

# Reactions of Amines and Epoxides

## Preparation of Amines

Amines are colorless, basic, and have a strong, fishy odor. They are prepared by the reduction of nitriles.



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



## Bond Types, Strength, Length, Polarity and Dipole Moment

### Types of Bonding Interactions

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 Strength of Bonds



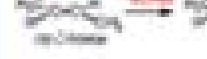
### Bond and Bonding Interactions



### Bonding Interactions



### There are two types of bonding interactions



## Sigma and pi bonds

Covalent bonds are classified as 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 bonds** are sigma bonds.
- **Double bonds** are sigma and 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.



- If the difference in electronegativity is less than 0.5, the electrons are shared equally (nonpolar bond).
- If the difference in electronegativity is between 0.5 and 1.7, the electrons are shared unequally (polar bond).
- If the difference in electronegativity is greater than 1.7, the electrons are not shared (ionic bond).

- A difference of 1.7 or higher can be used to determine if a bond is ionic or covalent.

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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 atom to the more electronegative atom.
- The more electronegative atom has a partial negative charge (δ<sup>-</sup>) and the less electronegative atom has a partial positive charge (δ<sup>+</sup>).
- δ<sup>-</sup> (delta minus) indicates an electron deficient atom.
- δ<sup>+</sup> (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 nonpolar even if the dipoles are present. A good example is carbon dioxide.



Carbon dioxide is a linear molecule and the dipoles cancel.

## Bond Length and Bond Strength

The length of a bond is important.

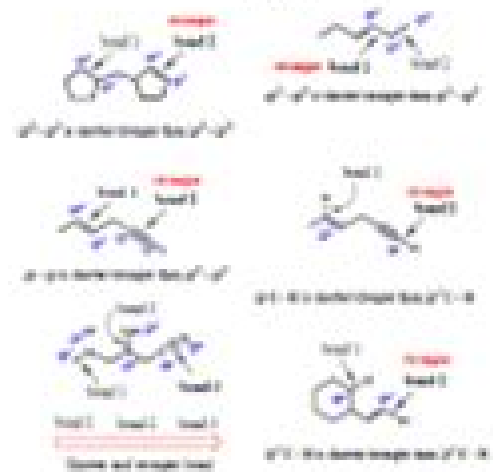


The length of a bond is important.

Average values of C-C and C-H bonds depending on hybridization			
C-C Bond	sp <sup>3</sup> -C-C	sp <sup>2</sup> -C-C	sp-C-C
Hybridization	sp <sup>3</sup> -sp <sup>3</sup>	sp <sup>2</sup> -sp <sup>2</sup>	sp-sp
Length	1.54 Å	1.34 Å	1.20 Å
Strength	33 kcal/mol	47 kcal/mol	58 kcal/mol
Hybridization	sp <sup>3</sup> -sp <sup>3</sup>	sp <sup>2</sup> -sp <sup>2</sup>	sp-sp
C-H Bond	sp <sup>3</sup> -H	sp <sup>2</sup> -H	sp-H
Length	1.09 Å	1.08 Å	1.06 Å
Strength	99 kcal/mol	110 kcal/mol	120 kcal/mol

Higher s character = stronger and shorter bond

## Examples



# Organic Chemistry I Study Guide

**Herbert Meislich, Howard  
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