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SYMMETRY GROUP THEORY

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ABSTRACT

Group theory is known as well-known algebraic structure of groups. Symmetry operations and symmetry elements are two basic and important concepts in group theory.Operation which leaves an object looking the same are called symmetry operations. Here we deal with the operations Identity, n-fold rotation, reflection, Inversion, Improper n-fold rotations on usingdifferent structures.

INTRODUCTION:

Symmetry means that one shape becomes exactly like another when you move it in some way: turn, flip or slide.For different objects (Structure), there are different kinds of symmetry operations we can perform. To finish a symmetry operation, we may rotate an object on a line as an axis, reflect it on a mirror plane, or invert it through a point located in the center. These lines, planes, or points are called symmetry elements. There may be more than one symmetry operations associated with a particular symmetry.

SYMMETRY ELEMENT

Symmetry element which is the axis, plane, line or point with respect to which the symmetry operation is carried out. The symmetry element consists of all the points that stay in the same place when the symmetry operation is performed.

CENTRE OF SYMMETRY:

A point within a crystal through which any straight line extends to points on opposite surfaces of the crystal at equal distances.

PLANE OF SYMMETRY:

A plane through a crystal that divides the crystal into two parts that are mirror images of each other.

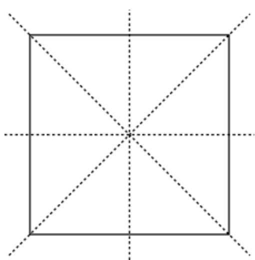
AXIS OF SYMMETRY

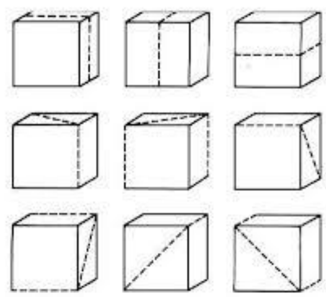
Axis of Symmetry is a line that divides the figure into two symmetrical parts in such a way that the figure on one side is the mirror image of the figure on the other side.

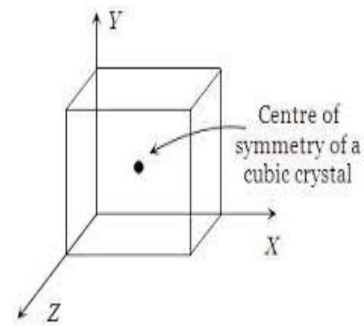
There can be drawn four such lines that would divide the square into two symmetrical parts.

A plane through a crystal that divides the crystal into two parts that are mirror images of each other.

PICTORIAL REPRESENTATION







Square with 4 Axes of symmetry

6 planes of symmetry of cube

SYMMETRY OPERATIONS

It is an opearation given to an object or structure if we apply it the structure remains unchanged. Every operation is performed through its symmetry element. There are five types of symmetry operations. They are as follows.

(A) IDENTITY (E)

All molecules have the identity operation. The molecule does not move and all atoms of the molecule stay at the same place when we apply an identity operation, E, on it. Identity operation can also be a combination of different operations when the molecule returns to its original position after these operations are performed.

(B) PROPER ROTATIONS AND C_N AXIS

C_n generates n operations, whose symbols are C_n, C_n^2, C_n^3, C_n^4,..., E $(=C_n^n)$.We can write the 4 operations generated by proper rotation C_4 in the form of360˚/n. From this table, we can see that the symbols of the 4 rotations generated by C_4 are C_6, C_3, C_2, C_3^2, C_6^5, E. One object can have many proper axes and the one with the largest n is called **principle axis.**

ROTATION ANGLE	OPERATIONS	SYMBOL
$\frac{2\pi}{4}$	C_4	C_4
$2*\frac{2\pi}{4}$	C_4^2	C_2
$3*\frac{2\pi}{4}$	C_4^3	C_4^3
$4*\frac{2\pi}{4}$	C_4^4	E

(C) REFLECTION: (S)

Reflection is an operation which divides the structure into two halves that one is the mirror image of the other. This symmetry is also called **line symmetry** or **mirror symmetry** because there is a line in the figure where a mirror could be placed, and the figure would look the same.

(D) INVERSION: (I)

A symmetry operation is a movement such as an **inversion** about a point, a rotation about a line or a reflection about a plane in order to get an equivalent orientation.

(E) IMPROPER ROTATIONS: (S_N)

An improper rotation is rotation, followed by reflection in the plane perpendicular to the axis of rotation.

SYMMETRY ELEMENTS IN SYMMETRY OPERATION

SYMMETRY OPERATION	NOTATION	SYMMETRY ELEMENTS
IDENTITY (E)	E	IDENTITY OPERATION

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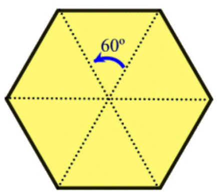
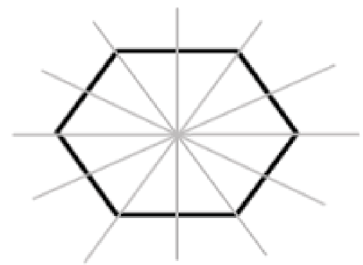
PROPER ROTATIONS	C_N	AXIS OF SYMMETRY
REFLECTION	S	PLANE OF SYMMETRY
INVERSION	I	CENTRE OF SYMMETRY
IMPROPER ROTATIONS	S_N	ROTATION FOLLOWED BY REFLECTION

PICTORIAL REPRESENTATIONS



A regular hexagon has rotational symmetry of 60°, 120°, 180°, 240°, and 300°.

The order is order 6.



A Regular hexagon has 6 reflectional symmetry

CONCLUSION

In chemistry many phenomena may be easily explained by considering symmetry. Here we demonstrated the symmetrical operations through geometrical shapes which can be applied to molecules. The symmetry is important for understanding structures and properties of organic compounds.

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