

# 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 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



### Bonding and Antibonding Molecular Orbitals



### Bonding molecular orbitals



### There are two types of molecules

1. Polar molecules



## 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 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.

• **Polar covalent bonds:** The difference in electronegativity is between 0.5 and 1.7.

• **Nonpolar covalent bonds:** The difference in electronegativity is less than 0.5.

• **If the difference in electronegativity is between 1.7 and 2.0, the bond is ionic.**

• **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.

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• **Electronegativity difference** is a measure of the ability of an atom to attract electrons.

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## 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.



• **The molecular dipole moment is the vector sum of the bond dipoles.**

## 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 |

• **The bond length increases as the atomic number increases.**

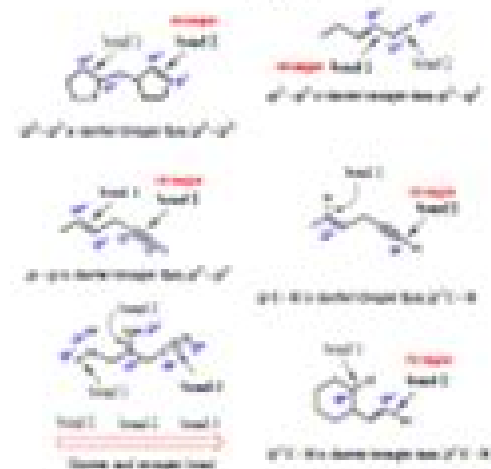


The bond length is the distance between the nuclei of the two atoms.

| 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                                                       | 347 kJ/mol  | 461 kJ/mol  | 591 kJ/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                                                         | 109 pm      | 108 pm      | 106 pm     |
| Strength                                                       | 413 kJ/mol  | 439 kJ/mol  | 505 kJ/mol |

• **The bond length decreases as the hybridization increases.**

## Examples



# Organic Chemistry Final Study Guide

**RJ Shavelson**



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