

Stereo isomerism

Stereo isomerism

- Stereoisomerism is a form of isomerism in which molecules have:
 - The **same molecular formula**
 - The **same sequence of bonded atoms** (i.e., the same structural formula)
 - But a **different spatial arrangement** of atoms or groups in 3D space
- So, unlike structural (constitutional) isomers, stereoisomers differ only in how atoms are oriented in space, not in how they're connected.

Classification of Stereoisomerism

A. Geometrical Isomerism (cis-trans or E/Z)

- Occurs due to **restricted rotation** (e.g., around double bonds or in cyclic systems)
- Groups are arranged **differently in space** relative to a reference plane
- Examples:
 - **Cis-but-2-ene** (same groups on the same side)
 - **Trans-but-2-ene** (same groups on opposite sides)
 - **E/Z isomerism** in alkenes with different substituents

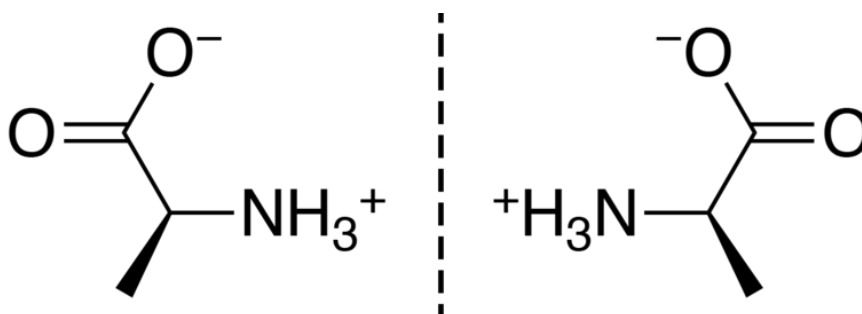
B. Optical Isomerism

- Arises due to the presence of chiral centers or asymmetry
- Molecules that can rotate plane-polarized light
- Based on the concept of chirality

Optical Isomerism

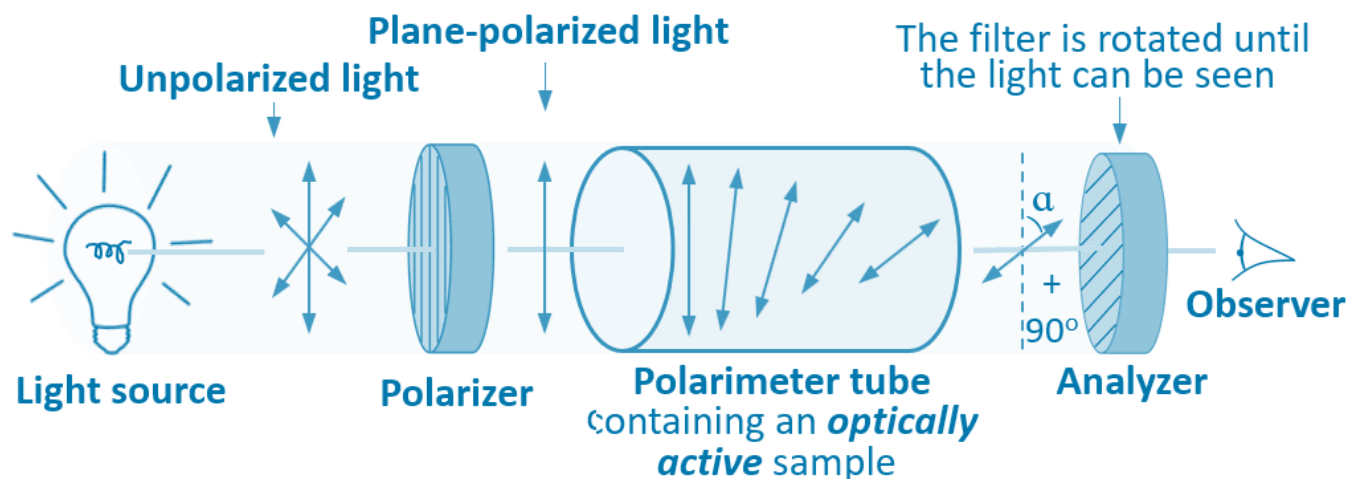
Definition:

- Optical isomerism occurs when molecules can exist in two (or more) non-superimposable forms (stereoisomers) that differ in the way they interact with plane-polarized light.
- If a molecule can rotate the plane of polarized light, it is said to be "optically active."



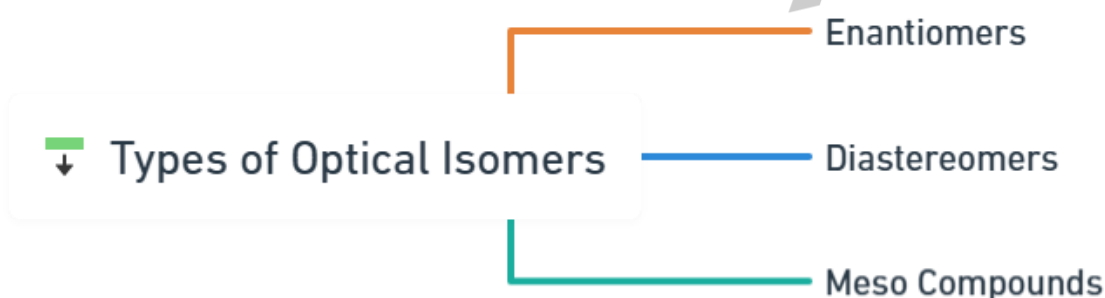
How Optical Activity is Measured

- **Plane-Polarized Light:** Ordinary light consists of waves vibrating in all planes. A polarizer (like a Nicol prism) filters out all but one plane of vibration, creating plane-polarized light.
- **Polarimeter:** An instrument used to measure how much a substance rotates plane-polarized light.
 - If the substance rotates the plane to the right (clockwise), it is called "dextrorotatory" (labeled as "+" or "d-").
 - If it rotates the plane to the left (counterclockwise), it is called "levorotatory" (labeled as "-" or "l-").



The polarizer passes the light in *only one plane*

Types of Optical Isomers



A. Enantiomers

- **Non-superimposable mirror images**
- Identical physical properties (except for optical rotation)
- Rotate plane-polarized light equally but in **opposite directions**
- Represented as:
 - **(+)-enantiomer** (dextrorotatory)
 - **(-)-enantiomer** (levorotatory)

B. Diastereomers

- Stereoisomers that are not mirror images

- Occur when there are two or more chiral centers
- Physical and chemical properties are different
- Example: In a molecule with 2 chiral centers, (R,R) and (R,S) are **diastereomers**

C. Meso Compounds

- Contain chiral centers
- But are achiral overall due to an internal plane of symmetry
- Are optically inactive
- Superimposable on their mirror images
- Example: Meso-tartaric acid

Racemic Mixtures

- A **1:1 mixture of two enantiomers**
- Optical activities **cancel each other out**
- The mixture is **optically inactive**
- Symbolized as: (±)-compound

Number of Optical Isomers

- If a compound has **n chiral centers**, the maximum number of **stereoisomers** is:
- **2^n** , where:
 - Half are **enantiomers**
 - The rest may be **diastereomers**
 - Subtract meso forms (if any) to find **optically active forms**

Example:

- A molecule with 2 chiral centers → up to **4 isomers**
 - (R,R), (S,S), (R,S), (S,R)
 - If (R,S) and (S,R) are **meso**, then only 3 unique stereoisomers exist

Enantiomers

Definition:

- Enantiomers are **non-superimposable mirror images** of each other.
- They have the same molecular formula and connectivity but differ in the spatial arrangement of groups around chiral centers.

Key characteristics:



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