4.3 Group and its Characteristics

A group is a collection of elements that are interrelated according to certain rule. We shall be concerned with the groups formed by the sets of symmetry

operations that may be carried out on molecules or crystals. The followings are the requirements for a mathematical group.

(a) Closure   (b) Identity

(c) Inverse   (d) Association

(a) **Closure**—The product of any two elements in the group and the square of each element must be an element in the group.

The product of any element A and B produce C. C must be element of the group.

$$A.B = C$$
$$A^2 = D$$
$$B^2 = E$$

C, D and E must be element of the group.

The order of combination is very important as AB is not necessarity equal to BA.

If AB = BA, the members A and B are said to commutative.

and if AB ≠ BA, the members A & B are not commutative. The members of the group which are commutative form *Abelian group*.

(b) **Identity**—One element of the group must commute with all other elements and leave them unchanged. This element is called identity and represented as E.

Identity must be present in a group.

$$E.A = A.E = A$$
$$E.B = B.E = B$$

A and B are elements of the group.

(c) **Inverse**—Every member of the group must have its inverse as an member of the group.

$$A.A^{-1} = A^{-1}.A = E$$

(d) **Association**—Multiplication must be associative.

$$A(B.C) = (A.B).C$$

Symmetry elements of a molecule constitute a group.