyme activity:-**

1- Temperature:- Every enzyme work at optimum temperature. In humans it's 36° and in plants it's 60°C. If temperature is increased it will denature enzyme (distort its shape) and activity is lost. If temperature is decreased it will deactivate enzyme.

2- PH:- Enzymes also work at optimum pH such as pepsin and trypsin works at 2 and 8 pH respectively. Any alteration in pH will harize it and enzyme activity is affected.

3- Substrate concentration:- Increasing substrate concentration will increase its activity but if active sites are constant then after some time when all active sites are occupied. Increasing substrate concentration will have no effect.

(Section B)

Q. No. 2 Part (xi)

Molecular ion peak is the peak that has high m/z ratio after any heavy isotopes and it tells about molecular mass of the compound.

Symbol:- $[M^+]$

Importance:- Its m/z ratio is equal to the molecular mass of the compound so it is important to tell us about molecular mass of compound.

forexample:.

molecular mass of ethene is 28

Molecular ion peaks $[M^+]$ m/z is also 28

$[C_2H_4^+]^+$ is the fragment that represent molecular ion peak.

Q. No. 2 Part (xii) **Given data:-** M^+ peak = 100%

M+1 peak = 5.5

Required data :. number of carbon atoms.

Solution :.

$$\therefore \text{No. of carbon atoms} = \frac{100\% \times [M+1]}{1.1\% \ [M^+]}$$

$$\text{Number of carbon atoms} = \frac{100\% \times 5.5\%}{1.1\% \times 100\%} = \frac{5.5\%}{1.1\%}$$

Number of carbon atoms = **5** carbon atoms

(Section B)

Q. No. 2 Part (xiii)

Stationary phase:- Stationary phase is either a liquid coated on solid or a solid. It is placed above mobile phase. This phase remains stationary while mobile phase moves past it carrying spots upward. **i.e;** in column chromatography use solid as stationary phase and liquid or gas can be mobile phase.

Solvent front:-

Solvent front is the distance covered by the solvent from the base line. The highiest distance covered is usually the solvent front. "rf" value of any solute is measured relative to solvent front.

Q. No. 2 Part (xiv) **Pesticides:-** Pesticides are chemicals or poisons that kill or control pest, insects, herb, fungus and weed growth.

negative aspects:-

1- Pesticides are some overapplied on plants that can seek into soil and may run off into nearby rivers where they can kill fishes.

2- Sometimes pesticides may remain on fruit and can be very harmful to human health.

3- It can also kill beneficial insects like bees that help in pollination.

(Section C)

Q. No. 3 (Page 1) **Nucleophile Substitution (SN1):-**

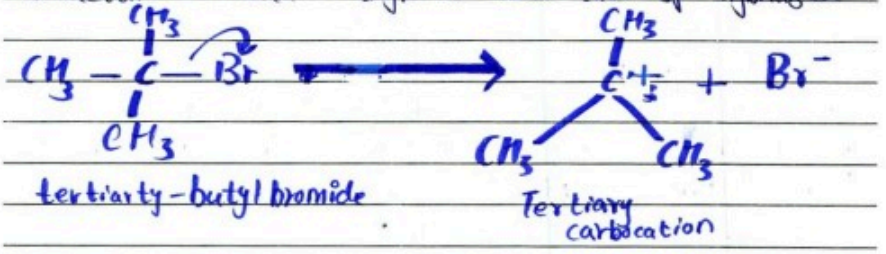
Substitution

(SN1) reaction is a unimolecular reaction and it takes place in two steps.

Tertiary alkyl halides undergo SN1 reaction because 3 alkyl groups cause steric hindrance so it can not occur in one step like primary and secondary halogenoalkanes.

Step 1:- Carbocation is formed.

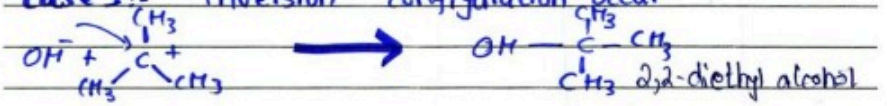
In this step, halides group departs and forms tertiary carbocation which is trigonal planer in structure. Bond angle is 120° and sp^2 hybridized.



Step 2:- H-OH attacks and substitution occurs

The nucleophile can attack on both sides of sides of carbocation so both retention configuration and inversion configuration occurs with 50% possibility both.

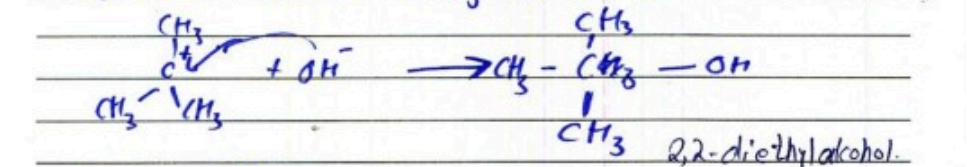
case 1:- Inversion configuration occur.



(Section C)

Q. No. 3 (Page 2)

case 2:- retention configuration occur.



2,2-diethylalcohol.

Rate of reaction:-

It depends only on alkyl halide [R-X]

So $R \propto [R-X]$

$R = k[R-X]$

Order of reaction:- It is first order reaction.

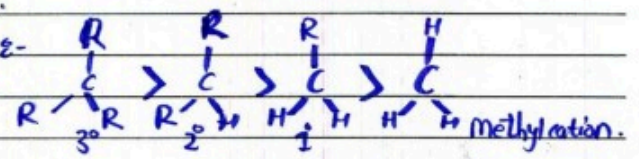
Polar protic solvents speed up SN1 reaction because it stabilizes cation.

- Role of inductive effect -

Inductive effect means that alkyl groups donate electrons to central carbon cation. This stabilizes cation. The more stable the carbocation, the ~~faster or~~ more reactive is the carbocation because anything that stabilizes its cation will make it more favourable to undergo a reaction.

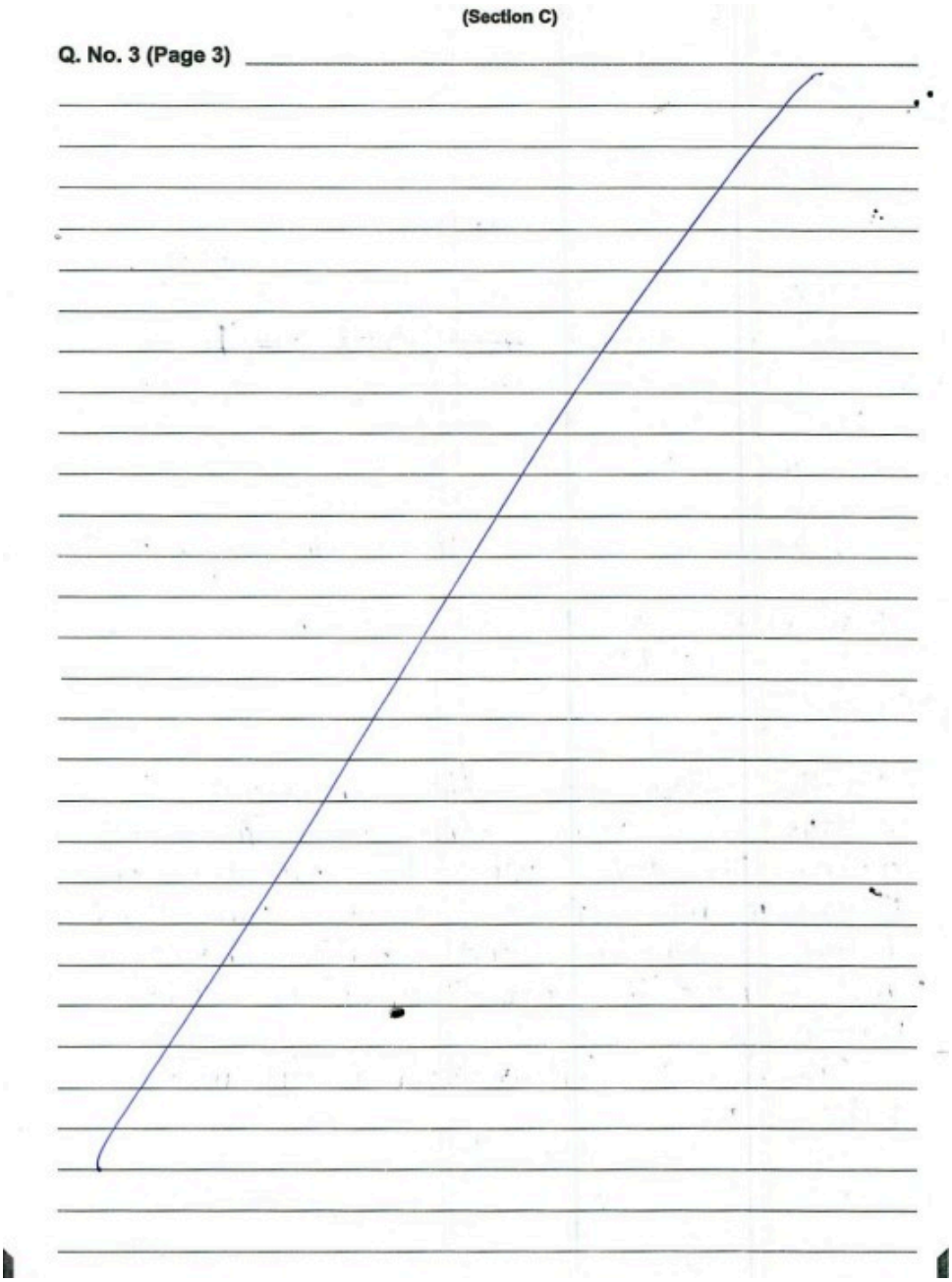
Therefore tertiary cation is the most stable one.

Stability order:-



(Section C)

Q. No. 3 (Page 3)



(Section C)

Q. No. 4 (Page 1)

Transition metals

Transition metals are d-block metals that show variable oxidation states.

Transitions metals are more like eachother than any other element in the periodic table. They are all metals and their states don't change from metal to metalloid and metalloids to non-metals.

4th period in transition metals include :-
Scandium (Sc), Titanium (Ti), Vanadium (V), Chromium (Cr), Manganese (Mn), Iron (Fe), Cobalt (Co), Nickel (Ni), Cupper (Cu) and Zinc (Zn) (not transition metal but belongs to d-block)

Transition metals are used in so many fields such as; **Copper**:- used in wires and coins.
Iron :- Used in construction for making bridges etc.
Gold:- Used in jwellery, artencils etc.

They are largely used as catalyst because they have variable oxidation state and can temporarily change their oxidation states during reactions.

However, Zinc is not a transition metal, it is only d-block element because it does not show variable

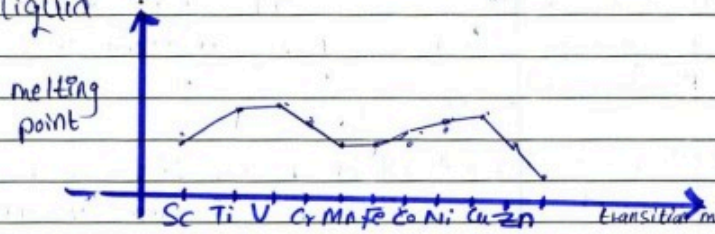
(Section C)

Q. No. 4 (Page 2)

oxidation states.
Scandium was initially not conformed if it was a transition metal but it shows +1 and +2 oxidation states in another compound.

Melting point :-

~~melting point of transition metals decreases~~ in the start and gradually decrease.
Melting point of transition metals depends on metallic bonding in them. Metallic bond is based on number of free electrons available. For transition metals, it is very high as compared to s and p-block elements due to availability of free electrons for metallic bonding.
However, we see a drop in melting points of Manganese (Mn) and Zinc (Zn) because their orbitals are partially and fully filled respectively. They are very stable and do not have lone pair of electrons so they are not involved in metallic bonding and so, their melting and boiling points drop.
This is the reason why mercury exist as liquid.



(Section C)

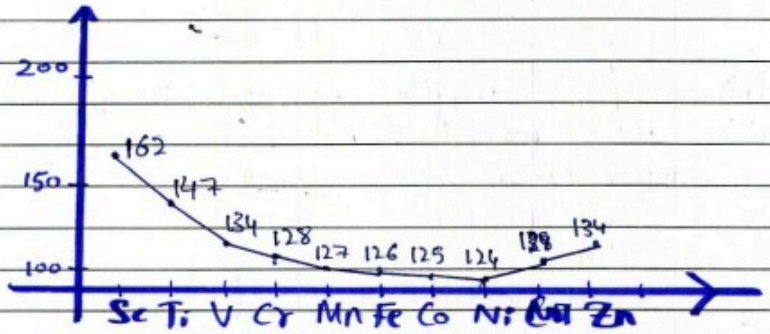
Q. No. 4 (Page 3)

Atomic radii:-

Atomic radii of transition metals decrease in the begining because the electrons are filling in 4S subshell as this is of low energy and strongly attacked by the nucleus because it is more permeable. So, addition of electron will increase nuclear charge acting on it and decrease radius.

Towards center of the period, the radii remains almost constant because now electrons are filling in 3d subshell. Now, 3d is shielding 4S orbital and both nuclear charge and shielding effect counter balance eachother.

Towards end of the period, atomic radii increase because now shielding effect is greater than nuclear charge and so radius increase.



(Section C)

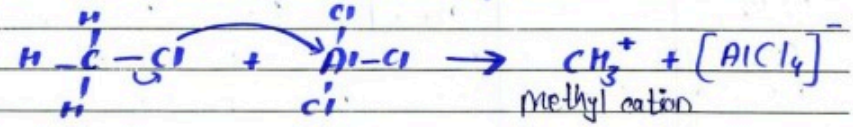
Q. No. 5 (Page 1)

Friedel-Crafts alkylation of benzene

In friedel-crafts alkyl reaction we used aluminium tri-chloride ($AlCl_3$) that is a catalyst and a lewis acid.

Mechanism This involves three steps.

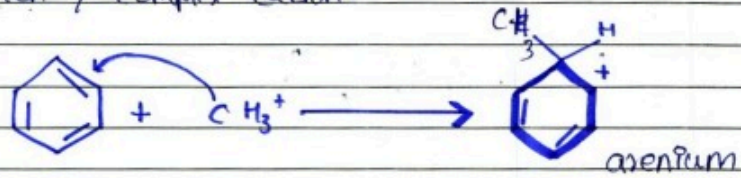
1- Generation of electrophile



Electrophile is a positively charged species which is methyl cation here. Lewis acid is used to generate an electrophile in this step.

2- Generation of arenium ion.

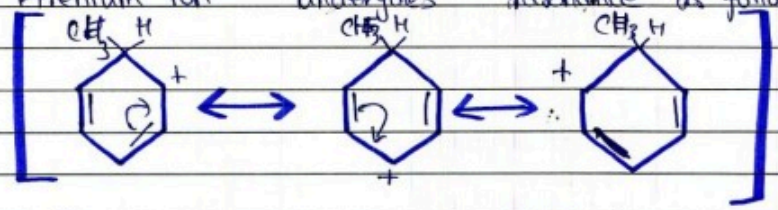
In this step electrophile attacks on benzene breaking its partial double bond and arenium ion / complex cation.



(Section C)

Q. No. 5 (Page 2)

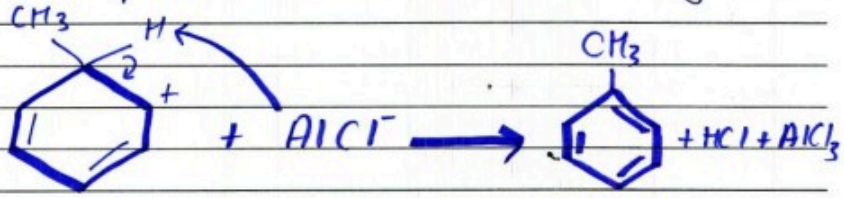
Arenium ion undergoes resonance as follows:-



Resonance stabilized structure of arenium ion.

3- Regeneration of Catalyst

In this step catalyst is regenerated. Cl-atom in lewis acid attached and depart with benzyl hydrogen to produce hydrochloric acid. Lewis acid /catalyst is regenerated.
Partial double is also formed in benzene and product is toulene or methyl benzene



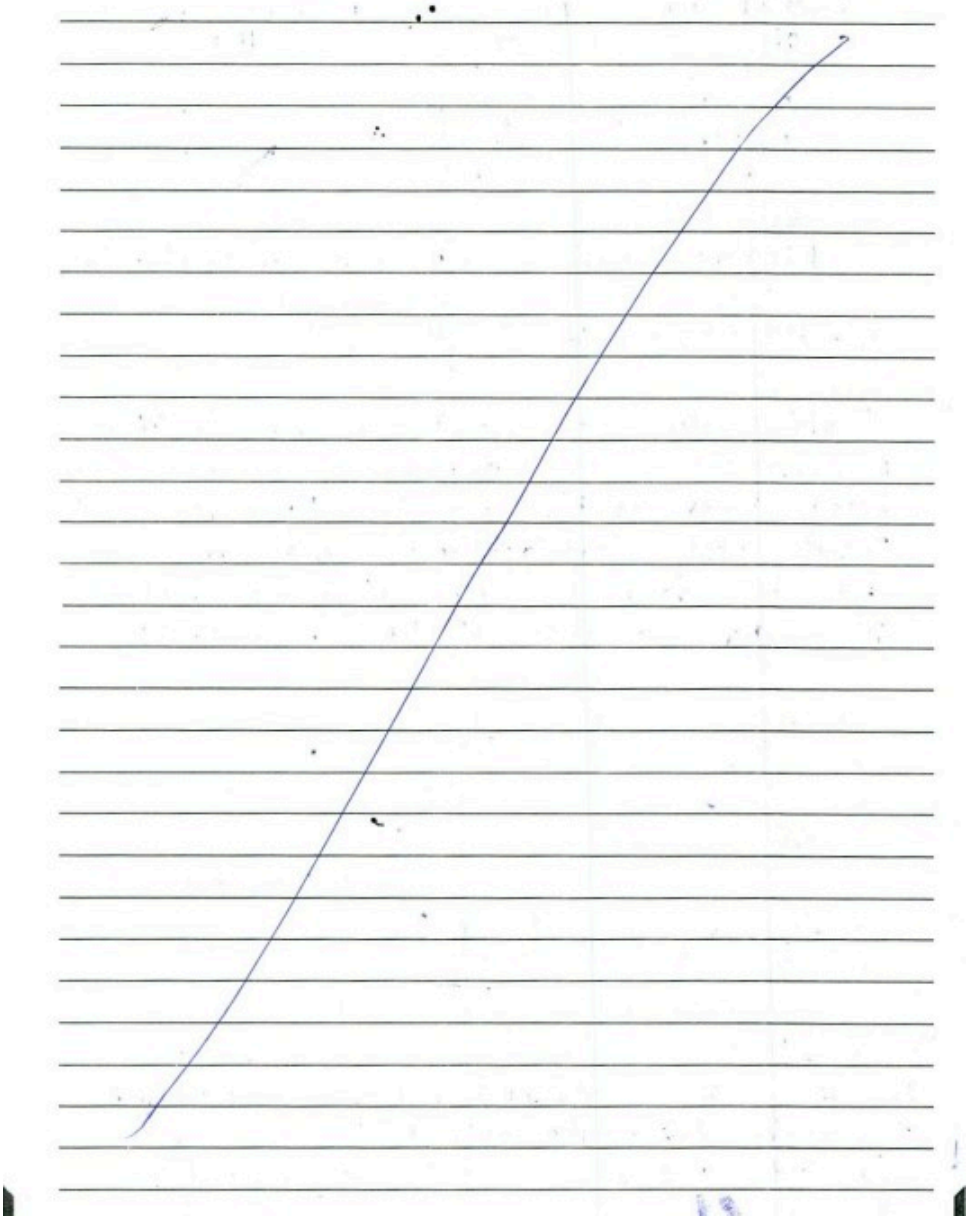
Toulene.

Role of lewis acid

$AlCl_3$ is lewis acid.
In first step lewis acid helps to produce an electrophile that is important for friedel-craft reaction.
In last step lewis acid is regenerated.

(Section C)

Q. No. 5 (Page 3)



(Section C)

Q. No. 6 (Page 1)

We know that **Phenol > water > Ethanol**

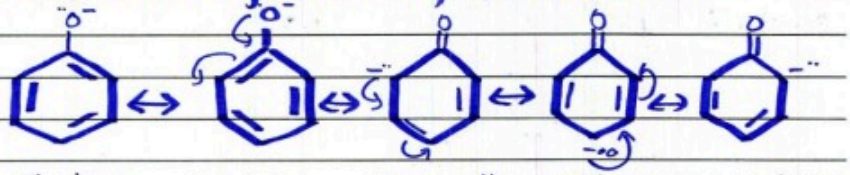
Phenol

In phenol acidic strength is highest because it shows resonance. Acidic strength means ability to donate proton.

In phenoxide ion, electrons of -OH (hydroxyl group) resonate through the ring and does not remain on one atom. Due to resonance, when negative charge does not build up on one atom, its ability to attract proton decreases and ability to donate proton increases that makes it a good acid.

PKa value of phenol :- 1.30×10^{-10}

Resonance hybride of phenoxide:-



Electrons resonate on ortha and para positions.

Alcohol - Ethanol

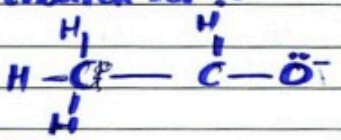
In ethanol when ethoxide ion is formed, it shows no resonance, due to which negative charge (lone pair of electrons) remain on oxygen atom. So it has ability to attaract proton more.

(Section C)

Q. No. 6 (Page 2)

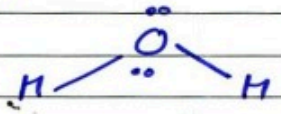
that is why it is the weakest acid.
pKa of ethanol :- 1.26×10^{-16}

Ethoxide ion:-



Water

Water is amphoteric in nature so it has ability to accept electrons (act as base) or donate electrons (act as acid). Its K_w (Ionization constant) at room temperature is very low $K_w = 1 \times 10^{-14}$. This makes it is a weak acid. It acid dissociation constant pKa value is $= 1.80 \times 10^{-16}$.



As, Phenol → $K_a = 1.30 \times 10^{-10}$
water → $K_a = 1.8 \times 10^{-16}$
Ethanol → $K_a = 1.26 \times 10^{-16}$

and also phenol shows resonance. Therefore, Phenol is the strongest acid, water is weaker, and ethanol is the weakest acid.

(Section C)

Q. No. 6 (Page 3)

