

# 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

### Types of Bonding Interactions

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).



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



### The Relative Strength of Ions



### Bond and Bonding Interactions



### Bonding Interactions



### There are two types of bonding interactions



## Sigma and pi bonds

Covalent bonds are classified as sigma and pi bonds.

- **Sigma bonds** are formed by head-on overlap of orbitals.
- **pi bonds** are formed by side-on overlap of orbitals.
- **Single bonds** are sigma bonds.
- **Double bonds** are sigma and 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.



- If the difference in electronegativity is less than 0.5, the electrons are shared equally (nonpolar).
- If the difference in electronegativity is between 0.5 and 1.7, the electrons are shared unequally (polar).
- If the difference in electronegativity is greater than 1.7, the electrons are not shared (ionic).

- A difference of 1.7 or higher can be high for the electrons are not shared (ionic).

## 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 to the more electronegative atom.
- The more electronegative atom has a partial negative charge (δ<sup>-</sup>) and the less electronegative atom has a partial positive charge (δ<sup>+</sup>).
- δ<sup>-</sup> (delta minus) indicates an electron deficient atom.
- δ<sup>+</sup> (delta plus) 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 dipoles are present. A good example is carbon dioxide.



Carbon dioxide is a linear molecule and the dipoles cancel.

## Bond Length and Bond Strength

The longer the bond, the weaker it is.

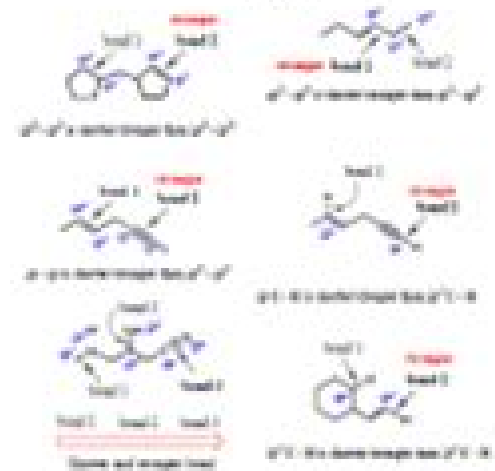


The longer the bond, the weaker it is.

| Average values of C-C and C-H bonds depending on hybridization |                                  |                                  |             |
|--|----------------------------------|----------------------------------|-------------|
| C-C Bond   | sp <sup>3</sup> -C-C             | sp <sup>2</sup> -C-C             | sp-C-C      |
| Hybridization  | sp <sup>3</sup> -sp <sup>3</sup> | sp <sup>2</sup> -sp <sup>2</sup> | sp-sp       |
| Length   | 1.54 Å                           | 1.34 Å                           | 1.20 Å      |
| Strength   | 33 kcal/mol                      | 47 kcal/mol                      | 58 kcal/mol |
| Hybridization  | sp <sup>3</sup> -sp <sup>3</sup> | sp <sup>2</sup> -sp <sup>2</sup> | sp-sp       |
| Length   | 1.54 Å                           | 1.34 Å                           | 1.20 Å      |
| Strength   | 33 kcal/mol                      | 47 kcal/mol                      | 58 kcal/mol |

Higher s character = stronger and shorter bond

## Examples



# Pavia Organic Chemistry Lab Study Guide

**Lingsheng Yao**



## **Pavia Organic Chemistry Lab Study Guide:**

*Organic Laboratory Experiments of the Future* Bruce H. Lipshutz, Hubert Muchalski, 2025-12-05 This lab manual offers students the opportunity to learn organic chemistry through a green chemistry lens resulting in a more sustainable future looking course Lipshutz and Muchalski's *Organic Laboratory Experiments of the Future* Doing Chemistry in Water approaches the subject with experiments diagrams and illustrations shaped by student feedback and honed through years of research and laboratory experience *Organic Laboratory Experiments of the Future* Doing Chemistry in Water includes material on reactions run in water including but not limited to ppm Pd catalyzed couplings SNAr reactions nitro group reductions enzyme catalyzed reactions catalytic hydrogenation of olefins olefin metathesis reductive aminations and chemoenzymatic sequences This lab manual is ideal for courses in organic chemistry biochemistry sustainable and green chemistry and environmentally responsible lab courses Provides practical information and techniques for utilizing green chemistry and chemistry in water in particular in the study of modern organic chemistry Includes numerous figures examples illustrative problems and appendices that reinforce laboratory concepts and methods Features coverage on experiments that focus on chemocatalysis as well as biocatalysis reactions that include Nobel Prize winning organometallic chemistry multi step sequences involving chemocatalysis or chemoenzymatic catalysis

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