



Geometric Isomerism

Definition:

Geometric isomerism, also known as cis-trans isomerism or E-Z isomerism, is a type of stereoisomerism where compounds with the same molecular formula and connectivity of atoms have different spatial arrangements of atoms or groups around a rigid structure, typically a double bond or a ring system.

Key Features:

1. Restricted Rotation:

Geometric isomerism arises because of restricted rotation around a double bond or within a ring. In the case of a double bond, the π -bond prevents free rotation.

2. Different Spatial Arrangements:

The different spatial arrangements lead to distinct isomers with different physical and chemical properties.

Types of Geometric Isomerism:

1. Cis-Trans Isomerism:

- **Cis Isomer:** The substituents are on the same side of the double bond or ring.
- **Trans Isomer:** The substituents are on opposite sides of the double bond or ring.

2. E-Z Isomerism:

When there are more complex substituents, the E-Z notation is used based on the Cahn-Ingold-Prelog priority rules.

- **E (Entgegen):** The higher priority groups are on opposite sides.
- **Z (Zusammen):** The higher priority groups are on the same side.

Examples:

1. 2-Butene (C_4H_8):


- **Cis-2-Butene:** Both methyl groups (CH_3) are on the same side of the double bond.
- **Trans-2-Butene:** The methyl groups (CH_3) are on opposite sides of the double bond.

2. 1,2-Dichloroethene ($C_2H_2Cl_2$):

- **Cis-1,2-Dichloroethene:** Both chlorine atoms are on the same side of the double bond.
- **Trans-1,2-Dichloroethene:** The chlorine atoms are on opposite sides of the double bond.

3. Butenedioic Acid ($C_4H_4O_4$):

- **Cis-Butenedioic Acid (Maleic Acid):** The carboxyl groups ($COOH$) are on the same side of the double bond.
- **Trans-Butenedioic Acid (Fumaric Acid):** The carboxyl groups ($COOH$) are on opposite sides of the double bond.

 Cis and Trans Butenedioic Acid

4. E-Z Isomerism Example:

- Consider 2-bromo-2-butene:

- **E-2-Bromo-2-butene:** The bromo group (Br) and the higher priority ethyl group (CH_3CH_2) are on opposite sides.
- **Z-2-Bromo-2-butene:** The bromo group (Br) and the higher priority ethyl group (CH_3CH_2) are on the same side.

Characteristics of Geometric Isomers:

- **Different Physical Properties:** Geometric isomers often have different boiling points, melting points, solubilities, and densities due to the different spatial arrangements of the groups.
- **Different Chemical Properties:** The reactivity can also differ. For example, cis-alkenes may be more reactive in certain addition reactions than trans-alkenes due to steric factors.

Summary:

Geometric isomerism is an important concept in organic chemistry as it explains how the spatial arrangement of atoms or groups around a rigid structure, like a double bond or ring, can lead to different isomers with distinct properties. Understanding this concept is crucial for predicting and explaining the behavior of organic molecules in various chemical contexts.