

# 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). Examples:



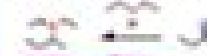
• **Covalent bonds** are formed by sharing of electrons between two atoms.



### The Relative Electronegativity of Atoms



### Bond and Electron Sharing



### Bonding in Molecules



### There are two types of bonding:

1. **Ionic bonding**



2. **Covalent bonding**



## Sigma and pi bonds

Covalent bonds are classified as sigma and pi bonds.

• **Sigma bonds** are formed by head-on (end-to-end) overlap of orbitals.

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

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

• **Two double bonds consist of one sigma and one pi bond.**



• **pi bonds are stronger than sigma bonds.**

## Polar and Nonpolar Covalent Bonds

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

• **Polar covalent bond:** A bond between two atoms with different electronegativities.

• **Nonpolar covalent bond:** A bond between two atoms with similar electronegativities.

• **If the difference in electronegativity is between 0.5 and 1.7, the bond is polar covalent.** The most important examples are the C-H and C-Cl bonds.

• **If the difference in electronegativity is between 1.7 and 2.0, the bond is ionic.** The most important examples are the Na-Cl and K-Br bonds.

• **A difference of 2.0 or higher indicates that the electrons are not shared, but are lost to the more electronegative atom.**

## Dipole Moment

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

It is a vector quantity.



The dipole moment is a vector pointing from the positive end to the negative end.

• The dipole moment is a vector pointing from the positive end to the negative end.

• The vector dipole moment is a vector pointing from the positive end to the negative end.

• **delta minus (δ-) indicates an electron deficient area.**

• **delta plus (δ+) indicates an electron rich area.**

## Molecular Dipole

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

The polarity of the molecule is a vector sum of the bond dipoles. The polarity of the molecule is a vector sum of the bond dipoles.



• **Overall the molecule is polar (dipole moment is not zero).**

## Bond Length and Bond Strength

• **The longer the bond, the weaker the bond.**

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.**

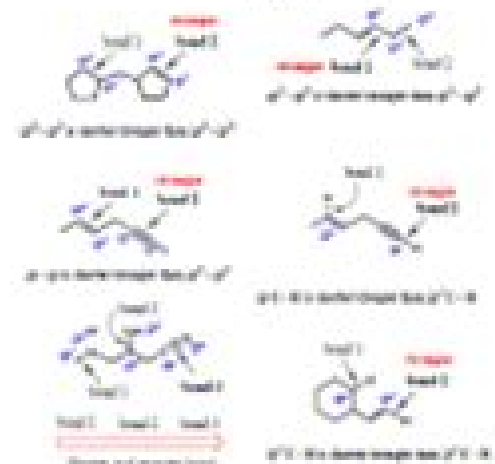


• **The longer the bond, the weaker the bond.**

Average values of C-H and C-Cl bonds depending on hybridization			
C-H Bond	$sp^3$ -C-H	$sp^2$ -C-H	$sp$ -C-H
Hybridization	$sp^3$	$sp^2$	$sp$
Length	109 pm	108 pm	106 pm
Strength	410 kJ/mol	437 kJ/mol	505 kJ/mol
Hybridization	$sp^3$	$sp^2$	$sp$
C-Cl Bond	$sp^3$ -C-Cl	$sp^2$ -C-Cl	$sp$ -C-Cl
Length	177 pm	170 pm	169 pm
Strength	339 kJ/mol	399 kJ/mol	403 kJ/mol

• **Higher s character = stronger and shorter bond.**

## Examples



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**Yicheng Fang**



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