Unit - 3: Molecular Symmetry and Symmetry Groups

Structure of Unit:

2.0 Objectives

At the end of the unit learner will be able to

- Understand the symmetry elements and symmetry operations generated by them
- Understand that how symmetry elements co-related with optical isomerism
- Determination of point groups

2.1 Introduction

In a nonmathematical sense the concept of symmetry is associated with regularity or proportionality. In short it is associated with beauty. Consider an example of

sign of exclamation. Now we rotate this sign seven times, through an angle of 45^{o} about an axis passing through the centre of the dot and perpendicular to the plane of the paper. The symmetry operation (rotation) about the symmetry element (axis) gives a beautiful flower in which each petal of flower is related to one another by rotation through 45^{o} about the symmetry axis.

In dealing with molecules, which are present in various conformations, we try to identify the symmetry elements and symmetry operations that will tell us that how the atoms in the molecules are related to one another in space. To do this we should know the kinds of symmetry elements and operations generated by them.

2.2 Symmetry Elements and Symmetry Operations

Although symmetry operations and symmetry elements are related to each other but are two different things. Symmetry element is a geometrical entity such as line plane or a point with respect to which one or more symmetry operations may be carried out.

A symmetry operation is the actual movement of atoms in a molecule such that after the operation has been carried out every atom is coincident with an equivalent atom. In other words after the operation has been carried out on a molecule we get an equivalent or identical configuration.

In other words if we note the position and orientation of the body before and after a movement is carried out, that movement is a symmetry operation, if these two orientations are indistinguishable.

Types of Symmetry Element: There are our types of symmetry elements-

a) Proper axis of symmetry (C)
b) Plane of symmetry (σ)
c) Improper axis of symmetry (S)
d) Centre of inversion (i)

One or more symmetry operations are associated with one symmetry element. Some authors have included identity as a symmetry element, but it is a symmetry operation.

The four kinds of symmetry elements and operations generated by them required to specify molecular symmetry-

S. No.	Symmetry Elements	Symmetry Operations
1	Proper axis of symmetry	One or more rotation about the axis
2	Plane of symmetry	Reflection in plane
3	Improper axis of symmetry	One or more repetitions of the sequence: rotation followed by reflection in a plane perpendicular to the rotation axis.
4	Centre of inversion	Inversion of all atoms through centre

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