

# 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



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

### Two types of bond strength

There are two types of bond strength: bond strength and bond energy.

- Bond strength is the energy required to break a bond in a molecule.
- Bond energy is the energy required to break a bond in a molecule.



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



### The Relative Strength of Covalent Bonds



### Bond and Bond Energy



### Bond Energy



### There are two types of bond energy

#### Definition of bond energy



## 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 double bonds consist of one sigma and one pi bond.



pi bonds are weaker 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 bond is nonpolar. If the difference is between 0.5 and 1.7, the bond is polar. If the difference is greater than 1.7, the bond is ionic.

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

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

## Dipole Moment

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



- The dipole moment is the product of the charge and the distance between the charges.
- The net dipole moment of a molecule is the vector sum of the individual dipole moments.
- If the net dipole moment is zero, the molecule is nonpolar.
- If the net dipole moment is not zero, the molecule is polar.

## Molecular Dipole

To determine the molecular dipole, the net dipole moment of the molecule is calculated.

The polarity of the molecule is determined by the net dipole moment. If the net dipole moment is zero, the molecule is nonpolar. If the net dipole moment is not zero, the molecule is polar.



Draw the net dipole moment of the molecule.

## Bond Length and Bond Strength

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



Double bonds are stronger than single bonds.

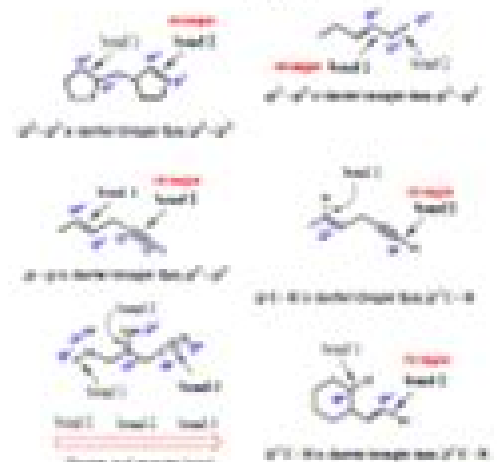


The bond length is the distance between the nuclei of the two atoms.

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	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	99 kcal/mol	110 kcal/mol	120 kcal/mol

Higher s character means stronger bond

### Examples



# Organic Chemistry I Study Guide

**Susan McMurry**



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