

# 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

### 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



### Bonding energy



### There are two types of bonding

#### Definition of ionic bond



#### Definition of covalent 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.

- **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.



- If the difference in electronegativity is less than 0.5, the electrons are shared equally (nonpolar bond). For example, the C-C and C-H bonds.

- If the difference in electronegativity is between 0.5 and 1.7, the electrons are shared unequally (polar bond). For example, the C-O and C-N bonds.

- A difference of 1.7 or higher is ionic (the electrons are not shared) - ionic bond is formed.

## Dipole Moment

The polarity of a bond is described by the dipole moment ( $\mu$ ).



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

- The vector electronegativity shows two important aspects: (1) the electronegativity value, and (2) the direction of the dipole moment.

- $\delta^-$  (delta minus) indicates an electron-deficient atom.

- $\delta^+$  (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. A good example is carbon dioxide.



Carbon dioxide is a nonpolar molecule.

## Bond Length and Bond Strength

The bond length is the distance between the nuclei of the two atoms.

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 triple bonds are stronger than double bonds.

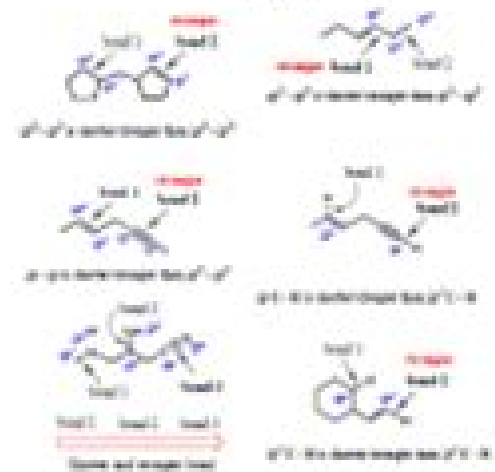


The bond length is the distance between the nuclei of the two atoms.

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	376 kJ/mol	472 kJ/mol	591 kJ/mol
Hybridization	$sp^3-sp^2$	$sp^2-sp$	$sp-sp$
Length	147 pm	133 pm	121 pm
Strength	418 kJ/mol	504 kJ/mol	602 kJ/mol

Higher s character means shorter and stronger bond.

## Example



# Organic Chemistry Study Guide

**Jiben Roy**



## Organic Chemistry Study Guide:

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chemistry like any skill is best learned by doing It is difficult to learn by rote memorization and true understanding comes only from concentrated reading and working as many problems as possible In fact problem sets are the best way to ensure that concepts are not only well understood but can also be applied to real world problems in the work place

**Organic Chemistry** Robert Thornton Morrison,1983      **Study Guide to Organic Chemistry** Robert Thornton Morrison,Robert Neilson Boyd,1987      Organic Chemistry Paula Y. Bruice,Paula Yurkanis Bruice,2001

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