

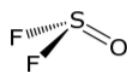
1.4: Molecular Point Groups 1

The symmetry properties of molecules (i.e. the atoms of a molecule form a basis set) are described by **point groups**, since all the symmetry elements in a molecule will intersect at a common point, which is not shifted by any of the symmetry operations. There are also symmetry groups, called **space groups**, which contain operators involving translational motion.

The point groups are listed below along with their distinguishing symmetry elements

C_1 : E (h = 1) \implies no symmetry

C_s : σ (h = 2) \implies only a mirror plane

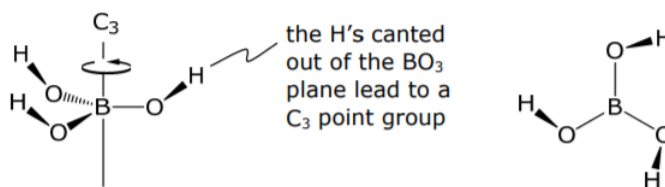


C_i : i (h = 2) \implies only an inversion center (rare point group)

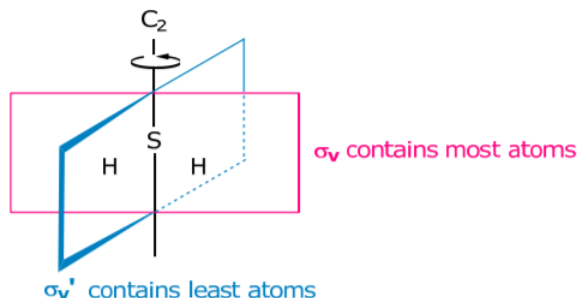


isomer of dichloro(difluoro)ethane

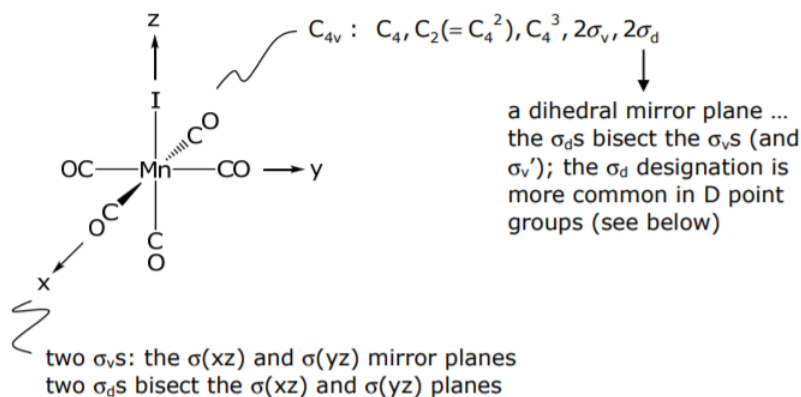
C_n : C_n and all powers up to $C_n^n = E$ (h = 2) \implies a cyclic point group



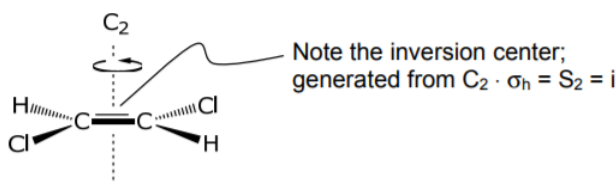
C_{nv} : C_n and $n\sigma_v$ (h = 2n) ... by convention a σ_v contains C_n (as opposed to σ_h which is normal to C_n). For n even, there are $\frac{n}{2}\sigma_v$ and $\frac{n}{2}\sigma_{v'}$ ' with the σ_v containing the most atoms and the $\sigma_{v'}$ containing the least atoms



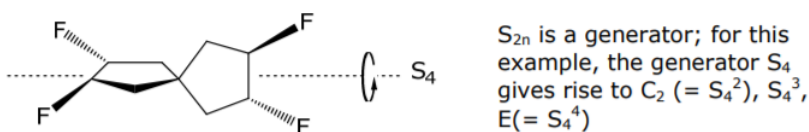
Consider a second example:



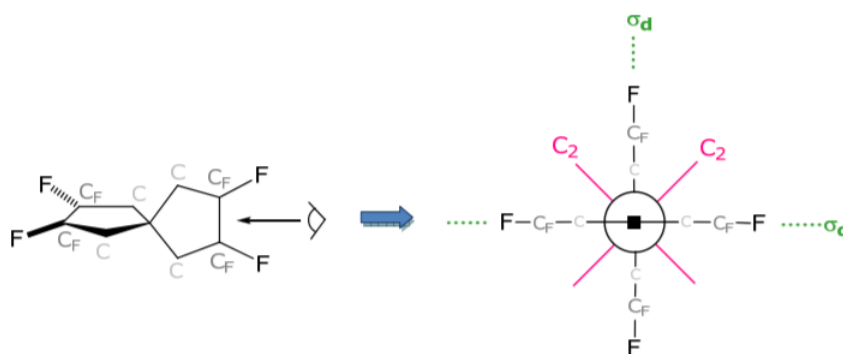
$C_{nh} : C_n$ and σ_h (normal to C_n) are generators of S_n operations as well ($h = 2n$)



$S_{2n} : S_{2n}$ and all powers up to $S_{2n}^{2n} = E$ ($h = 2n$).



The F's do not lie in the plane of the cyclopentane rings. If they did, then other symmetry operations arise; these are easiest to see by looking down the line indicated below:



Note S_n , where n is odd, is redundant with C_{nh} because $S_n^n = \sigma_h$ for n odd. As an example consider a S_3 point group. S_3 is the generator for S_3 , $S_3^2 (= C_3^2)$, $S_3^3 (= \sigma_h)$, $S_3^4 (= C_3)$, S_3^5 , $S_3^6 (= E)$. The C_3 's and σ_h are the distinguishing elements of the C_{3h} point group.

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