

Reactions of Amines and Epoxides

Preparation of Amines

Amines are colorless, basic, and have a strong, fishy odor.



A summary of Ring-Opening Reactions of Epoxides with Strong and Weak Nucleophiles



Epoxide Reactions and Mechanisms

Bond Types, Strength, Length, Polarity and Dipole Moment

Free-radical halogenation



There are two types of bonding: ionic bonding and covalent bonding.

• **Ionic bonds** are formed by the transfer of electrons from one element to another (ionization potential) and electron affinity (electron).



• **Covalent bonds** are formed by sharing of electrons between two atoms.



The Relative Electronegativity of Atoms



Bond and Bonding



There are two types of bonds:



Sigma and pi bonds

Covalent bonds are classified into sigma and pi bonds.

• **Sigma bonds** are formed by head-on overlap of orbitals.

• **pi bonds** are formed by side-on overlap of orbitals.

• **One single bond** is a sigma bond.

• **Two multiple bonds** consist of one sigma and two pi bonds.



pi bonds are stronger than sigma bonds.

Polar and Nonpolar Covalent Bonds

Depending on the difference in the electronegativity values, covalent bonds can be polar and nonpolar.

• **Polar bonds** are formed by the difference in electronegativity values of the two atoms.

• **Nonpolar bonds** are formed by the same electronegativity values of the two atoms.

• **If the difference in electronegativity is between 0.5 and 1.7**, the bond is polar.

• **If the difference in electronegativity is between 1.7 and 2.0**, the bond is ionic.

• **A difference of 2.0 or higher** is a ionic bond.

Dipole Moment

The polarity of a bond is described by the dipole moment (μ).

It is a vector quantity.



The dipole moment is a vector pointing from the less electronegative atom to the more electronegative atom.

• The dipole moment is a vector pointing from the less electronegative atom to the more electronegative atom.

• The vector dipole moment is a vector pointing from the less electronegative atom to the more electronegative atom.

• **delta minus** indicates an electron deficient atom.

• **delta plus** indicates an electron rich atom.

Molecular Dipole

To determine the molecular polarity, the vector sum of the dipole moments.

The polarity of the molecule is determined by the vector sum of the dipole moments.



Overall the molecule is polar (net dipole moment).

Bond Length and Bond Strength

The bond length is the distance between the two nuclei.

Bond	H-H	H-Cl	H-Br	H-I
Length	109 pm	127 pm	141 pm	154 pm
Strength	436 kJ/mol	431 kJ/mol	366 kJ/mol	298 kJ/mol

Double bonds are stronger than single bonds.



The bond length is the distance between the two nuclei.

Bond	H-H	H-Cl	H-Br	H-I
Length	109 pm	127 pm	141 pm	154 pm
Strength	436 kJ/mol	431 kJ/mol	366 kJ/mol	298 kJ/mol
Bond energy	436 kJ/mol	431 kJ/mol	366 kJ/mol	298 kJ/mol
Electronegativity	2.1	3.0	2.8	2.5
Length	109 pm	127 pm	141 pm	154 pm
Strength	436 kJ/mol	431 kJ/mol	366 kJ/mol	298 kJ/mol

Higher electronegativity values result in stronger bonds.

Examples



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Ralph J. Fessenden, Joan S. Fessenden



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