

# Symmetry in Chemistry

**Symmetry:** - Symmetry is a geometrical properties in which the structure is proportion and well balanced.

**Symmetry Operations:** -

A Symmetry Operation is a movement of a body such that, after the movement has been carried out, every point of the body is coincident with an equivalent point (or the same points) of the body in its original orientation.

Ultimately we can define the Symmetry Operation as a geometrical Operation such as reflection, rotation, inversion etc. which leads to a configuration indistinguishable from the original.

It means the two configurations are not exactly identical, but they look like in all respect.

**Symmetry Elements:** -

A Symmetry element is a geometrical entity such as a line, a plane, or a point with respect to which one or more Symmetry Operations may be carried out.

A line, a plane, or a point with respect to which one or more Symmetry Operations can be carried out is called Symmetry element.

Symmetry elements and Symmetry Operations are so closely interrelated because the Operation can be defined only with respect to the element, and the same time the existence of a Symmetry element can be demonstrated only by showing that the appropriate Symmetry Operation exist.

Thus, Since the existence of the Operation or Operations and vice-versa

The related types of elements and Operations are tabulated as follows:-

| Symmetry Elements                                  | Symmetry Operations                                                                             | Symbol   |
|----------------------------------------------------|-------------------------------------------------------------------------------------------------|----------|
| 1. Identity                                        | To leave the molecule unchanged                                                                 | E        |
| 2. Axis of Symmetry                                | Rotation by angle $\theta = \left(\frac{2\pi}{n}\right)$ about the axis                         | $C_n$    |
| 3. Plane of Symmetry                               | Reflection in plane                                                                             | $\sigma$ |
| 4. Centre of Symmetry<br>or<br>Centre of inversion | Inversion of all the atoms through the Centre                                                   | i        |
| 5. Improper axis of Symmetry                       | Rotation about the axis followed by reflection in a plane perpendicular to the rotational axis. | $S_n$    |

## Symmetry Operations

### 1. Identity (E) :

An identical operation results in the production of an orientation which is identical to original orientation.

This is operation of doing nothing.

When we do not do anything and leave the system unchanged and identical to the original system in all respect, the operation is called identity

and it is denoted by E

Identity is represented by the symbol E.

### 2. Centre of Symmetry or Inversion Centre :-

If a molecule can be brought into an equivalent configuration by changing the co-ordinates  $(x, y, z)$  of every atom, where the co-ordinates original point lies within or a point in atom.

or where the original co-ordinates lies at a point within the molecule into  $(-x, -y, -z)$  then the point at which origin lies is said to be as

a Centre of Symmetry or Centre of Inversion.

In other words, this is an imaginary point in the centre of the molecule, through which the reflection of each atom can be carried out, to result in its coincidence with an equivalent atom.

The symbol for inversion centre or for the operation of inversion is represented or denoted by italic  $i$  or  $(i)$