

## 2.3 Covalent Bonding

- Electrons are shared in covalent bonds.
- General properties include: solid, liquid, or gas at SATP, low bp, low mp
- Molecular compounds are made from discrete molecules. The molecules are formed by covalent bonding.

### Definitions

- |                       |                            |
|-----------------------|----------------------------|
| • Diatomic molecule   | • Structural formula       |
| • Polyatomic molecule | • Bonding capacity         |
| • Covalent bond       | • Polyatomic ion           |
| • Lewis structure     | • Coordinate covalent bond |
| • Lone pair           | • Intramolecular force     |
| • Octet rule          | • Intermolecular force     |

### Formation of Covalent Bonds

- Covalent bonds are the sharing of electrons between nuclei. Neither loses or gains the electron to become ionic.
- In a Lewis structure if electrons are paired up then they are considered a lone pair and will not be involved in bonding.
- A bonding electron is an electron that has not yet paired up. It will form a covalent bond so that both of the atoms involved can have a filled octet. The number of bonding electrons is known as the bonding capacity.
- E.g. Using Lewis structure to show the bonding of a diatomic gas.

- Structural formula is used to simplify the Lewis structure.
- E.g. O<sub>2</sub> gas

### Rules for Lewis Structures

- **Read your textbook!**
- The key ideas of the Lewis theory of bonding are:
  - Atoms and ions are stable if they have a noble gas-like electron structure; i.e., a stable octet of electrons.
  - Electrons are most stable when they are paired.
  - Atoms form chemical bonds to achieve a stable octet of electrons.
  - A stable octet may be achieved by an exchange of electrons between metal and nonmetal atoms.
  - A stable octet of electrons may be achieved by the sharing of electrons between nonmetal atoms.
  - The sharing of electrons results in a covalent bond.

### Resonance Structures:

- When a structure containing a double bond can be drawn with the double bond in two or more locations without changing the arrangement of atoms, a resonance structure is said to exist. These different structures for the same molecule are called “resonance hybrids”.
- Example: SO<sub>3</sub> (sulfur trioxide)

- The bond lengths and strengths have been experimentally determined to fall between single and double bonds.
- The electrons forming the double bond(s) are said to be “delocalized” (shared) over all the bonds.

**Co-ordinate Covalent Bond:**

- A covalent bond in which one atom donates both bonding electrons. (This is an exception to regular covalent bonding where one electron is donated by each atom.)

Examples:

Name	Formula	Electron dot diagram
Ammonium	$\text{NH}_4^{+1}$	
Hydronium	$\text{H}_3\text{O}^{+1}$	
Nitrosyl trifluoride	$\text{NF}_3\text{O}$	

**Exceptions to the Octet Rule:**

1. Example:  $\text{PCl}_5$

- Molecules that have more than four atoms bonded to the central atom.

2. Example:  $\text{BF}_3$

- Molecules that contain no double bonds and whose central atom has fewer than four bonding electrons.

### 3. Example: NO

- Molecules containing an odd number of electrons.
- Molecules of this type are also “paramagnetic” because they are attracted by a magnetic field.

#### **Explaining the Properties of Molecular Compounds**

- Intermolecular forces are the forces used to hold atoms together in a molecule. They can be ionic or covalent bonds.
- Intramolecular forces are the forces that hold molecules together. They are much weaker than ionic or covalent bonds.

#### **Homework**

- Practice Questions: 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
- Section Questions: 1,2,3,4