• All matter has both particle and wave character.
• The less massive the particle, the more important its wave character.
• The electron has a very low mass, low enough to have significant wave character.
Covalent Bond Formation

Two hydrogen atoms interact to form one hydrogen molecule.
Covalent Bond Formation

- Increased negative charge between the two positive nuclei leads to increased +/- attraction and holds the atoms together.
- **Covalent bond** = a link between atoms due to the sharing of two electrons
• **Molecule** = an uncharged collection of atoms held together by covalent bonds.
• Two hydrogen atoms combine to form a hydrogen molecule, which is described with the formula $\text{H}_2$. 
Nonpolar Covalent Bond

- If the electrons are shared equally, there is an even distribution of the negative charge for the electrons in the bond, so there is no partial charges on the atoms. The bond is called a nonpolar covalent bond.
Polar Covalent Bond

- If one atom in the bond attracts electrons more than the other atom, the electron negative charge shifts to that atom giving it a partial negative charge. The other atom loses negative charge giving it a partial positive charge. The bond is called a **polar covalent bond**.

Electrons shift toward the chlorine atom, forming partial plus and minus charges.

Hydrogen attracts electrons less.

Chlorine attracts electrons more.
Ionic Bond Formation

- Sodium metal, Na
- Chlorine gas, Cl₂
- Sodium atom, Na⁺ metallic cation
- Chlorine atom, Cl⁻ nonmetallic anion
- Ionic bond, an attraction between a cation and an anion

Each Na atom loses one electron and gets smaller.
Each Cl atom gains one electron and gets larger.

Sodium atom, Na metallic element

Chlorine atom, Cl nonmetallic element
Ionic Bond

- The attraction between cation and anion.
- Atoms of nonmetallic elements often attract electrons so much more strongly than atoms of metallic elements that one or more electrons are transferred from the metallic atom (forming a positively charged particle or cation), to the nonmetallic atom (forming a negatively charged particle or anion).
Sodium Chloride, NaCl, Structure

- Each chloride anion is surrounded by six cations.
- Each sodium cation is surrounded by six anions.

Ball-and-stick model

Space-filling model

Salt (sodium chloride)
Bond Types

Nonpolar Covalent Bond
Equal sharing of electrons
Both atoms attract electrons equally (or nearly so).
No significant charges form.

Polar Covalent Bond
Unequal sharing of electrons
This atom attracts electrons more strongly.
Partial positive charge
Partial negative charge.

Ionic Bond
Strong attraction between positive and negative charges.
This atom attracts electrons so much more strongly than the other atom that it gains one or more electrons and gains a negative charge.
This atom loses one or more electrons and gains a positive charge.
Types of Compounds

• All nonmetallic atoms usually leads to all covalent bonds, which from molecules. These compounds are called **molecular compounds**.

• Metal-nonmetal combinations usually lead to ionic bonds and **ionic compounds**.
Classification of Compounds

**Molecular compound**  
Hydrogen chloride, HCl, gas

- HCl molecule
  - Nonmetal
  - Nonmetal
  - Covalent bond

**Ionic compound**  
Sodium chloride, NaCl, solid

- Nonmetallic anions
- Metallic cations
Summary

- **Nonmetal-nonmetal** combinations (e.g. HCl)
  - Covalent bonds
  - Molecules
  - Molecular Compound

- **Metal-nonmetal** combinations (e.g. NaCl)
  - Probably ionic bonds
  - Alternating cations and anions in crystal structure
  - Ionic compound