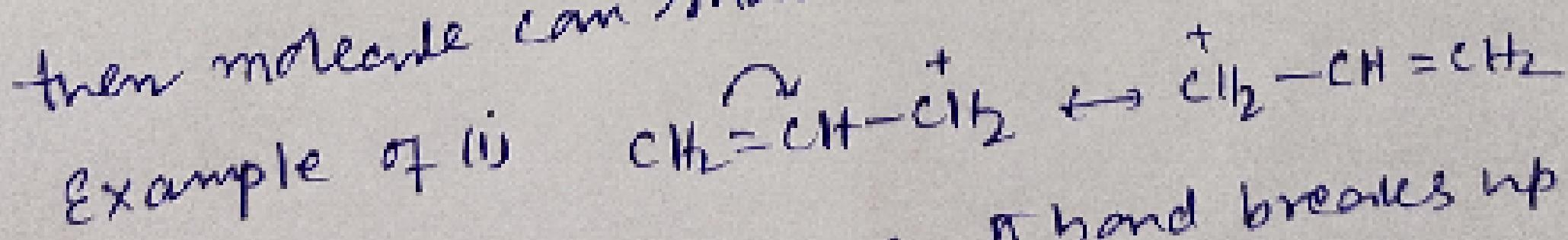


Resonance:

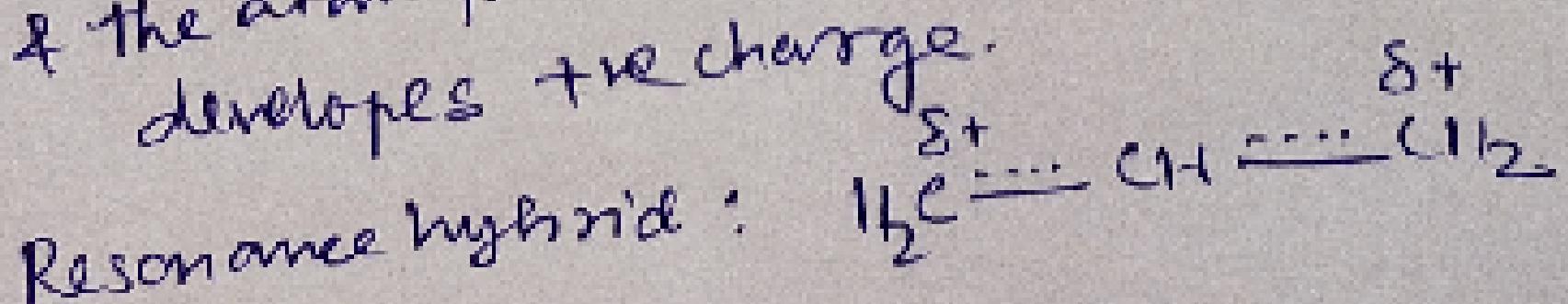
(1)

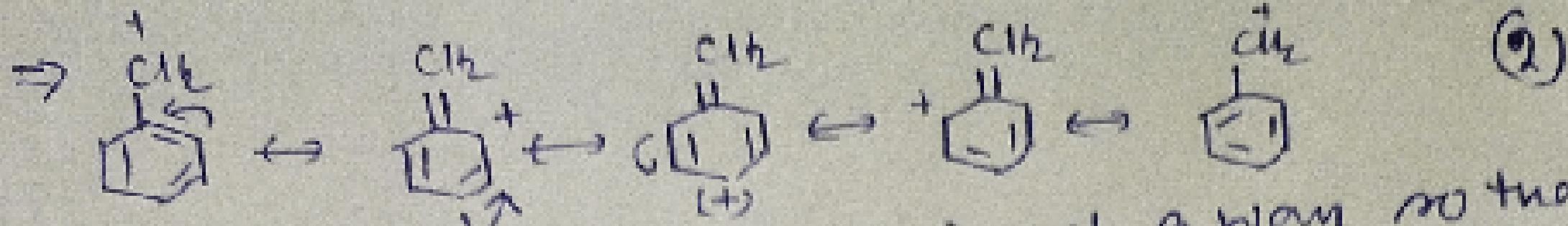
- ⇒ It is an intramolecular process.
 - ⇒ It stabilises the molecule.
 - ⇒ Here molecule is represented by more than one structure known as resonance structures or canonical form which does not have real existence. The combination of all resonance structures called resonance hybrid which is real.
 - ⇒ Here \bar{e} movement takes place but atom movement can not take place.
 - ⇒ Potential energy of the molecule is reduced.
- Condition for resonance:
Generally molecule has π bond. w.r.t π bond, next atom is i) has +ve charge
or
ii) has -ve charge
or
iii) has at least one lone pair of electron
or
iv) sp^2 hybridised carbon
or
v) sp hybridised carbon
or
vi) free electron is present
vii) free electron pair is present.
then molecule can show resonance.



Always during resonance, π bond breaks up.

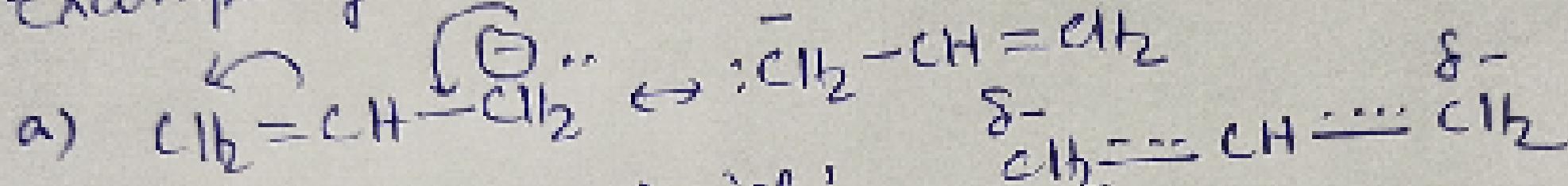
- ⇒ Always during resonance, π bond develops -ve charge.
- ⇒ The atom toward \bar{e} is shifted develops -ve charge & the atom from which \bar{e} is shifted goes away develops +ve charge.



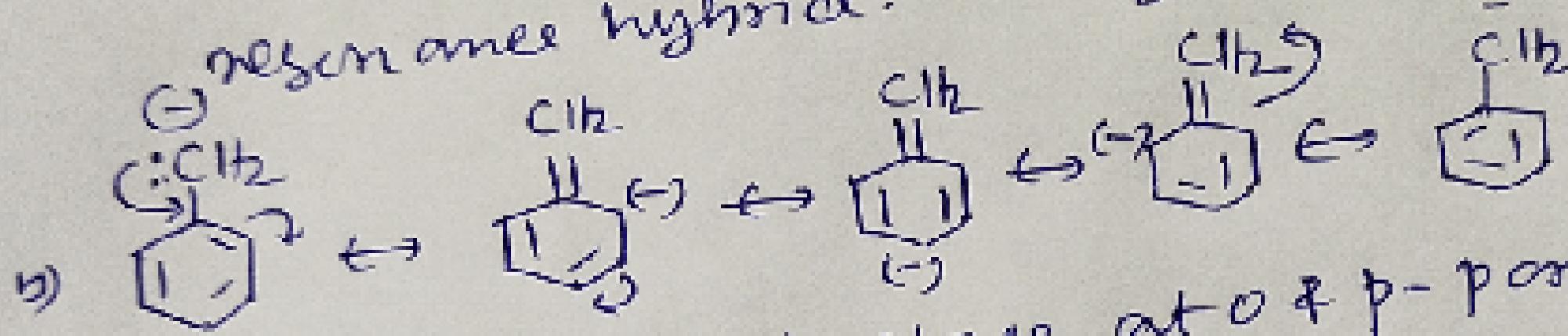


[π movement takes place in such a way so that the charge is neutralized. Here +ve charge is spread over the ring. If any charge develops, then charge at o & p-position +ve charge appears in reso; meta position never has any charge].

Example of (ii)



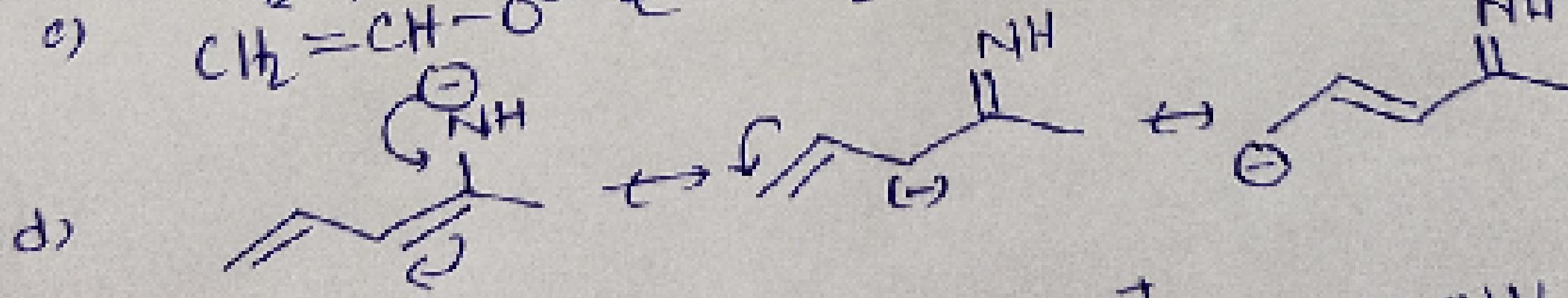
resonance hybrid!



[Here -ve charge develops at o & p-position not at meta position during resonance].

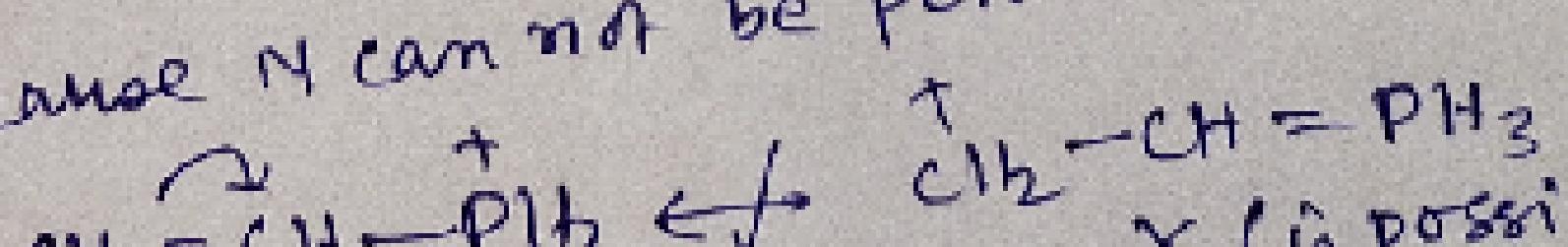
Resonance Hybrid:

Here πes in ring is delocalised (spread over the entire ring). It is due to resonance.

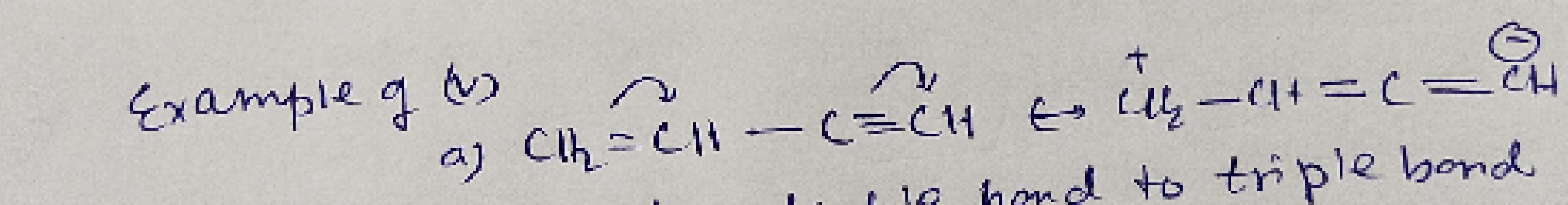
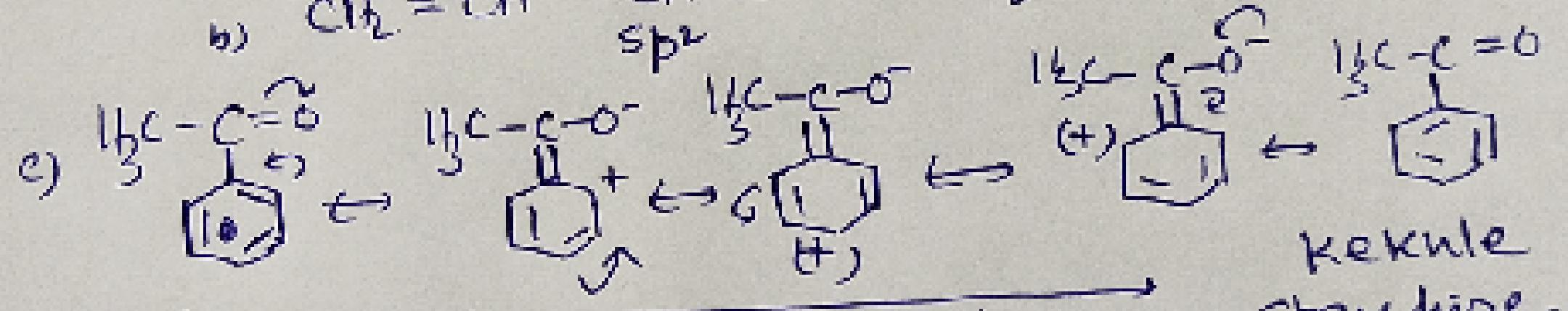
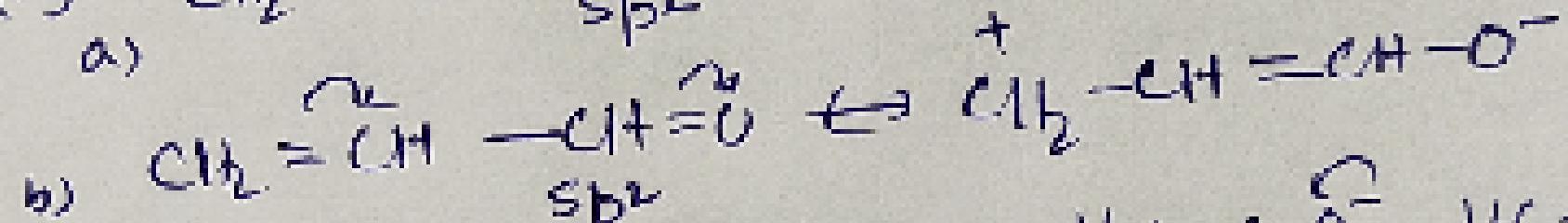
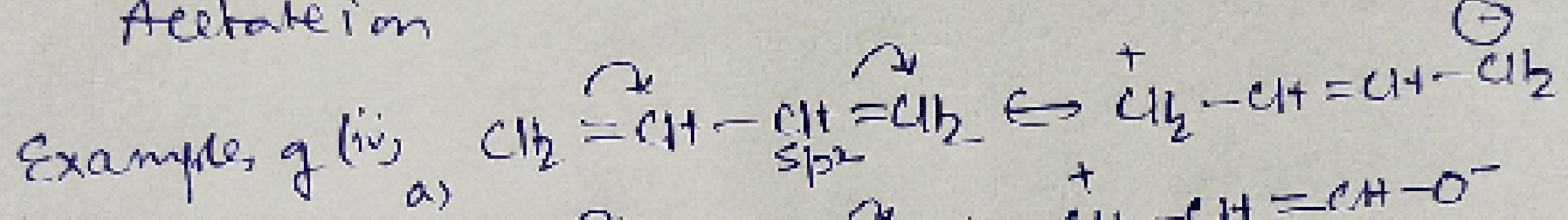
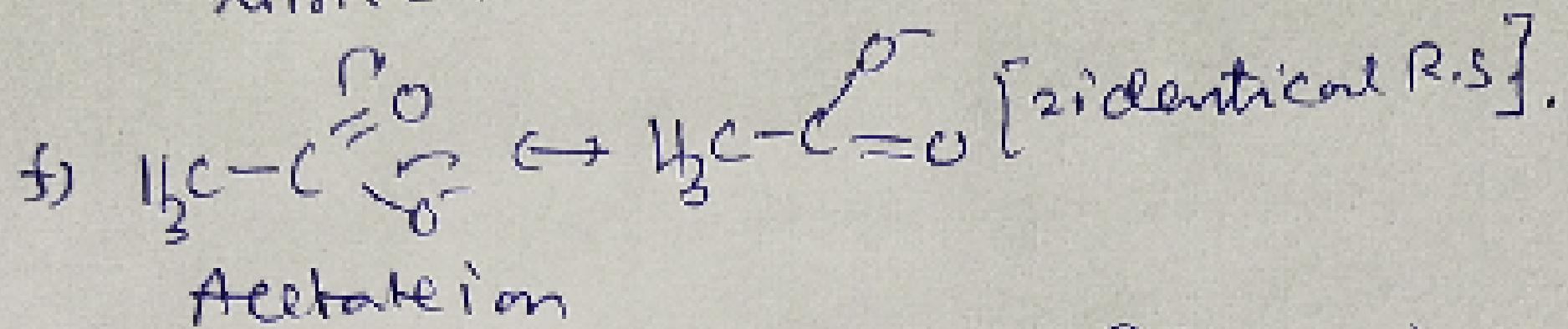
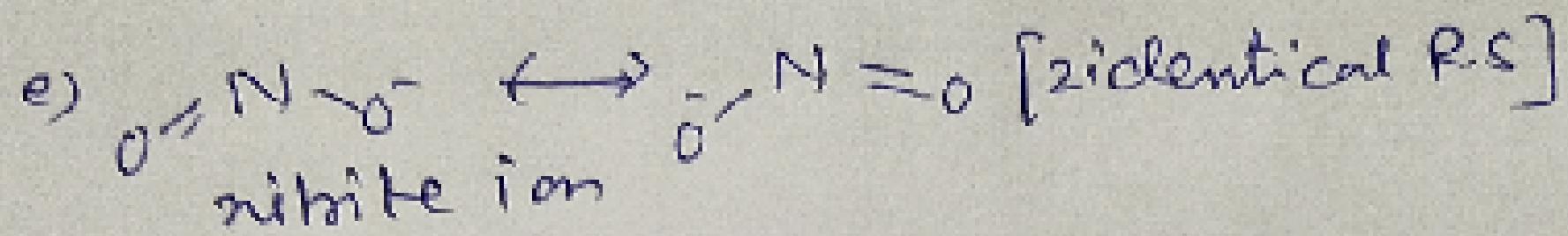
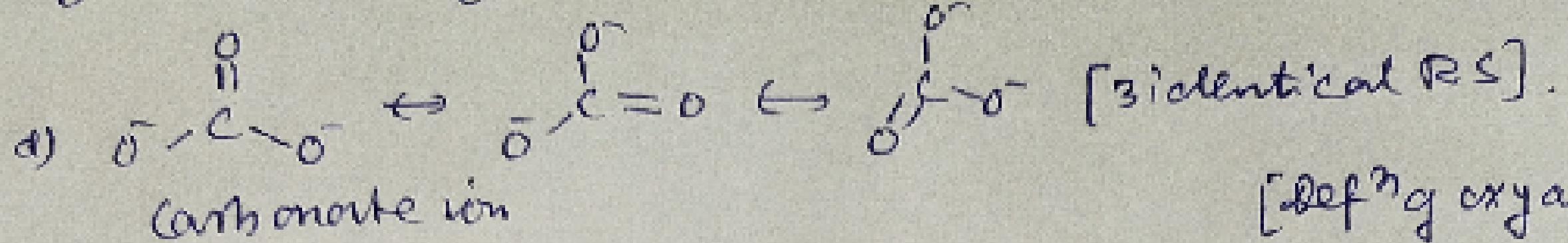
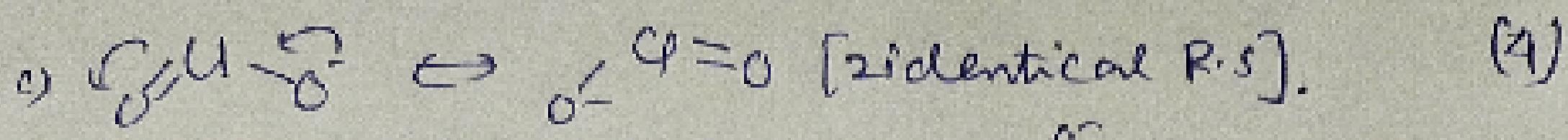


Exception: $\text{CH}_2=\text{CH}-\text{N}^{\oplus}\text{H}_3 \not\leftrightarrow \text{CH}_2-\text{CH}=\text{N}^{\oplus}\text{H}_3$

The resonating structure (x) is not possible because N can not be pentavalent

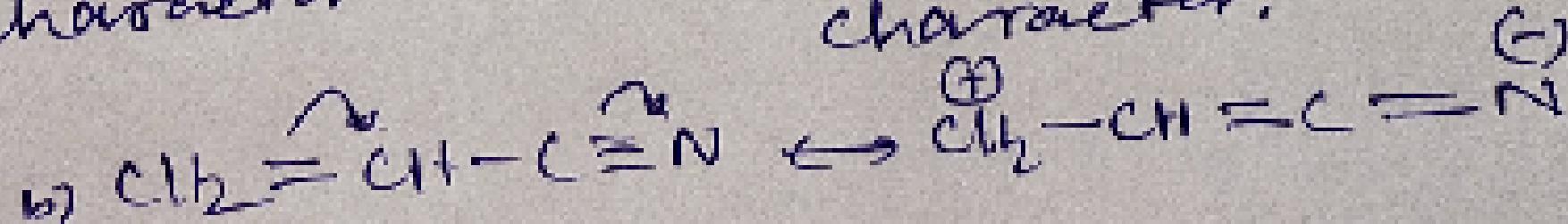
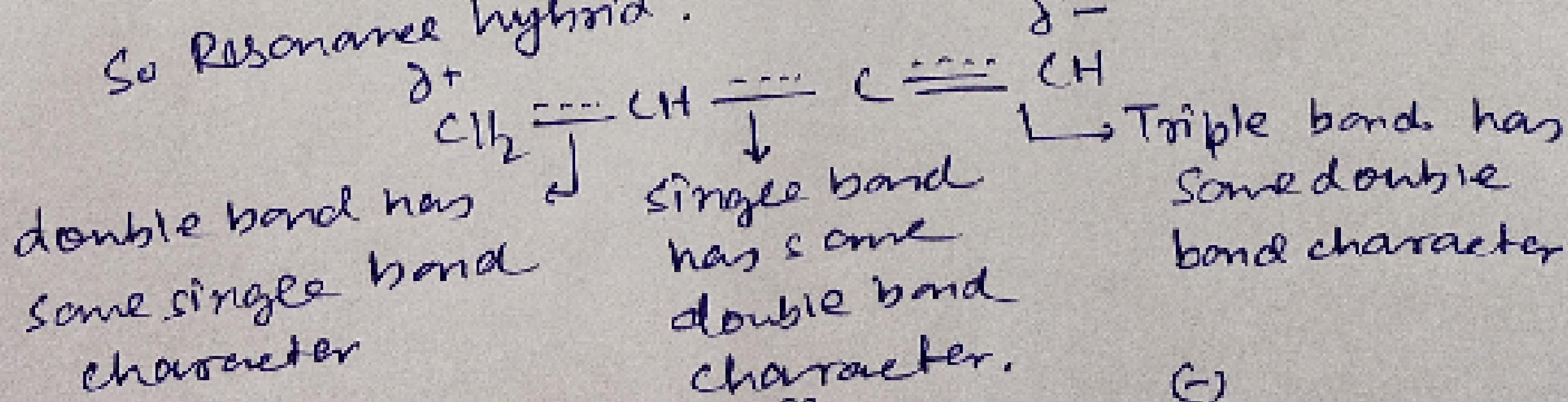


(x) is possible because P can be pentavalent

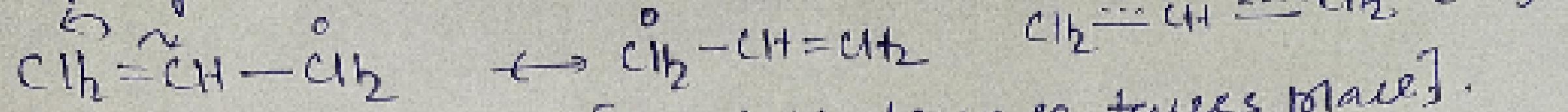


[Here δ is shifted from double bond to triple bond because triple bonded carbon is more electronegative than double bonded carbon].

So Resonance hybrid:



Example of (vi) (5)



Odd \bar{e} species [Hemolytic cleavage takes place]. called free radical. It is called radical resonance.

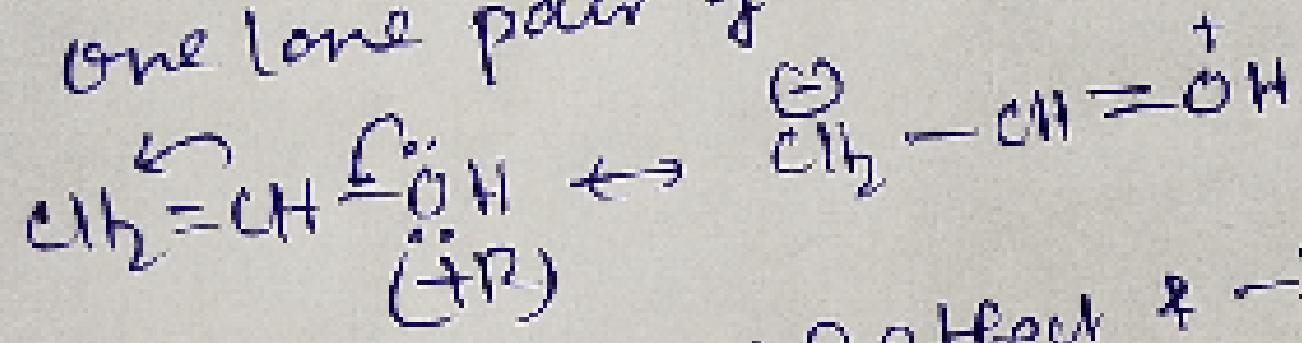
2 types of resonance effect takes place

- i) +R effect [electron donating effect through resonance].
- ii) -R effect [\bar{e} withdrawing effect through resonance].

Criteria / Condition for +R effect: (of the group)

\Rightarrow Molecule must undergo resonance.

\Rightarrow central atom of the group must have at least one lone pair of electron.



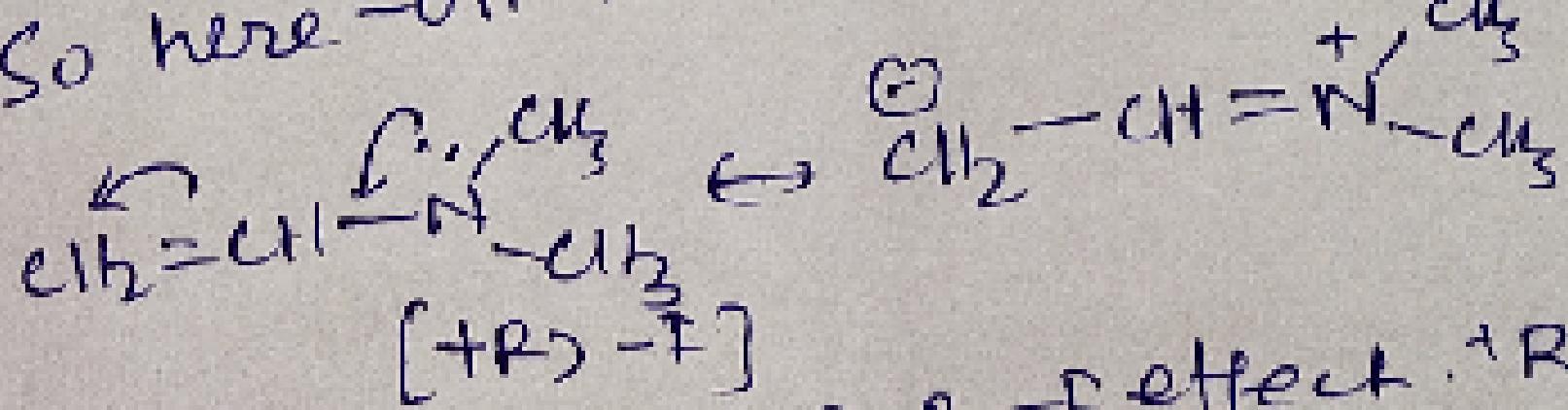
(+R) Here -OH shows +R effect & -I effect; through -I effect it withdraws \bar{e} bonded to C & through +R effect it donates its lone pair of \bar{e} .

But for -OH $[-I > +R]$. So -OH is \bar{e} donating effect.

$\text{CH}_3-\text{CH}_2-\text{OH}$ (-I effect only).

Here -OH group does not show +R effect because there is no resonance. It shows only -I effect.

So here -OH has \bar{e} withdrawing effect.

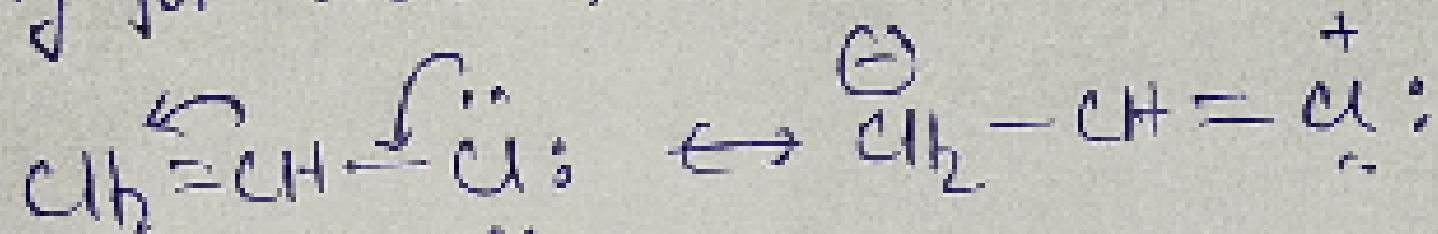


(+R) -I effect. Here $\text{N}\left(\text{CH}_3\right)_2$ shows +R & -I effect. $+R > -I$ effect.

Here $\text{N}\left(\text{CH}_3\right)_2$ shows +R & -I effect. $+R > -I$ effect.

So $-\text{N}(\text{CH}_3)_2$ is \bar{e} donating group.

but $\text{CH}_3\equiv\text{CH}-\text{N}(\text{CH}_3)_2$ [Here $-\text{N}(\text{CH}_3)_2$ shows $-I$ effect only (6) because there is no resonance].
 Only for halide, $-I > +R$ effect. [except halide, if Other group shows $+R < -I$ effect then $+R > -I$ effect].



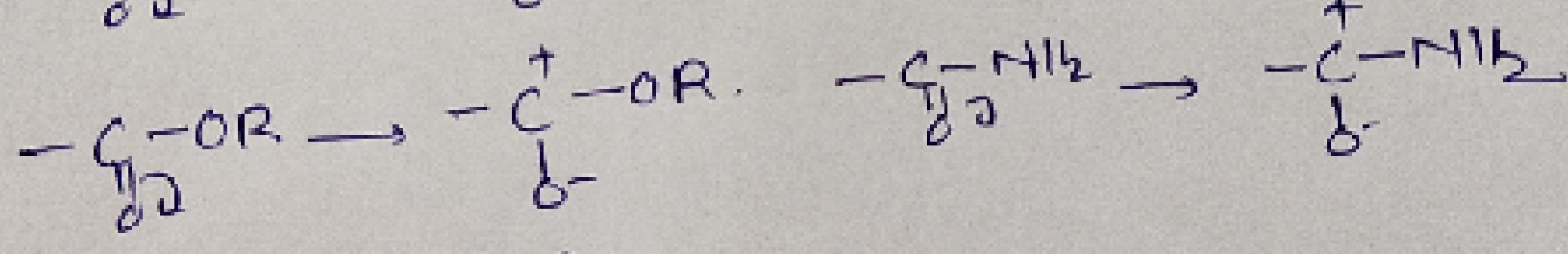
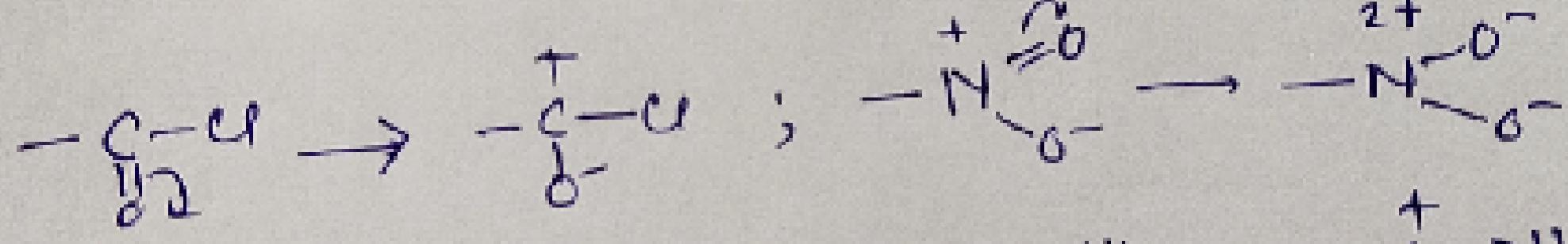
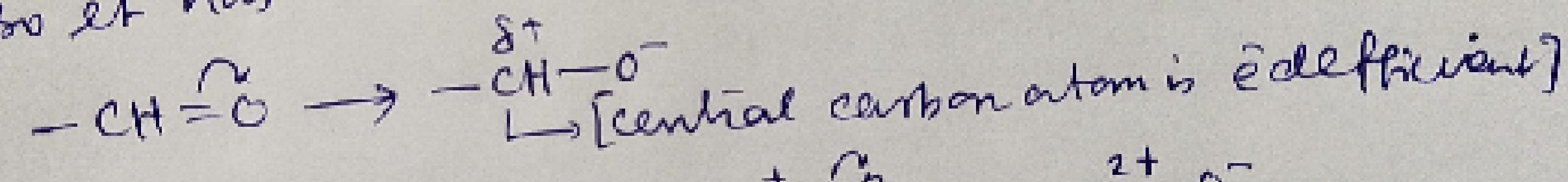
(+R effect).

Halide group is considered as δ withdrawing group.

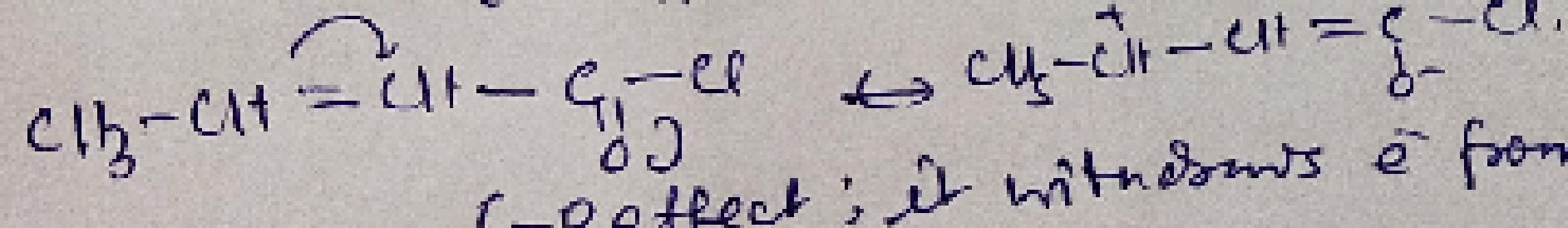
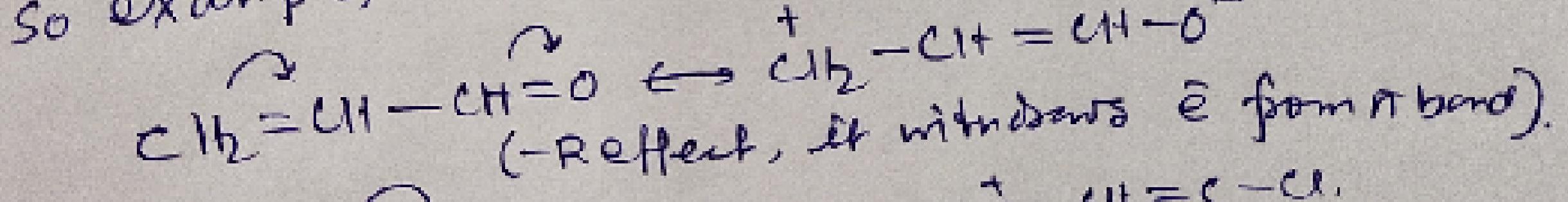
(Criteria/ condition for $-R$ effect (of the group)).

\Rightarrow Molecule must undergo resonance
 \Rightarrow Central atom of the group must be δ deficient
 (either it has δ^+ charge or it has full +ve charge).

In Polar multiple bond, central atom has δ^+ charge
 so it has $-R$ effect.



So examples are



[Points to be noted:

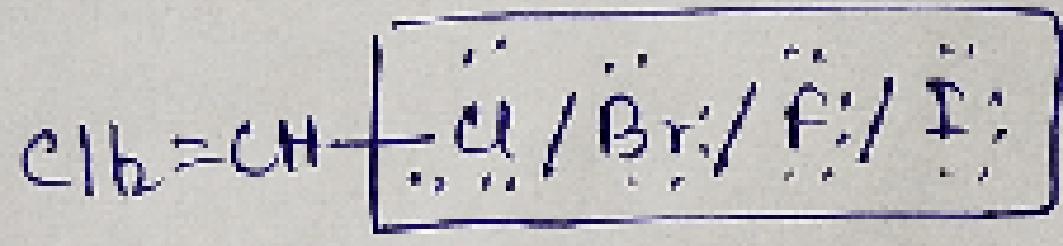
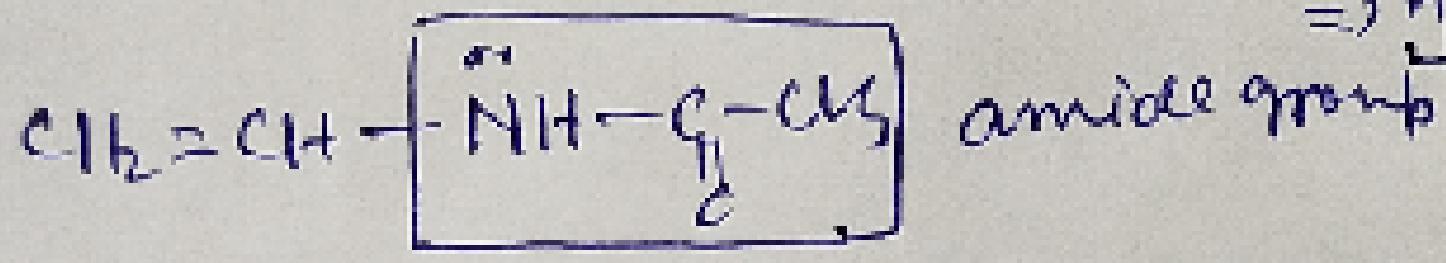
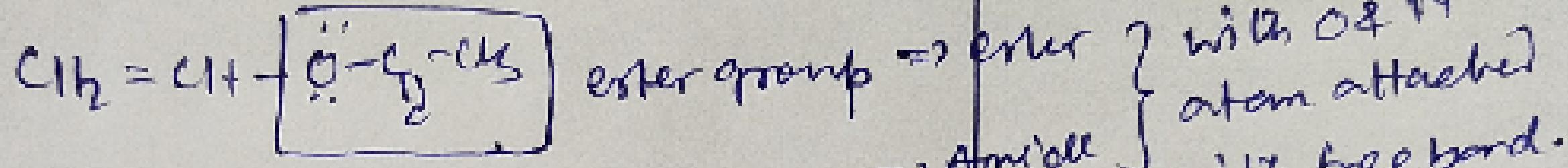
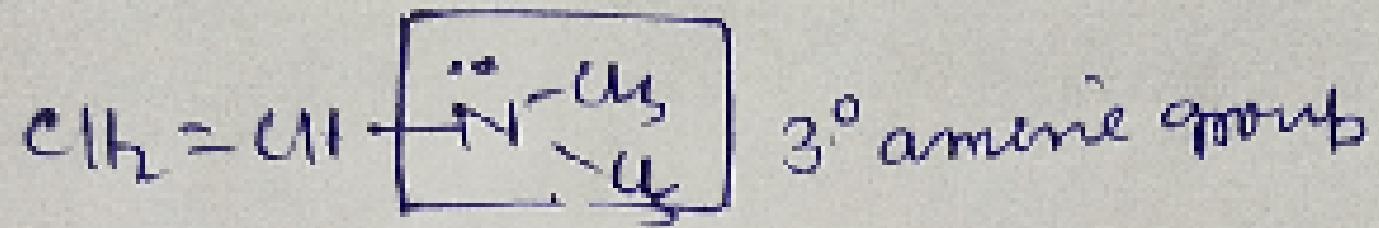
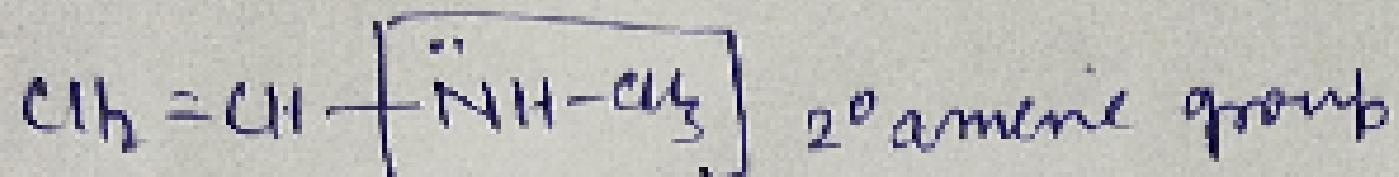
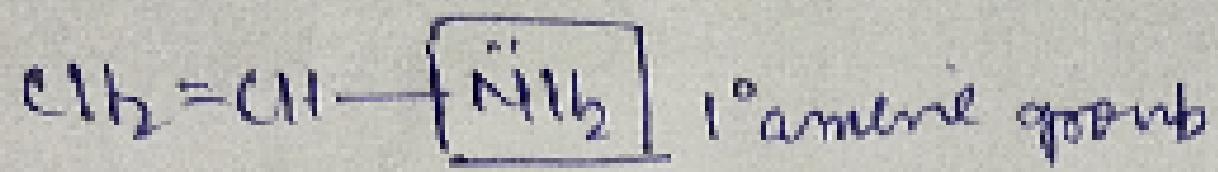
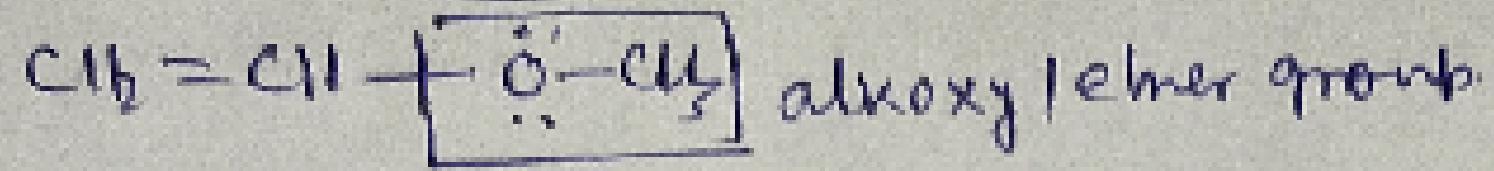
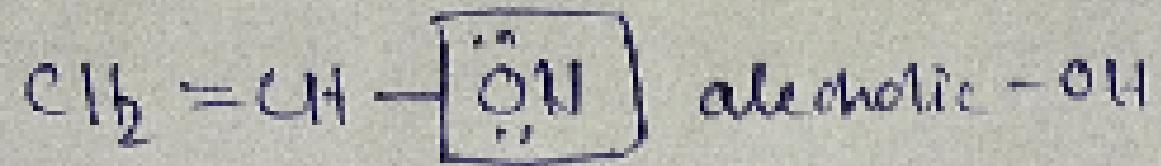
neutral N has one lone pair of δ .

neutral O has two lone pairs of δ .

neutral Halogen has three lone pairs of δ].

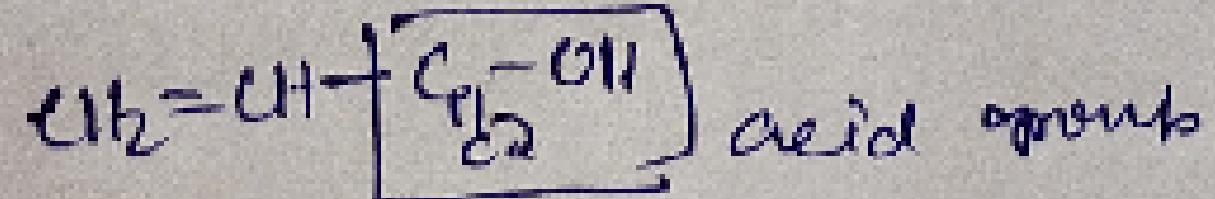
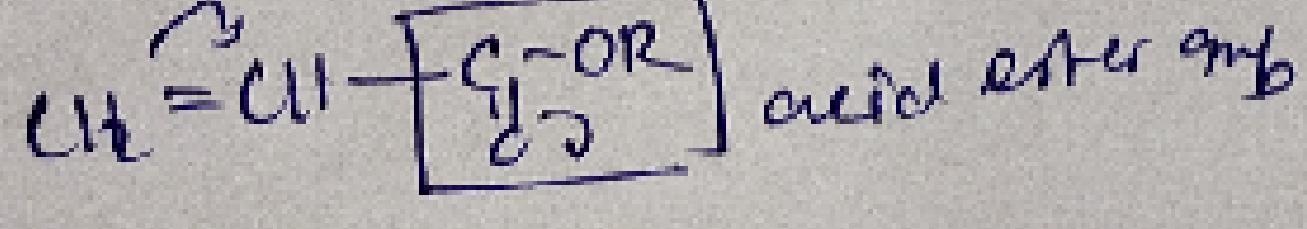
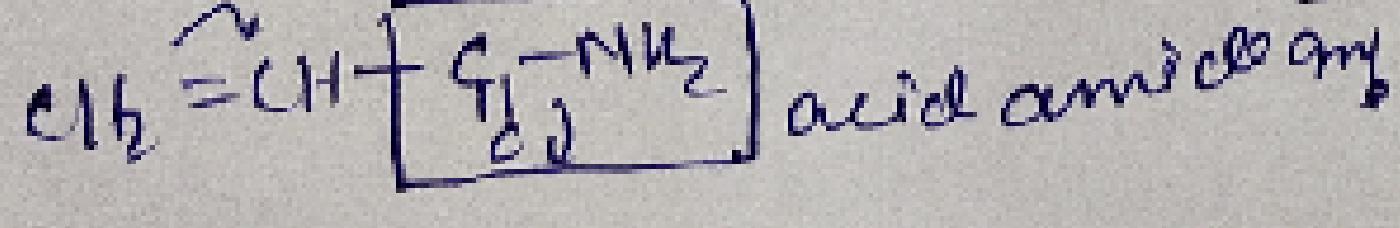
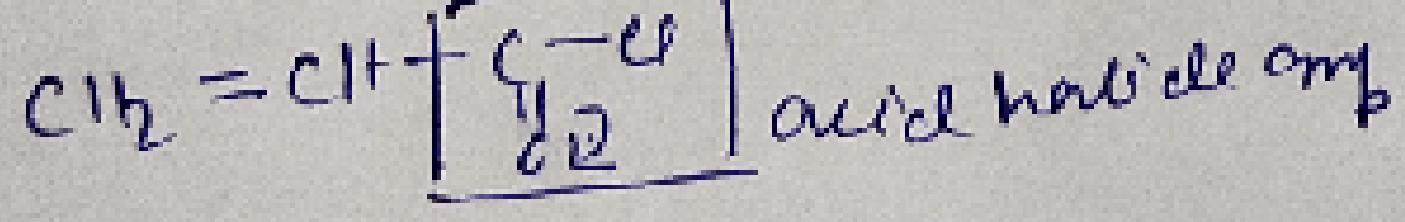
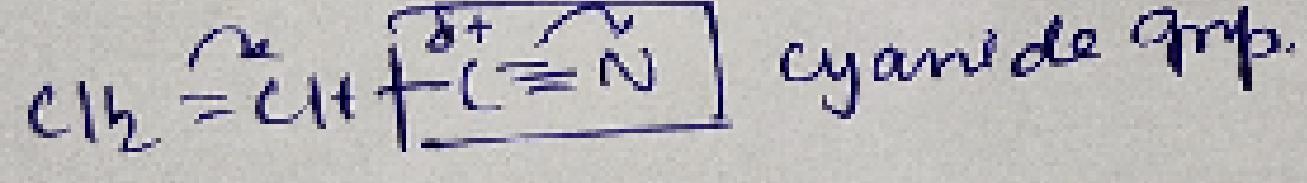
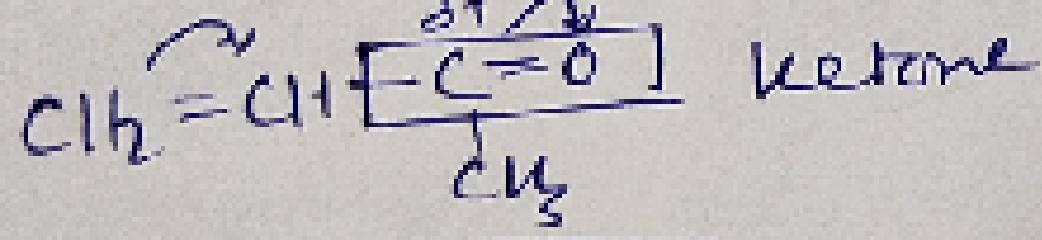
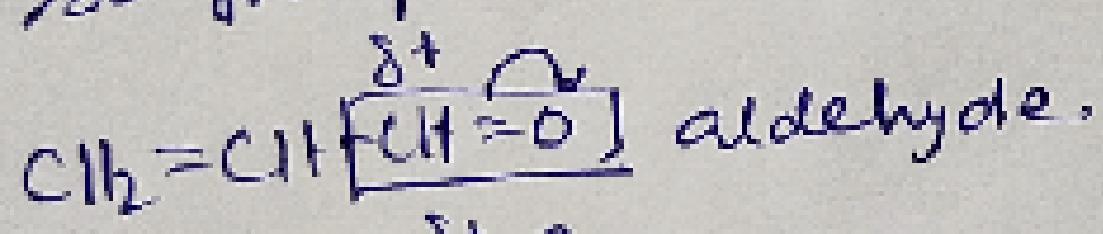
100 Groups showing +R effect.

(2)



They are considered as e⁻ with same group because -I > +R.

See graph showing -R effect.

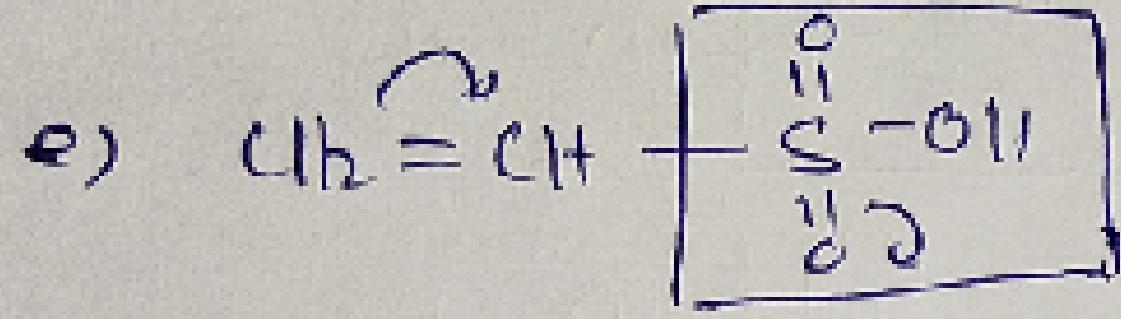
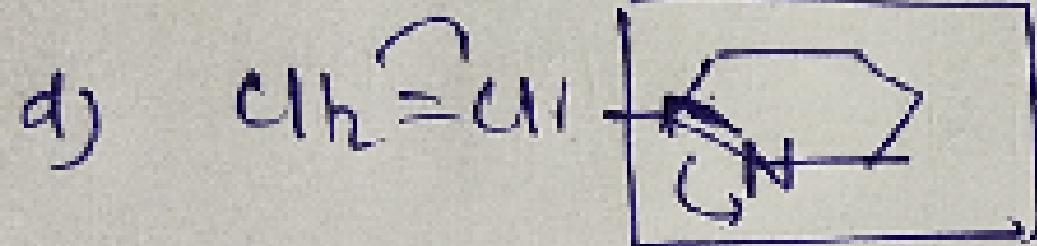
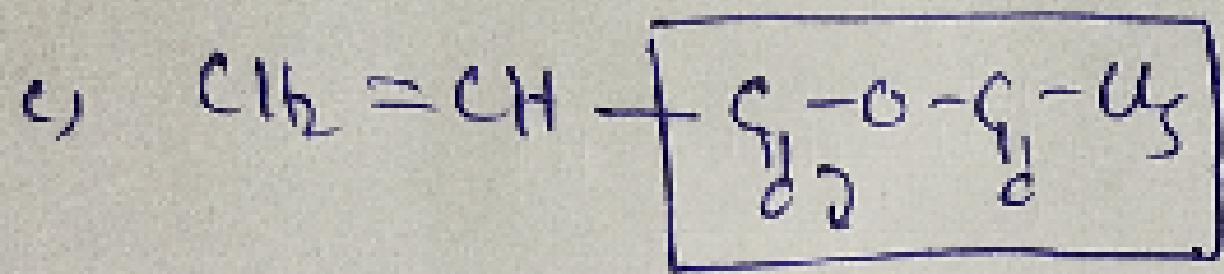
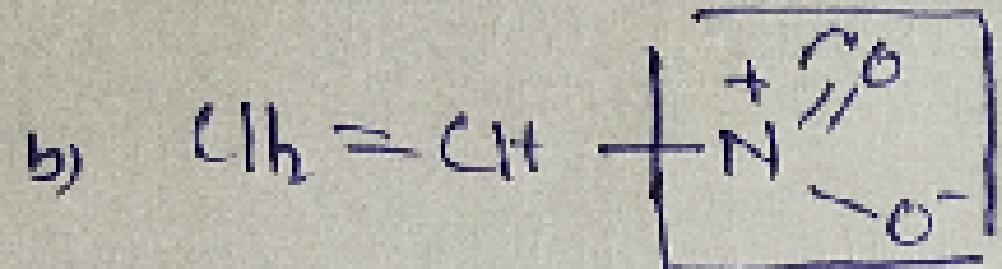
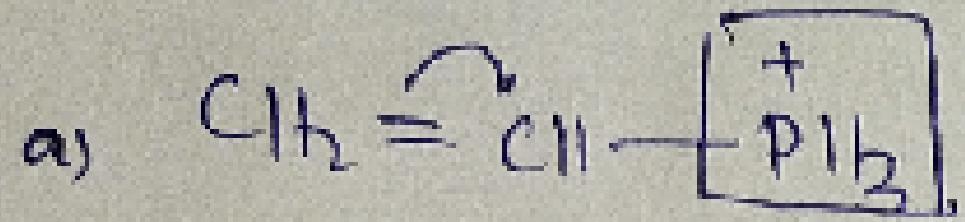


they all show - R P - I effect. because they all are example of multiple polar bond where $\delta+$ charge is on central atom of the group.

with $-C_2-$ is attached
with free bond.

They are considered as a withdrawing group.

Other examples of groups having -R effect: (8)



In all example, terminal carbon of double bond develops δ^+ charge. So these groups withdraw δ density from π bond. They are δ withdrawing through resonance. That's why they show -R effect. They also show -I effect. All groups showing -R effect always show -I effect.

: Points to be noted:

\Rightarrow Alkyl group does not show resonance effect.

$\text{CH}_2 = \text{CH} + \boxed{\text{CH}_3}$ \leftrightarrow no resonance because sp^3 carbon cannot undergo resonance.

\hookrightarrow It shows +I effect.

$\text{CH}_2 = \text{CH} + \boxed{\text{CH}_2\text{CH}_3 / \text{Propyl} / \text{Butyl}}$ no resonance, no R effect shows +I effect.

$\Rightarrow \text{CH}_2 = \text{CH} - \text{Ph}$ can show both effect

$\boxed{\text{CH}_2 = \text{CH}}$ \hookrightarrow It shows +R effect

It shows -R effect

\hookrightarrow It shows +R effect

$\boxed{\text{CH}_2 = \text{CH} - \text{C}=\text{O}}$ \hookrightarrow It shows -R effect

It shows +R effect

+

$\Rightarrow \boxed{\text{CH}_2 = \text{CH} - \text{Ph}}$ Here -Ph shows -R effect. $\hookrightarrow \boxed{\text{CH}_2 = \text{CH}^{(+)}}$ $\leftarrow \dots$

$\text{e} = \text{N}$ (shows -R effect)



Here -Ph shows +R effect. $\hookrightarrow \boxed{\text{CH}_2 = \text{CH}^{(+)}}$ $\leftarrow \dots$

$= \text{N}^-$

+

Rules of resonance:

(9)

(1) Cyclic delocalisation $(4n+2)\pi\text{es}$ is more stable than acyclic delocalisation of $(4n+2)\pi\text{es}$. [$n=0, 1, 2, 3 \dots$ any +ve integer]

f

(2) Cyclic delocalisation of $4n\pi$ is less stable than acyclic delocalisation of $4n\pi\text{es}$.

[$n=0, 1, 2, 3 \dots$ any +ve integer]

Cyclic compounds

Aromatic	Antiaromatic	Nonaromatic
\Rightarrow cyclic	\Rightarrow cyclic	\Rightarrow cyclic str
\Rightarrow Planar.	\Rightarrow Planar	\Rightarrow If es are
= All es inside the ring is delocalised.	\Rightarrow All es inside the ring is delocalised	not delo calised
$\Rightarrow (4n+2)\pi\text{es}$.	$\Rightarrow (4n\pi\text{es})$ (n is +ve integer)	\Rightarrow not parti cipating reso in entire ring.
Hückel's Rule.	\Rightarrow very unstable	
\Rightarrow very stable	\Rightarrow Unstable at room temperature.	
$\Rightarrow n=0$ or any +ve integer		$\Rightarrow 4\pi, 8\pi, 12\pi\text{es} \dots$
$\Rightarrow 2\pi, 6\pi, 10\pi, 14\pi\text{es} \dots$ (cyclic delocalised)		(cyclic delocalised)

Points to be noted:

\Rightarrow C_6^+ (carocation) is sp^2 hybridised.

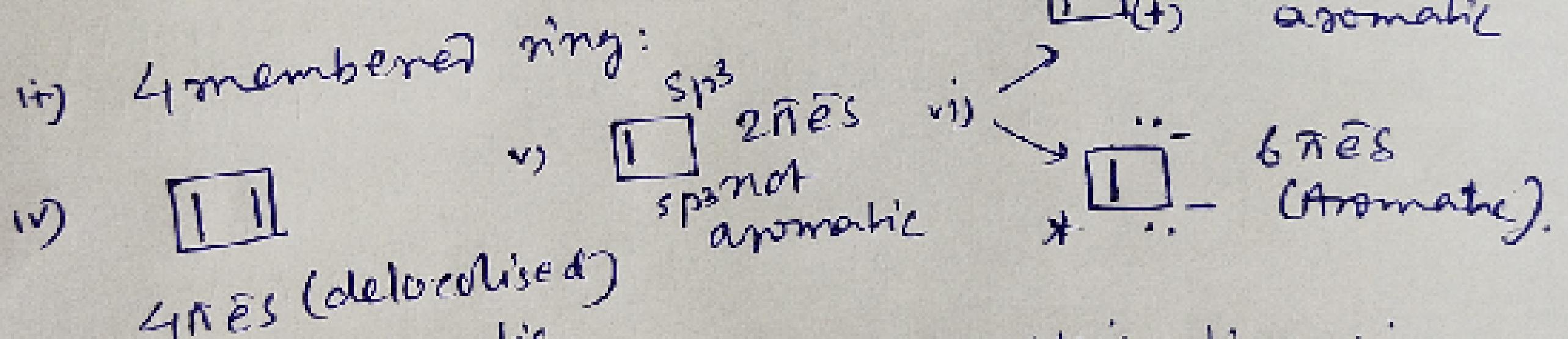
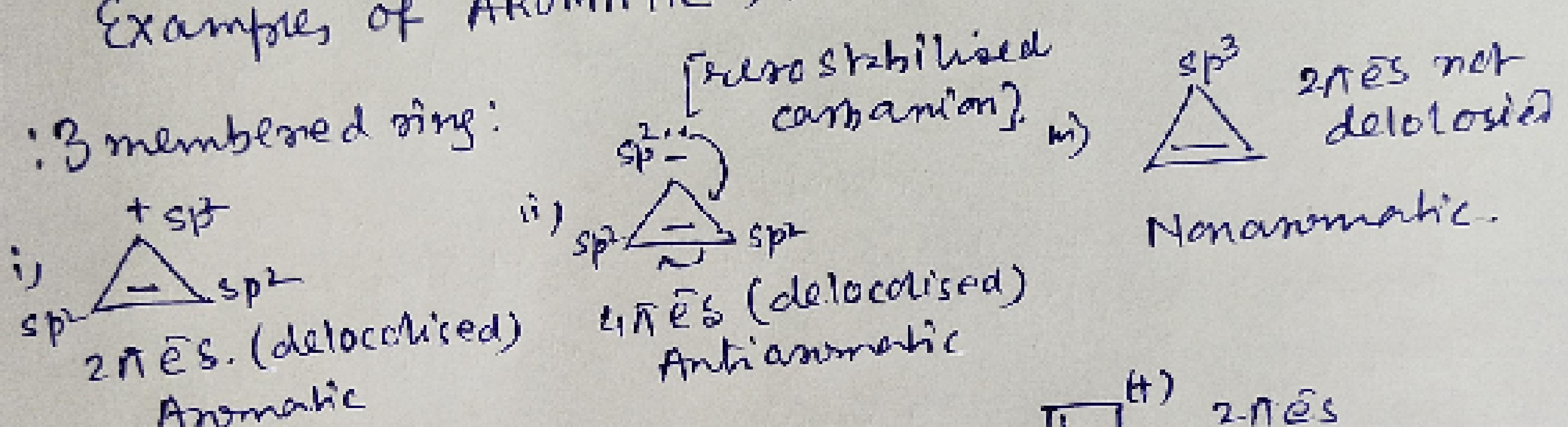
\Rightarrow C_6^- (Carbanion) is sp^3 hybridised but if

resonance stabilised carbanion is present, then it is sp^2 hybridised.

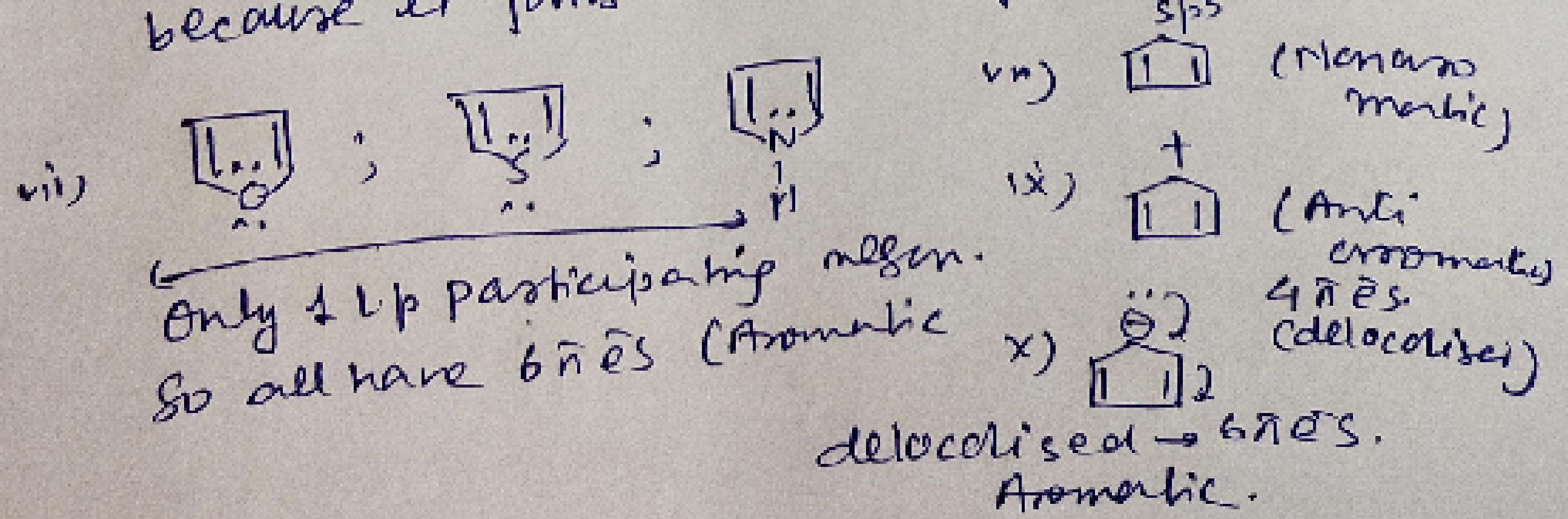
\Rightarrow $\text{O}^{\text{I/S}}$ has two lone pair of es , but only 1 lone pair of e is participating in resonance.

- ⇒ If any of the ring atom is sp^3 hybridised, then (10) the cyclic molecule is nonaromatic because π bonding does not occur in entire ring.
- ⇒ If in some region, molecule loses planarity then resonance does not take place in cyclic ring, then cyclic ring is nonaromatic.
- ⇒ If electron outside the ring or lone pair on atom outside the ring should not be counted in determining aromaticity.

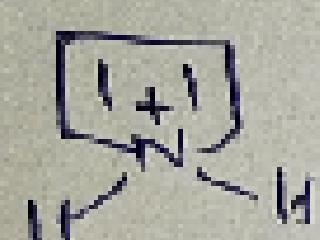
Examples of AROMATIC ; ANTIAROMATIC ; NONAROMATIC.



[* If lone pair on ring atom participating in resonance, it should be counted as π electrons because it forms π bond during resonance].



xii)



sp³ hybridized N.
So Nonaromatic

xiii)



[because boron has vacant p_z orbital so it takes e cloud from π bond]. (ii)
4π_{6s}
(Antiaromatic) delocalised.

xiv)



xv)



lone pairs (delocalised)
↓ Aromatic.

xvi)



6π_{6s}
Aromatic

xvii)



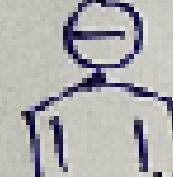
lone pairs
delocalised (Aro)

xviii)



lone pairs (delocalised)

xix)



(Aro)
(6π_{6s})

xx)



+
π_{6s}
Aro (6π_{6s})

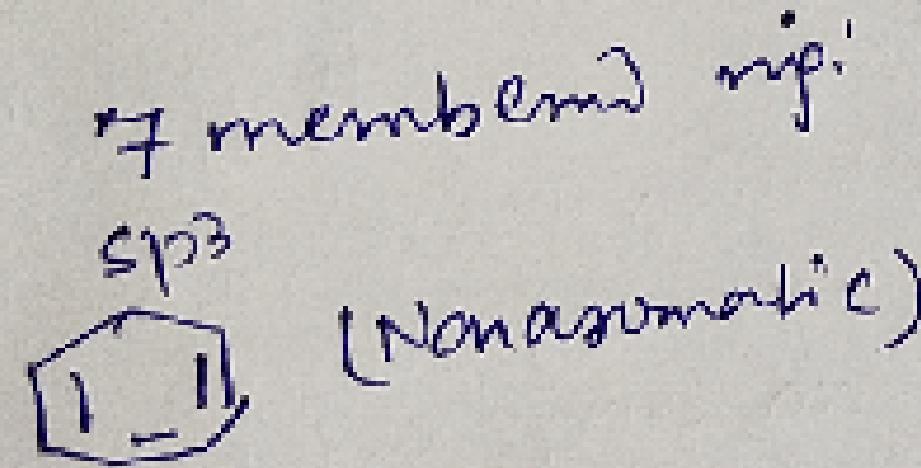


6π_{6s} (Here lone pair on N does not participate in res.)
participate in res.
Aromatic

[el_{1h} = CH → π_{1h} (This lone pair participates in res.)]

el_{2h} = NH [This lone pair does not participate in res.]

xxi)



7 members ring:
sp³
(Nonaromatic)

xxii)



Tropylium ion; very stable ion.

6π_{6s} (Aro)

xxiii)



8 members ring:
Nonaromatic
(Nonplanar).

xxiv)



6π_{6s}
(Aro)



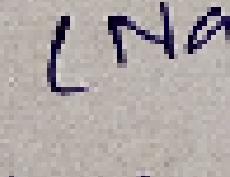
lone pairs
(aromatic)



sp³

Nonaromatic

xxv)



Nonaromatic
(Nonplanar).

Any aromatic ion (cation/ anion) very stable
⇒ Any antiaromatic ion (cation/ anion) very unstable
⇒ Any nonaromatic ion (cation/ anion) intermediate
Stability: AROMATIC > NONARO > ANTIAROMATIC

Other examples:

- 25) Antiaromatic (4πes)
- 26) Antiaromatic (4πes)
- 27) Aromatic (10πes)
- (12) Aromatic 2πes
- 28) Aromatic 2πes
- 29) 10πes (Nonaromatic)
πes not delocalised.
- 30) 10πes (nonaro)
πes not delocalised
- 31) Aro (10πes)
- 32) If any ring have one benzene ring then system whatever is the other ring, the system is aromatic?
- 33) C1h (Nonaromatic)
- 34) (Monaro)
- 35) (Nonaro)
- In all the molecules, sp² carbon is present in ring atom.
So πes is not delocalised. So nonaromatic.
- 36) (Inorganic benzene / Borazene / Aro
/ 6πes / delo (aromatic))
- 37) N1H2
N2C=NH2
N3C=NH2
Melamine.
(6πes, delo / Aromatic).
- 38) 6πes (Aromatic)
- 39) A bond outside the ring is not counted in delocalisation
- 40) (6πes / Aro)
- 41) 6πes (Aro)
- 42) 6πes (Aro)
- 43) (Aro)

- 44) + Aro (6πes)
- 52)
- All benzene derivatives are aromatic (13)
- 45)
- 53)
- 46)
- 54)
- squalene Acid (Aromatic)
- 47)

 Aromatic
- 55)
- 56)
 πes not delocalised
- 57)
- 58)
 [N¹ lone pair does not participate in resonance but N² lone pair participates in resonance]
- 49)
 [not counted in resonance]
- 50)
 [not counted in resonance]
- 59)
- 60)
- 51)
 → sp² hybridized

(47); (48); (53); 40; 41; (42) also called quasiaromatic.