How molecules are classified on the basis of their point groups!

Give examples of molecules belonging to the point Groups C_1, C_s, C_i, C_{2v}, C_{3v}, C_{4v}, C_{2h}, C_{3h}, D_3, D_{2d}, D_{3d}, D_{3d}, D_{2h}, D_{3h}, D_{4h}, D_{5h}, D_{6h} $C_{\infty v}$, $D_{\infty h}$, T_d, O_h and I_h.

Molecules may be of high symmetry or may be of low symmetry. Symmetry of the molecule can be judged using the symmetry elements and symmetry operations present in them.

All the symmetry operations present in molecule forms a group.

A molecular group is called as a point group.

The symmetry group or a point group of a molecule is denoted by a specific symbols.

This symbols was introduced by Schoenflies.

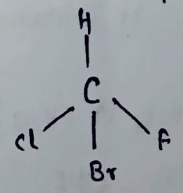
Several molecules have the same set of operation and hence, belong to the same point group.

But different set of operations belongs to the different point groups.

Classification of Molecules on the basis of their Point groups

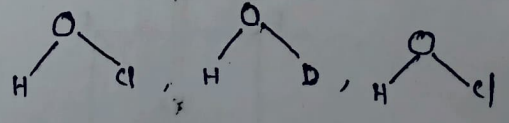
(1) Point group C_1 :- Molecules having no other symmetry elements except identity (E) belong to this group. This group has an onefold proper axis of rotation (C_1) and includes all molecules possessing one symmetric atom.

Example :-



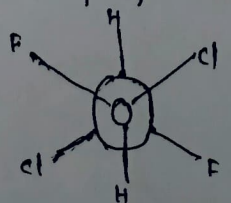
(2) Point group C_s :- This group has only two elements of symmetry i.e E (identity) and σ (Plane of Symmetry)

Example :-

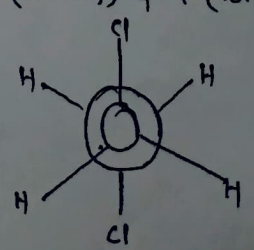


(3) Point group C_i :- This group has only two elements of symmetry, i.e E (Identity) & i (Point of Symmetry)

Examples :-



1,2 - Dichloro - 1,2 - difluoro ethane

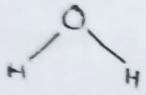


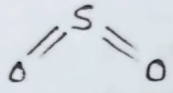
1,2 - Dichloro ethane

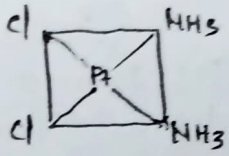
(4) Point group C_{nv} :-
The association of a rotational axis (C_n) with n vertical planes ($n\sigma_v$) generates C_{nv} point group. There are so many molecules which belong to C_{nv} point group.

(a) C_{2v} point group :- It contains E, C_2 and $2\sigma_v$

e.g. H_2O, SO_2, CH_2Cl_2, ClF_3, SO_2Cl_2
$SiCl_2Br_2$, $BClF_2$, C_6H_5X, $C_6H_4X_2$ (ortho & meta)
Cis $[Pt(NH_3)_4Cl_2]^{2+}$, Cis $[Pt(NH_3)_2Cl_2]$
Cis - H_2O_2

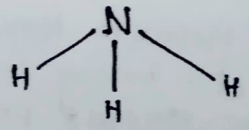






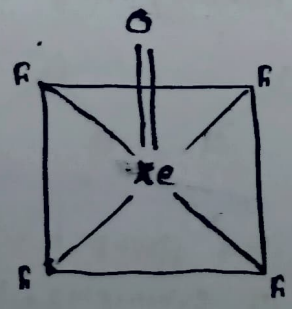
(b) C_{3v} Point group :- It contains E, $2C_3$, and $3\sigma_v$

example :- NH_3, PH_3, PCl_3, $CHCl_3$, $POCl_3$, CH_3Cl



(c) C_{4v} Point group :- It contains E, $3C_4$, and $4\sigma_v$

example $[Co(NH_3)_4Cl(H_2O)]^{+}$, SF_5Cl (Octahedral)
$XeOF_4$, ClF_5

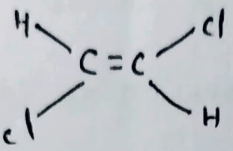


Point group C_{nh} :- A rotational axis C_n and σ_h perpendicular to C_n gives rise to C_{nh} Point group.

Here S_n, $(C_n \cdot \sigma_h)$ is present

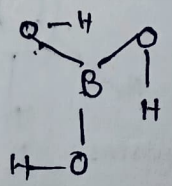
(a) C_{2h} :- It contains $E, C_2, \sigma_h, S_2 (\equiv i)$

example, Trans H_2O_2, Trans - 2 butene,
Trans - $CHCl = CHCl$, Trans H_2F_2



(b) C_{3h} :- It Contains $E, 2C_3, \sigma_h, 2S_3$

example H_3BO_3 (Planar)



) Point group D_n :- A D_n Point group is generated by high order rotational axis C_n $(n \geq 2)$ and n C_2 axes perpendicular to it. This group has only a few molecular species.

D_3 : for example $[Co(en)_3]^{3+}$.

& Gauche Conformation of ethane.