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History

- In 1874, van't Hoff (1874, 1875) and Le Be1 (1874) independently and almost simultaneously proposed the case for enantiomerism in a substance of the type Cabcd: the four substituents are arranged tetrahedrally around the central carbon atom to which they are linked.

- The four linkages to a carbon atom point toward the corners of a regular tetrahedron **(Figure 1)** and two nonsuperposable arrangements of atoms or groups (enantiomers) are thus possible.

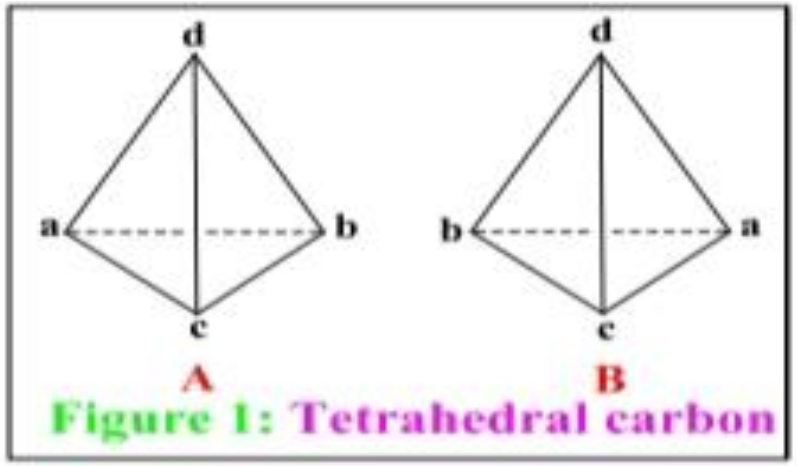

Figure 1: Tetrahedral carbon

- The model corresponding to a given enantiomer (e.g., **Figure 1; A**) and the molecule that it represents are called "***chiral***" (meaning handed, from Greek ***cheir,*** hand) because, like hands, the molecules are not superposable with their mirror images.

Chiral Molecules and Chiral Samples

- When a ***molecule*** is ***chiral***, it must be either "right-handed" or "left-handed". But if a ***substance or sample*** is said to be ***chiral***, this merely means that it is made up of ***chiral*** molecules; it does not necessarily imply that all the constituent molecules have the same "***sense of chirality***".

- The statement that a macroscopic sample (as distinct from an individual molecule) is ***chiral*** is ambiguous. It may be ***racemic*** or ***non-racemic***.
- ***Chiral and non-racemic sample***: The sample is made up of molecules that all have the same sense of chirality (homochiral molecules).
- ***Chiral but racemic sample***: The sample is made up of equal (or very nearly equal) numbers of molecules of opposite sense of chirality (heterochiral molecules).

Chiral Molecules and Chiral samples

- There is, however, little ambiguity about the meaning of "***chiral, racemic***": ***Chiral, racemic*** means that the sample is made up of equal numbers of molecules of opposite sense of chirality. But in a "***chiral, non-racemic***" sample there can be some molecules of a sense of chirality opposite to that of the majority; that is, the sample may not be enantiomerically pure (or enantiopure).

- Everything has a mirror image. What's important in chemistry is whether a molecule is identical to or different from its mirror image. Some molecules are like hands. Left and right hands are mirror images of each other, but they are not identical **(Figure 2)**. If one hand is placed on the other, they can never superimpose either all the fingers, or the tops and palms. Socks, on the contrary, are superposable to each other **(Figure 2)**.

Chiral and Achiral Molecules

Figure 2: Left and right hands are not superposable. They are chiral

Socks are achiral: they are mirror images that are superimposable

Figure3: Socks are achiral

- To superimpose an object on its mirror image means to align all parts of the object with its mirror image. With molecules, this means aligning all atoms and all bonds.

- A molecule (or object) that is not superimposable on its mirror image is said to be ***chiral***.

Chiral and Achiral Molecules

- Other molecules are like socks. Two socks from a pair are mirror images that are superimposable. One sock can fit inside another. A sock and its mirror image are identical.

- A molecule (or object) that is superimposable on its mirror image is said to be ***achiral***.

Answer the Following Questions

1. There are twenty-six letters in English language. How many of them are symmetric and how many of them are non-symmetric, considering them as two-dimensional.

2. Classify the following as ***chiral*** or ***achiral***. Give reasons.
   (a) H_2O (ii) CH_2BrCl (iii) CHBrClF

Ordinary Light and Plane Polarised Light

- An **ordinary light** beam consists of a group of electromagnetic waves of a range of different wavelengths that vibrate in many different planes at right angles to the direction of propagation of the light ray. It vibrates in all directions as in **Figure 4A**.

- When such a beam strikes a polarising film or a **Nicol prism** (made from a crystal of calcium carbonate) only those waves vibrating in a specific plane with respect to the axis of the film or prism may pass through; all others are blocked out. Upon emergence the light beam is plane polarised as in **Figure 4B**. Here, all of its waves vibrate in a single plane (or, more precisely, in parallel planes). Light of this kind is said to be **polarised**. French physicist Malus discovered this light in 1809.

Ordinary Light and Plane Polarised Light

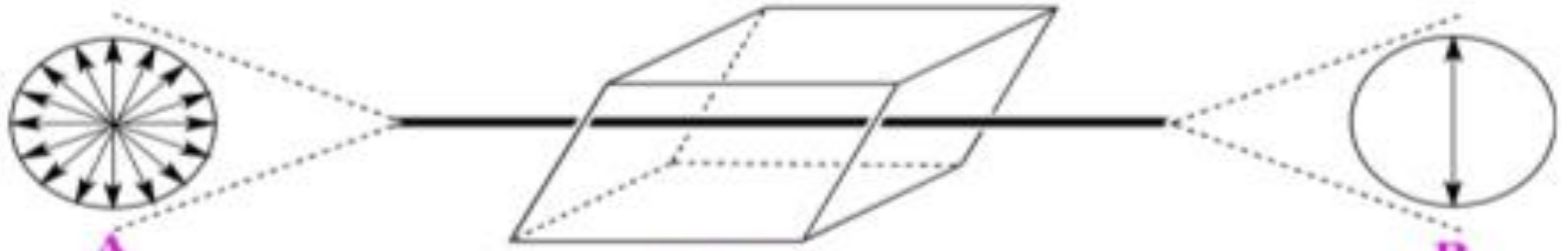

Figure 4: Ordinary Light (A) and plane Polarised Light (B)

- ***Monochromatic light*:** Monochromatic light, such as emitted by a sodium lamp (λ = 589 nm), is of discrete wavelength but still vibrates in an infinite number of planes.

- The term monochromatic derives from the Greek words ***monos***, meaning one or sole, and ***chromos***, meaning color.

THANK YOU