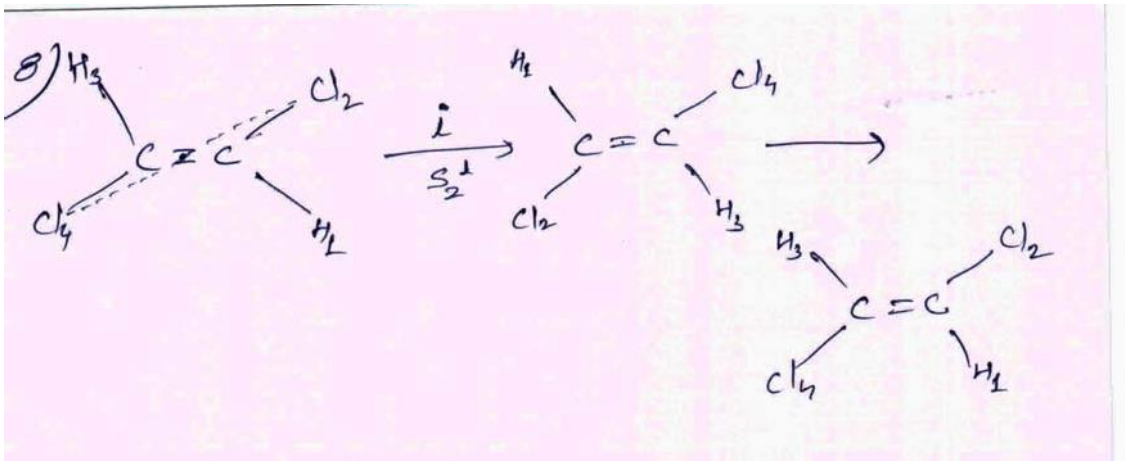
Centre of inversion

A molecule is said to possess a centre of symmetry if reflection of each atom through centre of the molecule results in its coincidence with an equivalent atom. We define it as for every atom at x, y z here exist an identical atom at -x,-y,-z. It means that if any atom in the molecule is connected with the centre of symmetry, equivalent atom lies on the opposite side. This is best illustrated by the following example:



The centre of inversion is represented by i and the operations generated by this is expressed by i^n. It can be seen that

i^n=E {if n=even}

i^n=i { if n= odd}

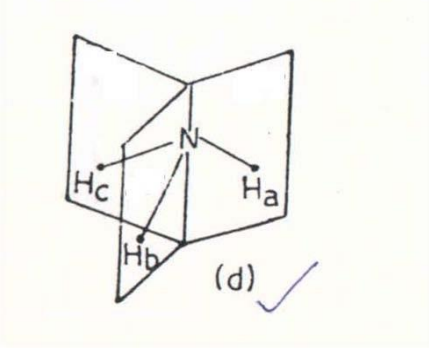
Unlike plane of symmetry, the centre of inversion generates only one operation. The configuration generated by S_2 axis is equivalent to that generated by a centre of inversion and hence an S_2 axis is always represented by i. Other examples of molecule having centre of inversion are CO_2, C_2H_4, N_2O_2, $[Co(NH_3)_6]^{3+}$ etc.

Identity

This is an operation which brings back the molecule to the original orientation. It is represented by E. There are several different types of operations which bring back the molecule to its original orientation, they are not considered separately but are put together as identity. For example an axis of four folds symmetry C_4^1, C_4^2 and C_4^3 are considered as rotation operations. But C_4^4 that is rotation by 360^o is not considered as a rotational operation because it is an identity operation. Over a plane of symmetry only one reflection operation is considered. If the reflection is repeated, the original orientation is obtained and hence the second reflection is an identity operation. Thus the identity operation in effect means doing nothing on the molecule and hence does not seem to be of much importance lies in considering the molecules as a group and to apply the group theory to molecules.

Exercise-

Qu. 1 How many symmetry elements are present in benzene molecule.



Qu. 2 How many symmetry elements are present in ammonia molecule.

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