

# 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



Epoxide Reactions and Mechanisms

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

### Two types of covalent bond

There are two types of covalent bond: ionic and covalent bond.

- **Ionic bonds** are formed by the transfer of electrons from one element to another (ionization potential) and electron affinity (electron affinity).



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



### The Relative Strength of Covalent Bonds



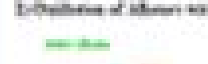
### Bond and Bond Energy



### Bond Energy



### There are two types of covalent bond



## 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.

- **Single bond** is a sigma bond.

- **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 of the atoms, covalent bonds can be polar and nonpolar.

• **Polar covalent bond** is formed when the difference in electronegativity is between 0.5 and 1.7.

• **Nonpolar covalent bond** is formed when the difference in electronegativity is less than 0.5.

• **Polar covalent bond** is formed when the difference in electronegativity is between 0.5 and 1.7.

• **Nonpolar covalent bond** is formed when the difference in electronegativity is less than 0.5.

## Dipole Moment

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

It is a vector quantity.



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

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

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

- **μ** (dipole moment) indicates the direction of the dipole.

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## Molecular Dipole

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

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



Calculate the vector sum of the dipole moments to find the molecular dipole.

## 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   | 107 pm     | 127 pm     | 141 pm     | 154 pm     |
| Strength | 436 kJ/mol | 431 kJ/mol | 366 kJ/mol | 298 kJ/mol |

Double bonds are stronger than single bonds.

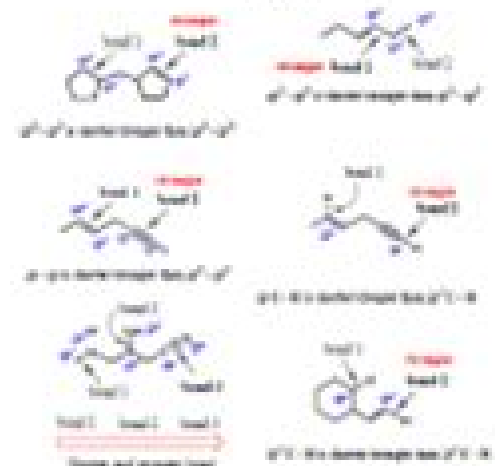


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| Bond     | H-H        | H-Cl       | H-Br       | H-I        |
|----------|------------|------------|------------|------------|
| Length   | 107 pm     | 127 pm     | 141 pm     | 154 pm     |
| Strength | 436 kJ/mol | 431 kJ/mol | 366 kJ/mol | 298 kJ/mol |

Higher electronegativity difference leads to stronger bond.

## Examples



Calculate the vector sum of the dipole moments to find the molecular dipole.

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**Wenbin Ji**



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