

# 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



Regioselectivity and Stereochemistry

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

### Free-radical halogenation



There are two types of halogen bond: ionic halogen bond and covalent halogen bond.

- Ionic halogen bond: formed by the transfer of electrons from one halogen to another (halogenation) (oxidation) and another (reduction) (halogenation).



- Covalent halogen bond: formed by sharing of electrons between two atoms.



### The Relative Electronegativity of Atoms



### Bond and Bonding in a Molecule



### Bonding in a Molecule



### There are two types of halogen bond

Definition of halogen bond



Definition of halogen bond



Definition of halogen 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.

- A single bond is a sigma bond.
- A double bond consists 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.



- 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 indicates that the electrons are not shared (ionic bond).

## 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 vector electronegativity of an atom is a measure of its electronegativity, expressed as a positive charge (δ+).

- δ+ (delta plus) indicates an electron-deficient atom.

- δ- (delta minus) 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 dipole moments are present. A good example is carbon dioxide.



Cancel the vector as the vector pointing from the center out.

## Bond Length and Bond Strength

The length of the bond is important.



Double bonds are stronger than single bonds, and triple bonds are stronger than double bonds.

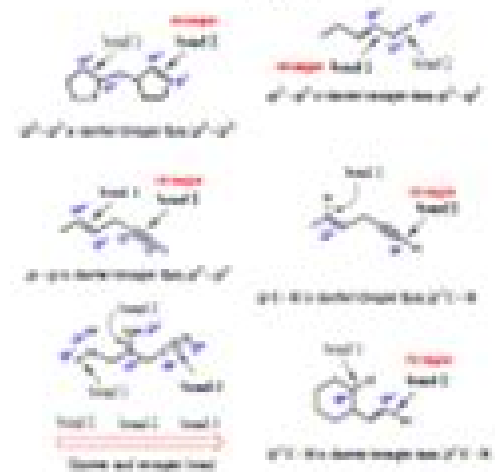


The length of the bond is important.

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	1.54 Å	1.34 Å	1.20 Å
Strength	33 kcal/mol	47 kcal/mol	58 kcal/mol
Hybridization	$sp^3-sp^3$	$sp^2-sp^2$	$sp-sp$
C-H Bond	$sp^3-sp^3$	$sp^2-sp^2$	$sp-sp$
Length	1.09 Å	1.08 Å	1.06 Å
Strength	98 kcal/mol	110 kcal/mol	120 kcal/mol

Higher s character means stronger bond

## Example



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**David R. Klein**



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