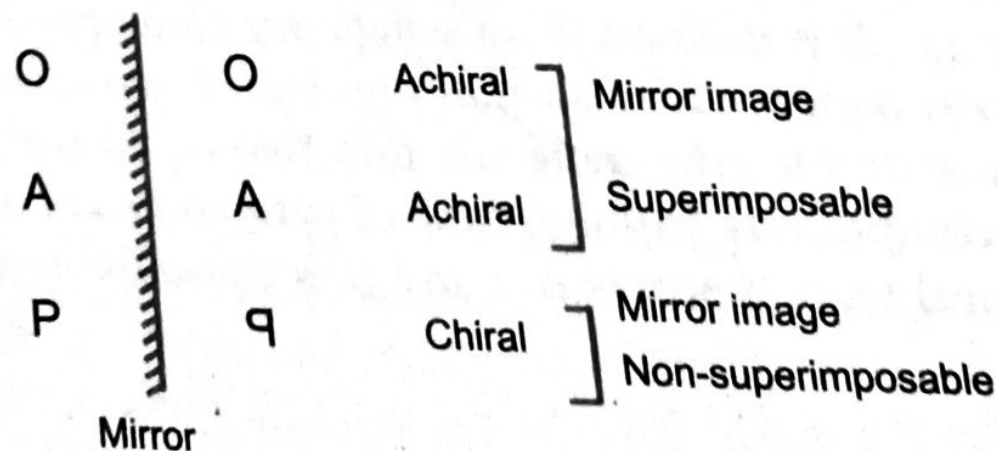
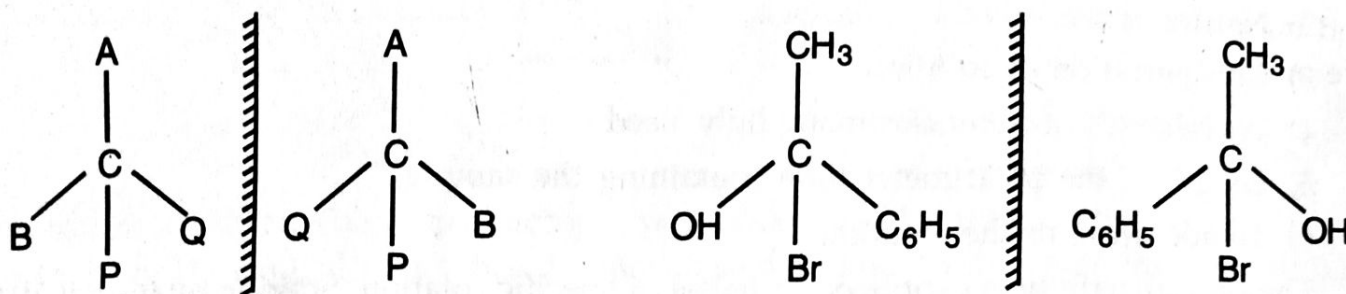


**d) Chirality of molecules :** It is observed that the molecular structure of all the optically active compounds is chiral (dissymmetric) in nature. A molecule is chiral or dissymmetric only if it is non super imposable on its mirror image. This property of non-super impossibility is called chirality. In contrast a molecule or an object which is superimposable on its mirror image is called achiral or symmetric for e.g. the english alphabet "O" and "A" are achiral while the alphabet "P" is chiral in nature.



Other examples of chiral objects are - Pair of human hands, some alphabets like E, P, F, J. Examples of achiral objects are- a chair, a sphere, a cube and some alphabets like "O" and "M".

e) **Chiral and Asymmetric Carbon** : This concept arises from the tetrahedral nature of carbon atom in various organic compounds. In 1873 Vant's Hoff assume that a saturated carbon forms four bonds which are directed towards the four corners of tetrahedron. If all the four atoms attached to the carbon are different then it will produces dissymmetry. Such a carbon is known as chiral or dissymmetric carbon. It can be represented as  $C_{ABPQ}$  where ABPQ are different groups. The mirror image of such carbon is non superimposable as shown below :



### Non-Superimposable Mirror Images

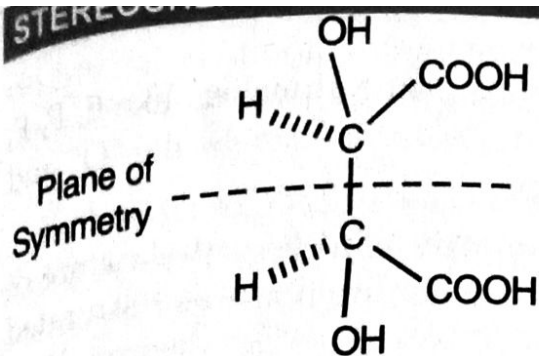
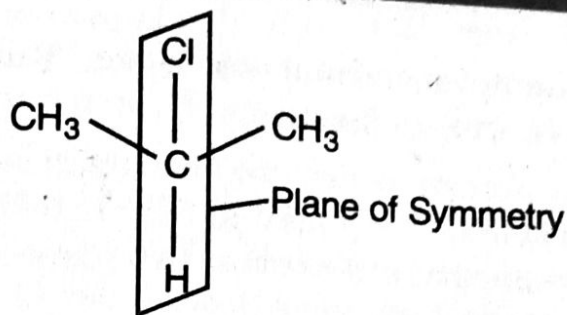
If two atoms attached to the carbon atom are similar, the chirality is lost and the molecule becomes symmetrical. As a simple rotation through  $180^\circ$  about its axis will make the compound superimposable on its mirror image. For e.g. 2-chloropropane is an achiral molecule. A chiral carbon is denoted by (\*) on the carbon atom. For e.g. lactic acid ( $CH_3-C^*HOH-COOH$ ), 2,3-dihydroxy propanal ( $CHOH-C^*HOH-CHO$ ), are chiral and are optically active.

From the above examples, it is clear that the necessary and sufficient conditions for a compound to be optically active is the presence of one or more chiral carbon atoms and the chirality of the molecule as a whole.

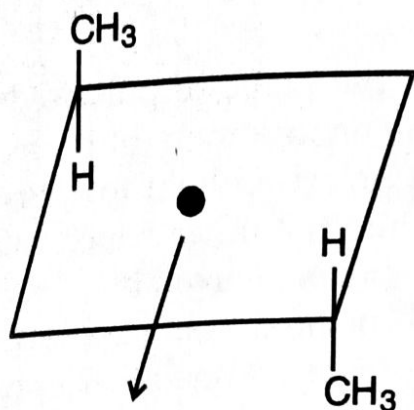
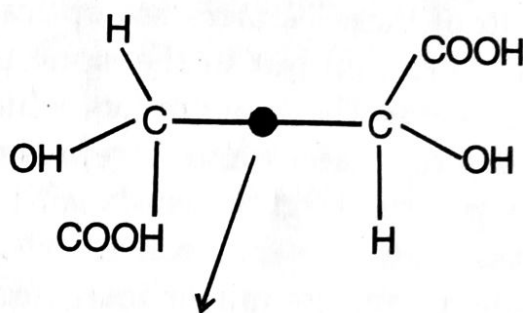
f) **Elements of Symmetry** : There are three elements of symmetry which helps in identifying the superimpossibility of a molecule or an object and its mirror image. Chiral objects do not have an element of symmetry while achiral objects and molecules have one or more elements of symmetry. The three elements of symmetry are :

- 1) Plane of symmetry
- 2) Centre of symmetry
- 3) Axis of symmetry

1) **Plane of symmetry** : It is defined as an imaginary plane passing through the molecule, which divides it into two equal halves so that one half is the mirror image of the another half. The imaginary plane divides the molecule into two equal halves which are mirror images of one another. So compounds having plane of symmetry are optically inactive. For e.g. Tartaric acid has two chiral carbon atoms but still it is optically inactive as it has a plane of symmetry.

**Meso-tartaric acid****2-Chloropropane**

2) **Centre of symmetry** : It is defined as the imaginary point in the molecule through which when lines are drawn on one side and produced an equal distance on other side, will meet identical or same groups and points on either side. For e.g. Trans-1, 3-dimethyl cyclobutane and mesotartaric acid have a centre of symmetry. So compounds having centre of symmetry are optically inactive in nature.

**Centre of Symmetry****Centre of Symmetry**

3) **Axis of Symmetry** : It is defined as an imaginary axis through which if a molecule is rotated through an angle of  $360^\circ$  it will give a molecule which is exactly similar to the original molecule. For e.g. 1,3-diethyl 2,4-dimethyl cyclobutane has an axis of symmetry and is achiral. Absence of axis of symmetry is the necessary condition for a molecule to be optically active.

