

# Molecular Geometry and VSEPR Theory

Understanding the shape of molecules based on electron pair repulsion

## Introduction to Molecular Geometry

Molecular geometry refers to the three-dimensional arrangement of atoms in a molecule, which affects physical and chemical properties such as reactivity, polarity, and phase of matter.

## VSEPR Theory Overview

Valence Shell Electron Pair Repulsion (VSEPR) Theory explains molecular shapes by assuming that electron pairs around a central atom repel each other and arrange themselves to minimize repulsion.

## Basic Postulates of VSEPR Theory

- Electron pairs (bonding and non-bonding) repel each other.
- Molecules adopt a shape that minimizes repulsion.
- Lone pairs occupy more space than bonding pairs.

## Common Molecular Geometries

- **Linear:**  $180^\circ$  bond angles (e.g.,  $\text{CO}_2$ ).
- **Trigonal Planar:**  $120^\circ$  bond angles (e.g.,  $\text{BF}_3$ ).
- **Tetrahedral:**  $109.5^\circ$  bond angles (e.g.,  $\text{CH}_4$ ).
- **Trigonal Bipyramidal:**  $90^\circ$  and  $120^\circ$  bond angles (e.g.,  $\text{PCl}_5$ ).
- **Octahedral:**  $90^\circ$  bond angles (e.g.,  $\text{SF}_6$ ).

## Effect of Lone Pairs on Molecular Geometry

Lone pairs exert greater repulsion than bonding pairs, which can alter bond angles and lead to geometries such as bent ( $\text{H}_2\text{O}$ ) and trigonal pyramidal ( $\text{NH}_3$ ).

## Applications of Molecular Geometry

- Predicting molecular polarity and dipole moment.
- Understanding reaction mechanisms.
- Determining physical properties like boiling and melting points.

## Conclusion

VSEPR Theory is an essential tool for predicting molecular shapes, which helps in understanding chemical properties and reactivity of compounds