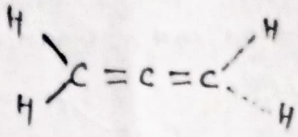
(7) Point group D_{nd} :-

The D_{nd} group are generated by the association of the D_n ($C_n + nC_2$) elements with n dihedral Planes ($n\sigma_d$)

(a) D_{2d} — D_{2d} Point group Contains

E, $3C_2$ (Mutually Perpendicular) and S_4

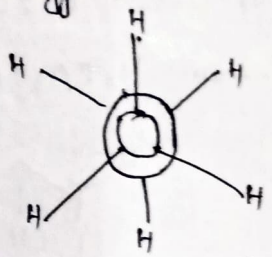
example:. Allene, Cyclo Octatetraene



Allene

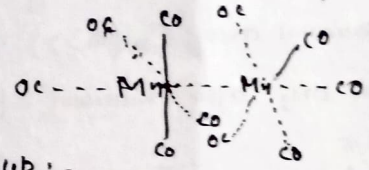
(b) D_{3d} :- D_{3d} Point group Contains E, $2C_3$, $3C_2$, S_6, i, $3\sigma_d$

example :- Staggered Ethane, Cyclo hexane



(c) D_{5d} :- D_{5d} Contains , E, $4C_5$, $5C_2$, $5\sigma_d$

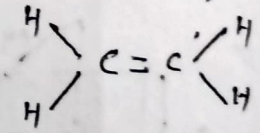
Example $Mn_2(CO)_{10}$, Manganese deca Carbonyl , staggered ferrocene



(8) D_{nh} Point group :- The D_{nh} groups are generated by the association of D_n ($C_n + nC_2$) with σ_h and Improper axes also.

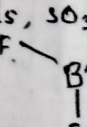
(a) D_{2h} :- D_{2h} Contains E, C_2, $2C_2$, $2\sigma_v$, σ_h, i

example :- C_2H_4, N_2O_4 (Planar), $C_2O_4^{--}$, trans $Pt(NH_3)_2Cl_2$, Para $(C_6H_4X_2)$ of Naphthalene



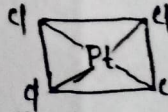
(b) D_{3h} :- D_{3h} Contains E, $2C_3$ $3C_2$, $3\sigma_v$, σ_h, $2S_3$

example:. BF_3, PF_5, PCl_5, SO_3, BCl_3, CO_3^{2-}, NO_3^-, C_2H_6 (eclipsed), Planar Tibromo Benzene



(c) D_{4h} :- It contains E, $3C_4$, $4C_2$, $4\sigma_v$, σ_h, i, $2S_4$

example:- $[PtCl_4]^{2-}$, $[Ni(CN)_4]^{2-}$ trans-SF_4Cl_2, Trans MA_4B_2



(d) D_{5h} :- It Contains. E, $4C_5$, $5C_2$ $5\sigma_v$, σ_h, $2S_5$

example:. Cyclo Pentane, eclipsed ferrocene.

(e) D_{6h} :- It Contains E, $5C_6$, $6C_2$ $6\sigma_v$, σ_h, $2S_6$, i

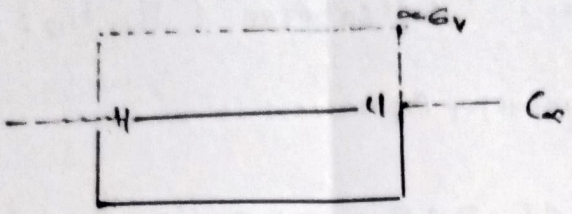
example:- Benzene,

Point group $C_{\infty v}$:—

The linear molecules have infinite rotational axis (C_∞) and infinite number of vertical Planes ($\infty \sigma_v$).

$C_{\infty v}$ Contains E, C_∞ and $\infty \sigma_v$

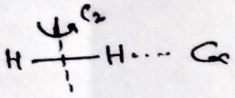
Example:- HCl, HCN, CO, HBr, NO etc.



$D_{\infty h}$ Point Group :—

$D_{\infty h}$ Point group Contains E, C_∞, ∞C_2, $\infty \sigma_v$, σ_h, i

Example, H_2, Br_2, Cl_2, $CH \equiv CH$, CO_2, $BeCl_2$, XeF_2



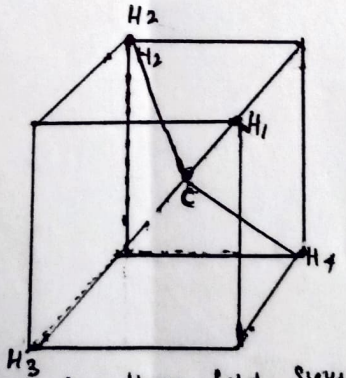
Point group T_d :- Regular tetrahedral molecules belong to T_d Point group.

example:- CH_4, CCl_4, $Ni(CO)_4$, $SiCl_4$, $[Zn(CN)_4]^{2-}$

Total Symmetry Operation in T_d :- E, $8C_3$, $3C_2$, $6S_4$, $6\sigma_d$ = 24

$1 + 8 + 3 + 6 + 6 = 24$

Symmetry Operations are illustrated as follows :-



(a) There are four axes for three fold symmetry each passing through C-atom and one H-atom. i.e $4C_3^1$, $4C_3^2$

(b) There are three axes of two fold symmetry each passing through the Centre of opposite eges.

i.e $H_1 - H_2$ and $H_3 - H_4$; $H_2 - H_3$ and $H_1 - H_4$, $H_2 - H_4$ and $H_1 - H_3$

(c) Each of the C_2 axes is also S_4 and S_4 is S_4^1, $2S_4^2$, Hence 6 S_4 are present.

(d) There are six planes of Symmetry each passing through one edge and Centre of opposite edges.

2) Point group O_h :- Regular octahedral molecules have O_h Point group

Example :- SF_6 $[PtCl_6]^{--}$ $[Co(NH_3)_6]^{3+}$

Total Symmetry Operations in O_h is as follows.

E, $6C_4$, $3C_2(C_4^2)$, $8C_3$, $6C_2$, $6S_4$, $8S_6$, $6\sigma_v$, $3\sigma_h$, i

$= 48$

) Point group I_h : —

Regular icosahedral molecules belongs to point group I_h.

Example :- Dodecaboran $(B_{12}H_{12})^{2-}$, [MoC

Total Symmetry Operations : ——

[E, $24C_5$, $24S_{10}$, $20C_3$, $20S_6$, $15C_6$, 156

= 120

For BF_3 Show that

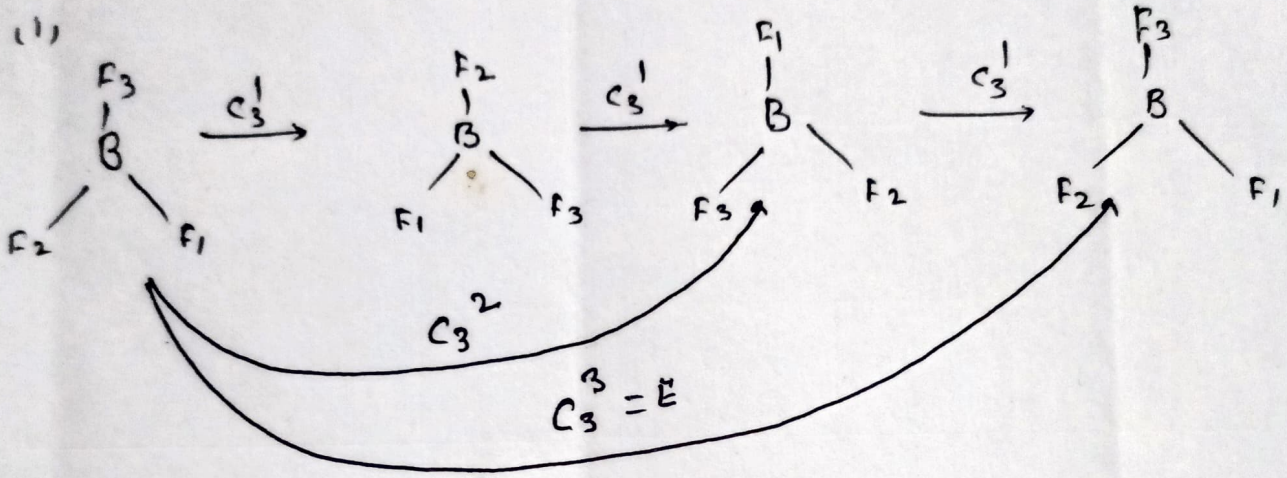
(i) $C_3^3 = E$

& (ii) $C_3^2 = C_3^{-1}$

Ans:-

BF_3 molecule has a C_3 hence

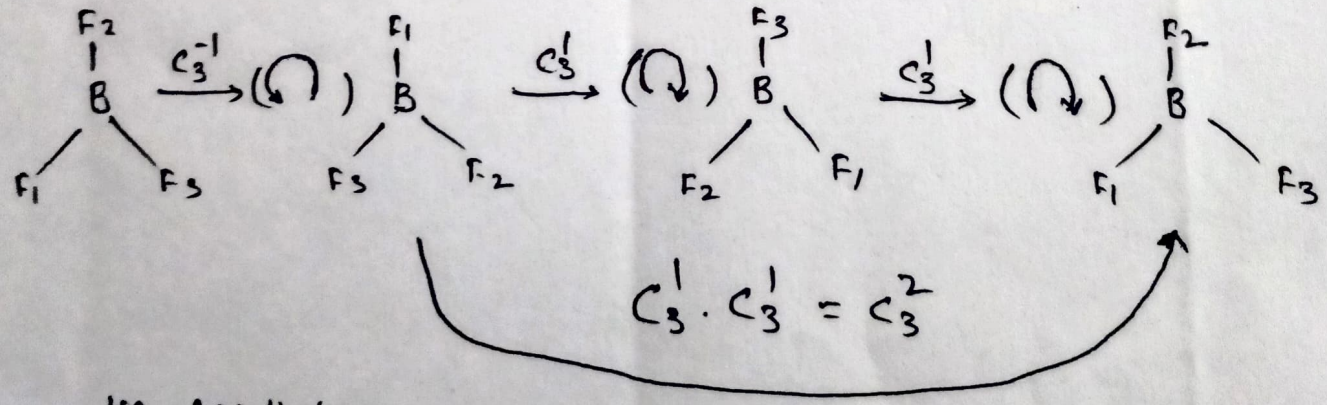
(i)



C_3^1 and C_3^2 show a rotation of 120 & 240 around C_3 axis, Hence:-

$$C_3^1 \cdot C_3^1 \cdot C_3^1 = C_3^3 = C_n^n = E$$

(ii) The C_3^2 operation i.e rotation of 240° around a C_3 axis is identical to a counter clockwise rotation of 120° which is C_3^{-1}



He see that:-

$$C_3^2 = C_3^{-1}$$

In other words, the clockwise rotation of $120 \times 2 = 240°$ around a C_3 axis, i.e C_3^2 is identical to the anti clockwise rotation of 120° i.e C_3^{-1} for a BF_3 molecule.