

# Reactions of Amines and Epoxides

## Preparation of Amines

Amines of different types can be prepared by various methods. The following are some of the common methods:



## Free electron lone-pairs

There are two types of bonding: **sigma bonding** and **covalent bonding**.

- **Sigma bonds** are formed by the overlap of orbitals from one atom to another (homogeneous overlap) and **covalent bonding** (heteroatomic bonding).



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



## The Relative Strength of $\sigma$ and $\pi$ Bonds



## Bond and Bonding in $\pi$ Bonds



## Bonding in $\pi$ Bonds



## There are two main types of $\pi$ bonds

• **Double bonds**



## A Summary of Ring-Opening Reactions of Epoxides with Strong and Weak Nucleophiles



Epoxide Reactivity and Mechanism

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

### Dipole Moment

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

It is a vectorial sum of the electronegativity differences of the two atoms.



Electronegativity differences of the atoms in a bond.

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

- The more electronegative atom has a partial negative charge ( $\delta^-$ ) and the less electronegative atom has a partial positive charge ( $\delta^+$ ).

- $\delta^-$  (delta minus) indicates an electron deficiency area.

- $\delta^+$  (delta plus) indicates an electron-rich area.

### Molecular Dipole

To increase the molecular polarity, the same side of the dipole is used.

The polarity of the molecule is a vectorial sum of the dipole moments of the individual polar bonds. A good example is carbon dioxide.



Cancel the vector in the other direction with the other one.

| 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 Å       | 134 Å       | 120 Å      |
| Strength  | 376 kJ/mol  | 473 kJ/mol  | 591 kJ/mol |
| Hybridization   | $sp^3-sp^3$ | $sp^2-sp^2$ | $sp-sp$    |
| Hybridization   | $sp^3-sp^3$ | $sp^2-sp^2$ | $sp-sp$    |
| Length  | 154 Å       | 134 Å       | 120 Å      |
| Strength  | 413 kJ/mol  | 473 kJ/mol  | 508 kJ/mol |

**Higher s character implies shorter and stronger bond**

### Sigma and pi ( $\pi$ ) bonds

Covalent bonds are classified as **sigma** and **pi** bonds.

- **Sigma bonds** are formed by head-on (axial) overlap of orbitals.

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

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

- One **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 values, covalent bonds can be **polar** and **nonpolar**.



- If the difference in electronegativity is **less than 1.7**, the electrons are shared equally (nonpolar bond). For two atoms, forming a **nonpolar covalent bond**. (This is typical examples are for C-C and C-H bonds).

- If the difference in electronegativity is **between 1.7 and 1.9**, the bond is **polar covalent bond**. (This is typical examples are atoms for carbon a bonded to N, O, F and other halogens).

- A difference of **1.9 or higher** is a **high** for the electrons are not shared (ionic bond) or **ionic bond** is formed.

### Bond Length and Bond Strength

• **Shorter the bond, the stronger it is.**

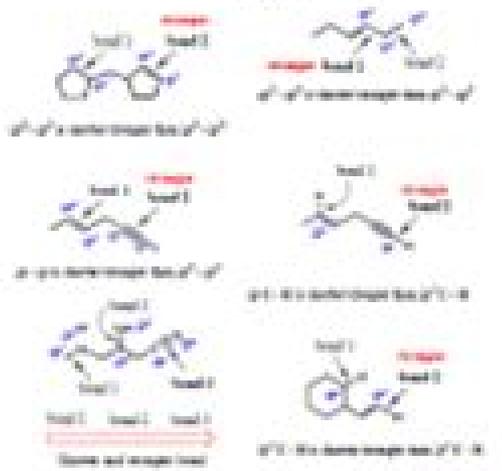
| Bond     | H-H        | H-Cl       | H-Br       | H-I        |
|----------|------------|------------|------------|------------|
| Length   | 74 Å       | 127 Å      | 141 Å      | 154 Å      |
| Strength | 436 kJ/mol | 431 kJ/mol | 366 kJ/mol | 298 kJ/mol |

Double bonds are stronger than single bonds in the double and a stronger bond.



• **Stronger the bond, the shorter it is.**

### Example



# Study Guide For Organic Chemistry

**R Pring**



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