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−I series

(*) Decreasing order of En/group En is known as −I series.

$$-\overset{\oplus}{N}F_3 > -\overset{\oplus}{N}R_3 > -\overset{\oplus}{N}H_3 > -NO_2 > -C\equiv N > -COOH$$

$$> -F > -Cl > -Br > -I > -COOR > -nR$$

$$> -OH > -NH_2 > -\overset{sp}{C}\equiv CH > -\text{C}_6\text{H}_5 > -\overset{sp^2}{C}H=CH_2$$

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+Inductive effect :-

$\Rightarrow$ A/G which are electron donating are known as +I groups.

or

$\Rightarrow$ - - - - -

$$\gamma_{A/G} < \gamma_H$$

+I series decreasing order of Electron donating Tendency.

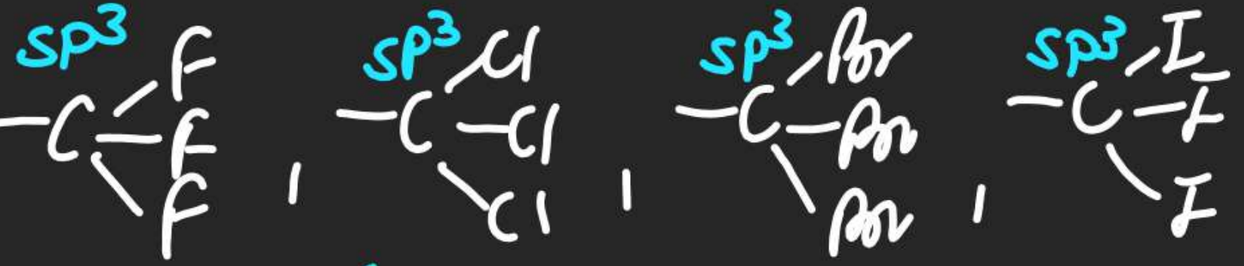
$$-\overset{\ominus}{C}H_2 > -\overset{\ominus}{N}H > -\overset{\ominus}{O} > -C(=O)-O^{\ominus}$$

$$> -C(CH_3)_3 > -CH(CH_3)_2 > -CH_2-CH_3 > -CH_3 > -T > -D > -H$$

Ex: Arrange following in ↓ order of I effect

(i) $-F$, $-Cl$, $-Br$, $-I$ (−I effect)

(I > II > III > IV)

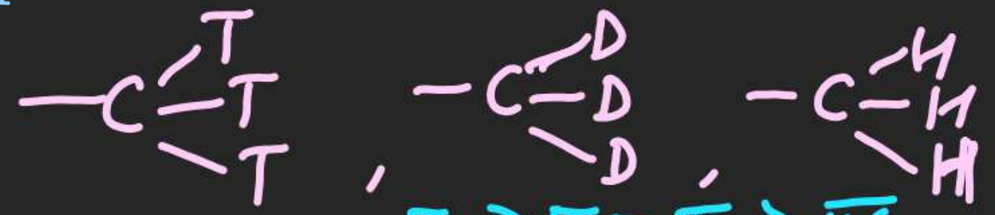
(ii) 

(−I effect)

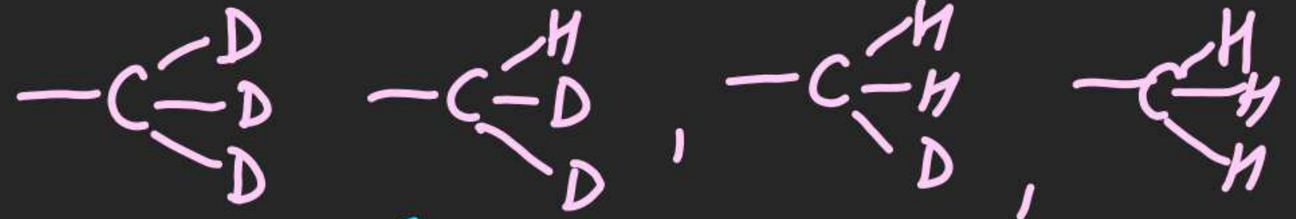
(I > II > III > IV)

(iii) $-T$, $-D$, $-H$ (+I effect)

(I > II > III)

(iv)  (+I effect)

I > II > III > IV

(v) 

(I > II > III > IV)

(vi) $-CH_2-CH_3$, $-CH_3$, $-H$ (+I effect)

(vii) $-CH_2-CH_2-CH_3$, $-CH_2-CH_3$, $-CH_3$

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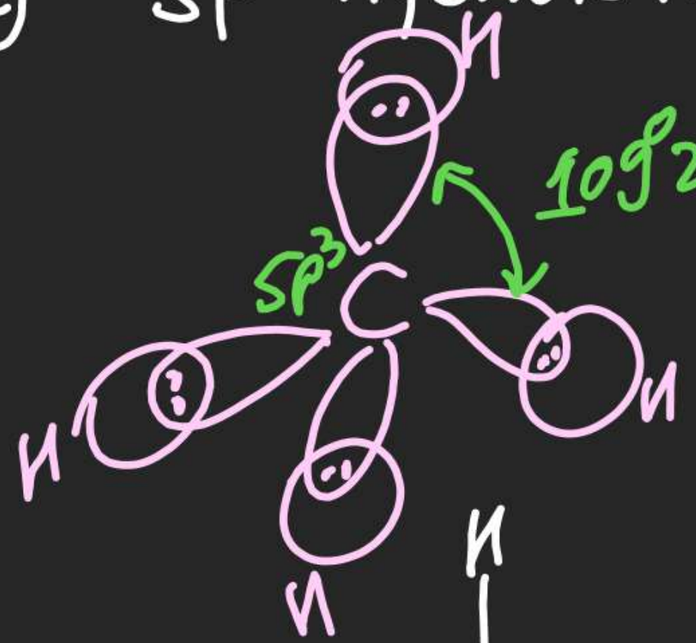
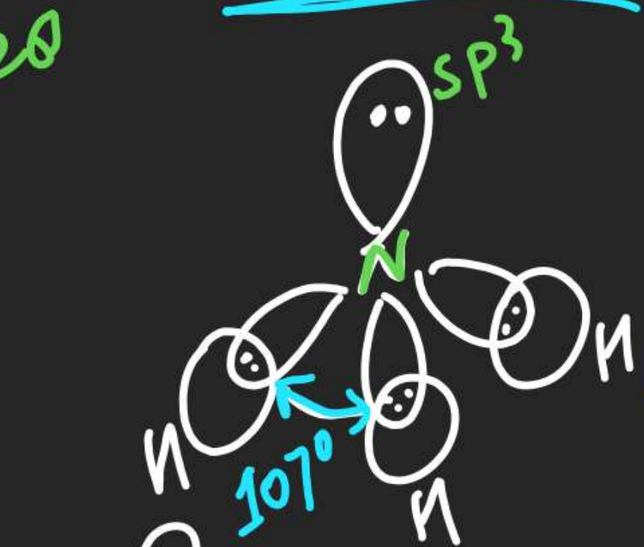
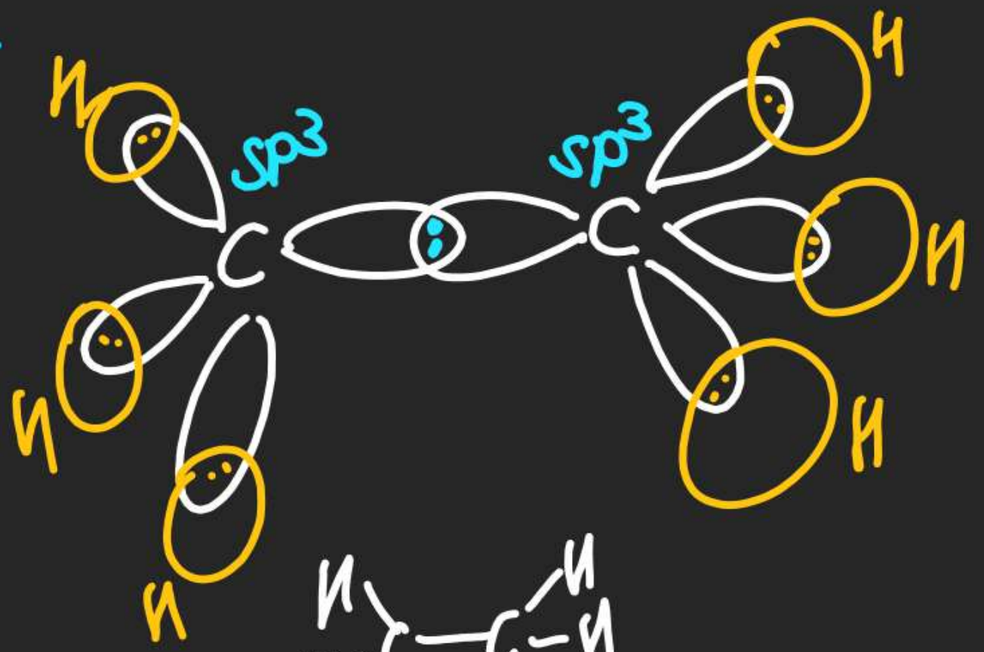
Ex :- Explain why I effect is applicable only on σ eg.

(#) sp^3 hybridisation ⇒ Atom must have 4 hybridised orbital
⇒ 4 σ Bond





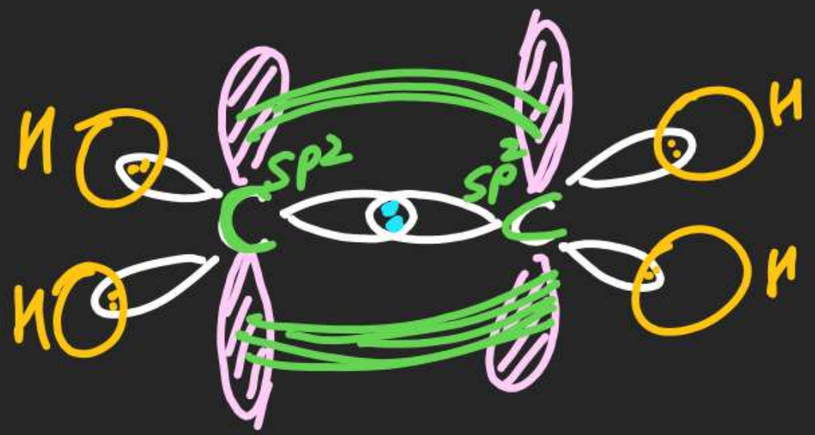


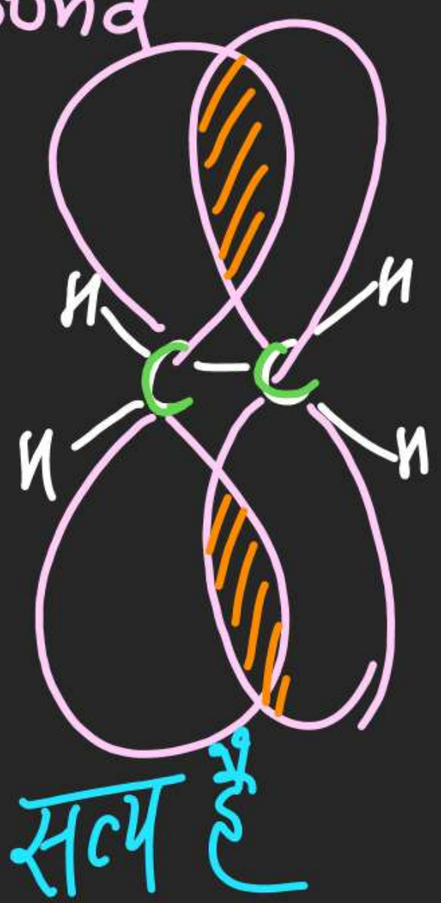
(#) sp^2 hybridisation

⇒ 3 hybrid sp^2 orbital & 1 unhybridised "p" orbital

⇒ 3σ Bond + 1π Bond

⇒ B·A = 120°



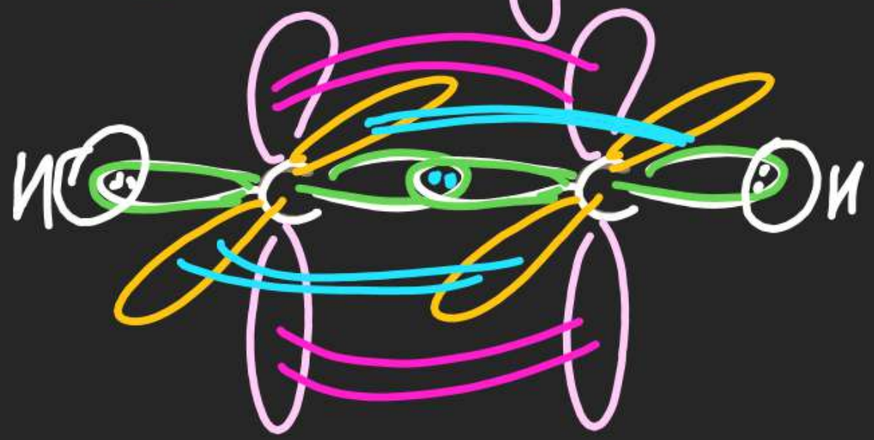


(#) SP hybridisation

$\Rightarrow$ 2 hybrid orbital + 2 unhybrid orbital (P_y, P_z)

$\Rightarrow$ ($2\sigma + 2\pi$) Bond

$\Rightarrow$ Bond Angle = 180°



H—C≡C—H

For sp:
$\cos\alpha = -\frac{1}{c}$

SP $\Rightarrow \cos\alpha = -1$
$\Rightarrow \alpha = 180°$

$sp^2 \Rightarrow \cos\alpha = -\frac{1}{2}$
$\Rightarrow \alpha = 120°$

$sp^3 \Rightarrow \cos\alpha = -\frac{1}{3}$
$\Rightarrow \alpha = 109°28'$

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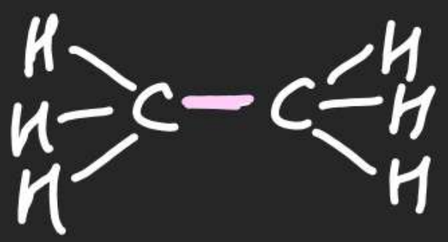
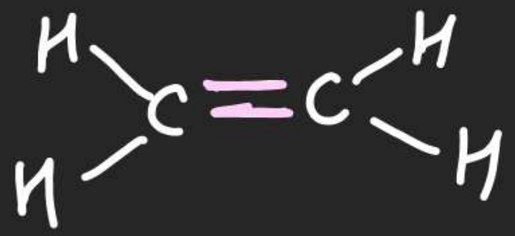
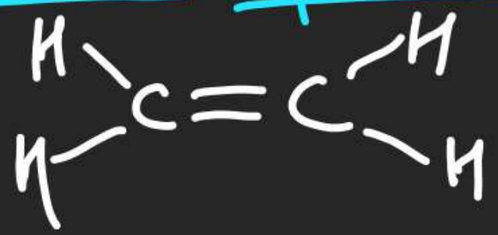
		BO(C–H)	BO(C–C)
(1)		1	1
(2)		1	2
(3)		1	3
(4)			

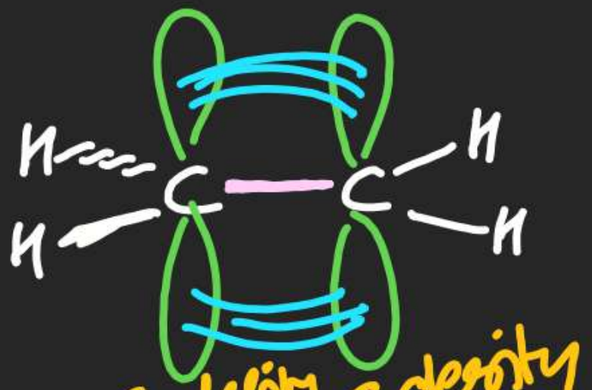
$BO_{C-H} \in (0,1)$

$BO_{C-C} \in (1,2)$ or $BO_{C-C} \in (2,3)$

Orbital Diagram :-

(5)



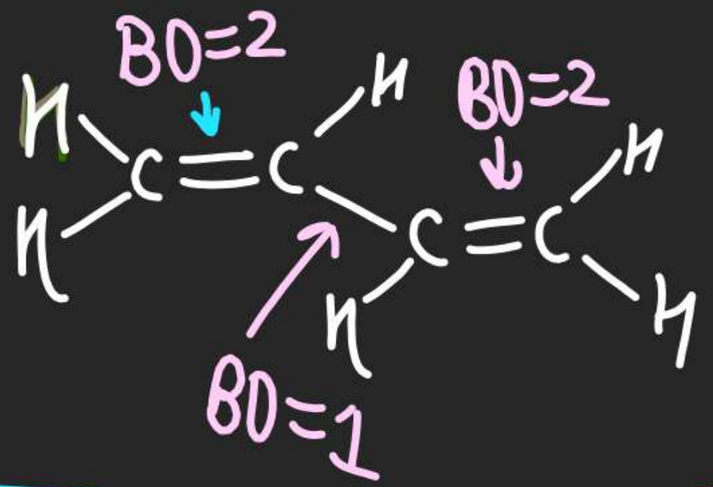


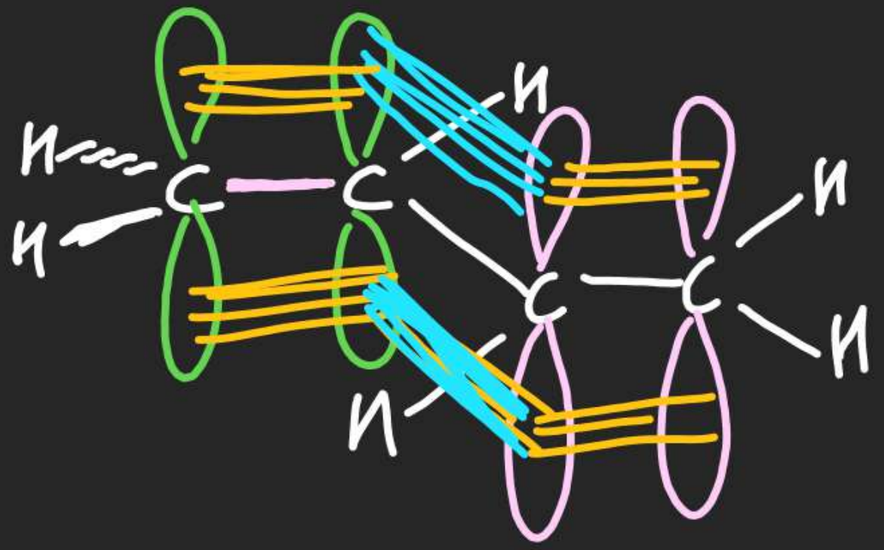
σ electron σ density

$BO = 1 + 1$

$= 2$

(6)





$BO(C-C) \in (1, 2)$

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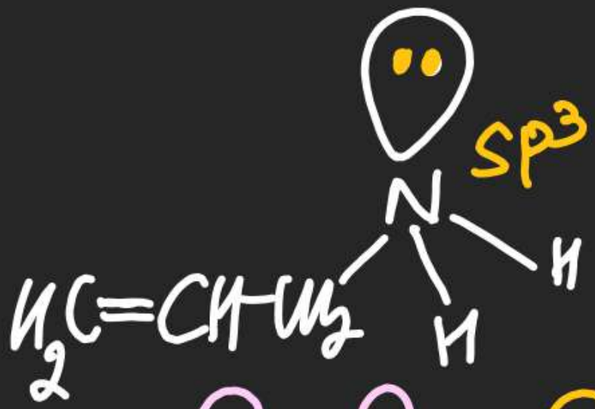
(7) $\overset{sp^3}{H_3C}-\overset{sp^3}{CH_2}-\overset{sp^3}{CH_2}-\overset{sp^3}{\ddot{N}H_2}$

localised lone pair

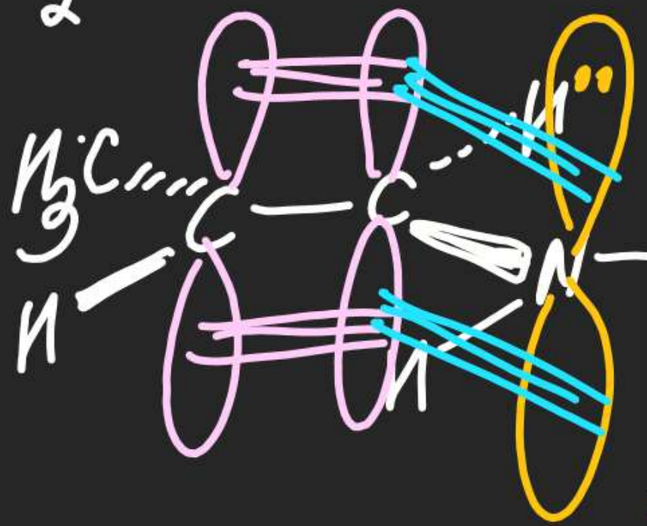
(8) $\overset{sp^2}{H_2C}=\overset{sp^2}{CH}-\overset{sp^3}{CH_2}-\overset{sp^3}{NH_2}$



localised lone pair

(9) $\overset{sp^3}{H_3C}-\overset{sp^2}{CH}=\overset{sp^2}{CH}-\overset{sp^2}{\ddot{N}H_2}$

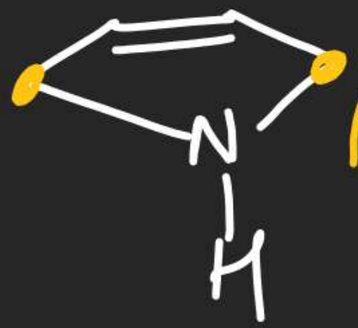
Simply Bonded



Delocalised lone pair

Note: If Singly Bonded lone pair atom contains "p" orbital on adjacent atom then that lone pair atom is "sp^2" hybridised & its one lone pair must be present in "p" orbital.

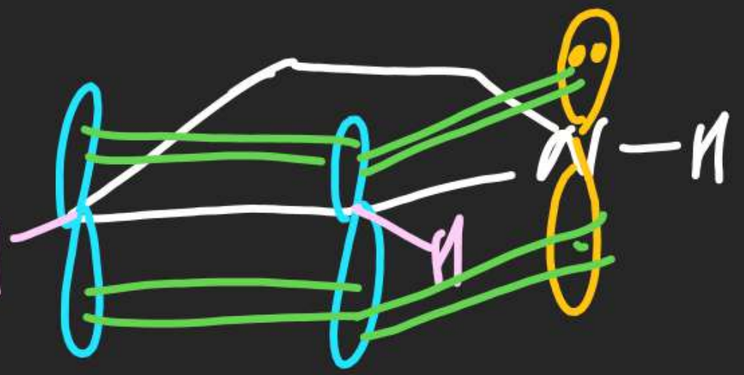
(10)



Localised lone pair

(11)

Delocalised lone pair

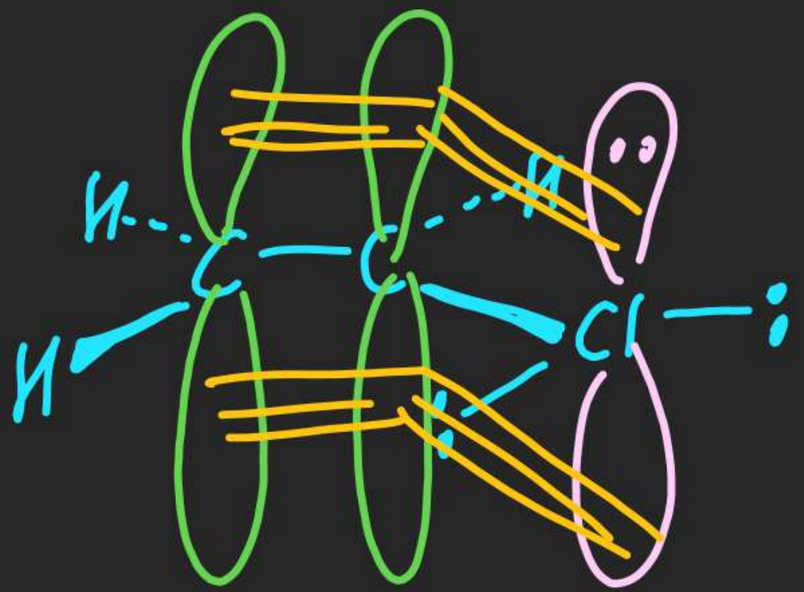


$\therefore$,

(12)

(a) $CH_3-CH_2-Cl + NaOH \longrightarrow CH_3-CH_2-OH + NaCl$

(b) $CH_2=CH-Cl + NaOH \longrightarrow$ NO Rx^n

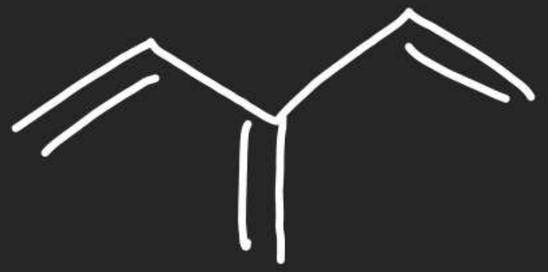


(13) 

(14) 

(15) 

(16) 

(17) 

(18) 

(19) 

(20) 

(21) 

(22) $\overset{\oplus}{C}F_3$

(23) $\overset{\ominus}{C}Cl_3$

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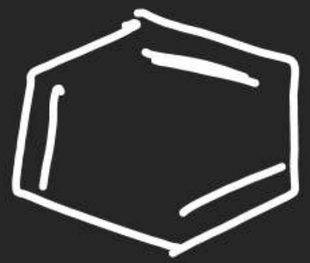
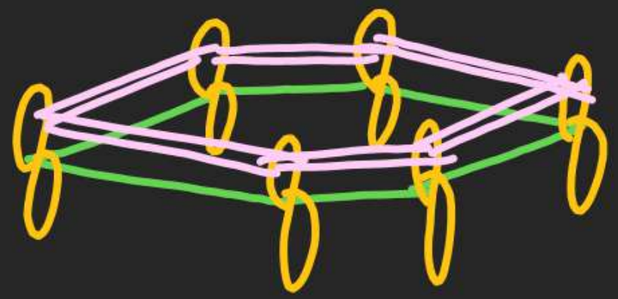
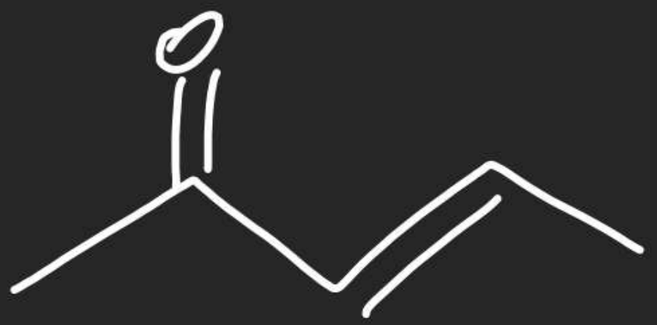
(24)



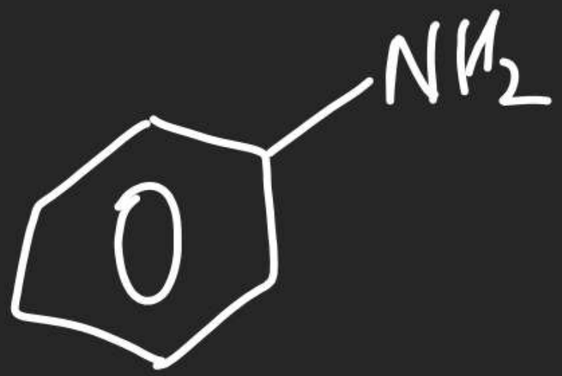
BO = 1.5



(25)



(26)



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(27)

(28)