

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



Regioselectivity and Stereochemistry

Bond Types, Strength, Length, Polarity and Dipole Moment

Types of Bonds

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

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



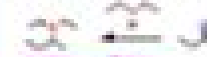
- **Covalent bonds** are formed by sharing of electrons between two atoms.



The Relative Strength of Bonds



Bond and Bond Energy



Bond Energy



There are two types of bonds

Definition of ionic bond



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.
- **Single bond** is a sigma bond.
- **Double bond** consists of one sigma and one pi bond.



pi bonds are weaker than sigma bonds.

Polar and Nonpolar Covalent Bonds

Depending on the difference in electronegativity

covalent bonds can be polar and nonpolar.



- If the difference in electronegativity is less than 0.5, the bond is non-polar covalent.
- If the difference in electronegativity is between 0.5 and 1.7, the bond is polar covalent.
- If the difference in electronegativity is greater than 1.7, the bond is ionic.

A difference of 1.7 or higher is a high value for the difference in electronegativity and is a ionic bond.

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Dipole Moment

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



- The dipole moment is a vector pointing from the less electronegative to the more electronegative atom.
- The more electronegative atom has a partial negative charge (δ^-) and the less electronegative atom has a partial positive charge (δ^+).
- δ^- (delta minus) indicates an electron deficient atom.
- δ^+ (delta plus) indicates an electron rich atom.

Molecular Dipole

To determine the molecular polarity, the vector sum of the dipoles is used.

The geometry of the molecule is important. Symmetrical molecules are non-polar even if the dipole moments are present. A good example is carbon dioxide.



Carbon dioxide is a linear molecule and the dipoles cancel.

Bond Length and Bond Strength

The longer the bond, the weaker it is.

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 and are shorter.

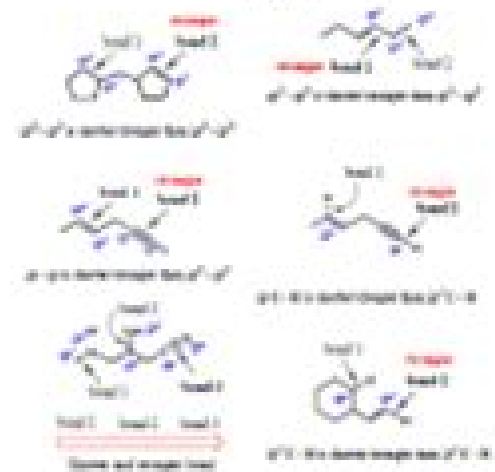


The longer the bond, the weaker it is.

Average values of C-C and C-H bonds depending on hybridization			
C-C Bond	sp^3-sp^3	sp^2-sp^2	$sp-sp$
Hybridization	sp^3-sp^3	sp^2-sp^2	$sp-sp$
Length	154 pm	134 pm	121 pm
Strength	347 kJ/mol	461 kJ/mol	591 kJ/mol
Hybridization	sp^3-sp^2	sp^2-sp	$sp-sp$
Length	147 pm	133 pm	121 pm
Strength	356 kJ/mol	461 kJ/mol	591 kJ/mol

Higher s character means shorter and stronger bond

Examples



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**Robert Thornton Morrison, Robert
Neilson Boyd**



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