

Reactions of Amines and Epoxides

Preparation of Amines

Amines are often made by reduction of nitriles or by reductive amination of aldehydes and ketones.



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



Regioselectivity and Stereochemistry

Bond Types, Strength, Length, Polarity and Dipole Moment

Two types of covalent bond

There are two types of covalent bond: **sigma bond** and **pi bond**.

- Sigma bonds** are formed by the overlap of atomic orbitals (AOs) in a head-on manner (end-to-end overlap).



- Pi bonds** are formed by the overlap of atomic orbitals (AOs) in a side-on manner (side-to-side overlap).



The Relative Strength of σ and π Bonds



Bond and Bond Energy



Bond Energy



There are two types of covalent bond

Definition of covalent bond



Sigma and pi bonds

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

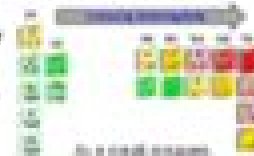
- Sigma bonds** are formed by the head-on overlap of atomic orbitals (AOs).
- Pi bonds** are formed by the side-on overlap of atomic orbitals (AOs).
- Sigma bonds** are stronger than pi bonds.
- Sigma bonds** are formed by the overlap of s, sp, and p orbitals.



σ bonds are stronger than π 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 bond is **nonpolar**.
- If the difference in electronegativity is **between 0.5 and 1.7**, the bond is **polar**.
- If the difference in electronegativity is **greater than 1.7**, the bond is **ionic**.

A difference of 1.7 or higher can be used to distinguish between ionic and covalent bonds.

A difference of 1.7 or higher can be used to distinguish between ionic and covalent bonds.

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 more electronegative atom has a partial negative charge (δ^-), and the less electronegative atom has a partial positive charge (δ^+).
- δ^- (delta minus) indicates an electron-deficient atom.
- δ^+ (delta plus) indicates an electron-rich atom.

Molecular Dipole

To determine the molecular polarity, the vector sum of the dipole moments is calculated.

The polarity of the molecule is determined by the vector sum of the dipole moments of the bonds.



Sum the vector of the dipole moments to find the net dipole.

Bond Length and Bond Strength

The length of the bond is related to the strength of the bond.

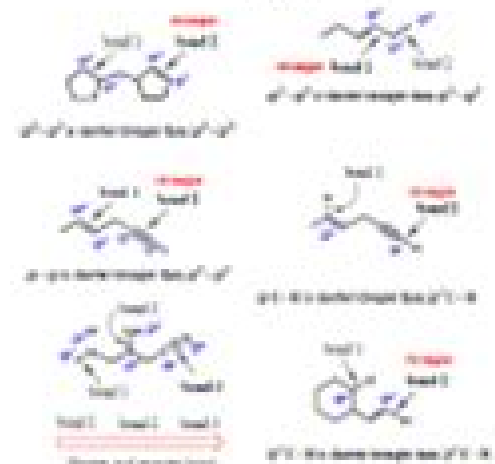


The length of the bond is related to the strength of the bond.

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	376 kJ/mol	472 kJ/mol	590 kJ/mol
Hybridization	sp^3-sp^2	sp^2-sp	$sp-sp$
C-H Bond	sp^3-sp^3	sp^2-sp^2	$sp-sp$
Length	1.09 Å	1.08 Å	1.06 Å
Strength	413 kJ/mol	439 kJ/mol	505 kJ/mol

Higher s character = stronger and shorter bond

Examples



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