

## Types of Bonds

### Bond

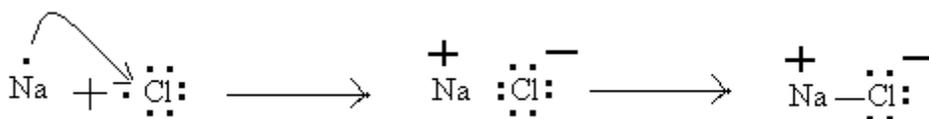
To start with, the bond is a some kind of chemical force (we do not want to go in detail as to the types of forces) that holds two atoms together. This chemical force is the results of attraction of electrons of one atom to the nucleus of the other atom. For example, if there is bond between A and B atoms, then the electrons of A are attracted to the nucleus of the B atoms and electrons of B atom are attracted to the nucleus of A atoms.

There are basically three types of bonds:

- Ionic bond
- Coordinate covalent bond or Dative bond
- Covalent bond

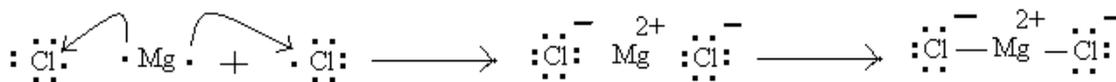
### Ionic Bond

Ionic bond is the bond that is formed by the *transfer of one or more electrons from one atom to another atom*. In other words, one atom donates electrons and other atom accepts electrons. The donating usually done by metals and accepting is done by non-metals. When this happens, the electrons are drawn more closely to the nucleus of the accepting atom and thereby making that atom negatively charged. On the other hand, the donating atom is positively charged because of the loss of electrons making some protons (positively charged particles in the nucleus) unmatched. Due to electrostatic attraction between the positive and negative charges, both nuclei are held together. The formation of bond in sodium chloride (NaCl) can be explained in terms of ionic bond. Na is a metal and Cl is anon-metal. Hence Na loses an electron ( Na has one valence electron) and Cl gains an electron making the octet ( 8 electrons in the valence shell) in the valence shell. Note that Cl to start with has 7 valence electrons and it completes the octet upon gaining one electron as shown below:



It is a usual practice to represent the share electrons by a single bond as depicted in the last diagram above.

Similarly, the formation of ionic bonds in  $\text{MgCl}_2$  can also be explained. Mg is a metal with 2 valence electrons. Cl is a non-metal with 7 valence electrons and hence it needs one electron to complete the octet. Thus Mg donates one electron to each Cl and becomes positively charged. Each Cl accepts one electron and becomes negatively charged.



Note that Mg has 2+ charges because it has lost 2 electrons and each Cl has one negative charge because each has gained one electron.

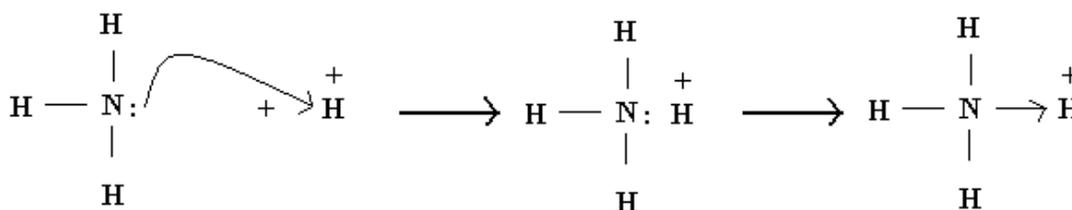
### Coordinate covalent bond

The coordinate covalent bond also known as dative bond is formed when *one atoms donates both electrons* (remember 2 electrons are needed to form one single bond). This happens when one atom lacks the necessary electrons for bonding and the other atom has two electrons to be donated.

Consider, for example, the reaction between ammonia ( $\text{NH}_3$ ) and hydrogen ion (proton) ( $\text{H}^+$ ) that takes place when ammonia reacts with water to form basic solution according to the following equation:



The formation of ammonium ion can be explained in terms of coordinate covalent bond:

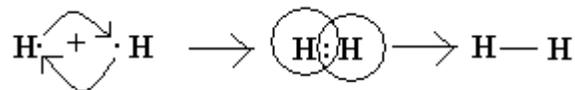


The N atom in  $\text{NH}_3$  has one lone pair of electrons and  $\text{H}^+$  has no electrons. Hence, N atom donates both electrons to proton to form the ammonium ion. The coordinate covalent bond is usually indicated by an arrow to show the direction of electron transfer.

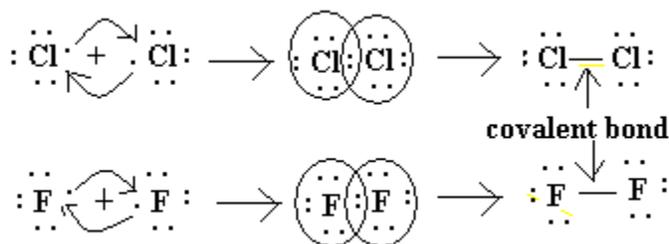
### The Covalent Bond

The covalent bond is formed when *electrons are equally shared by two atoms*. Such bond exists in  $\text{H}_2$ ,  $\text{Cl}_2$  or  $\text{F}_2$ .

H has one valence electron. Each H atom equally contributes towards the bond formation:



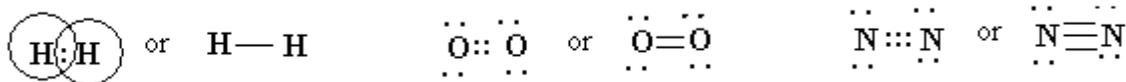
Cl and F have 7 valence electrons each. Out of 7, there are 3 paired electrons and one unpaired electron. Only the unpaired electron is shared as shown below.



When  $\text{Cl}_2$  and  $\text{F}_2$  are formed, the unpaired electrons participate in bonding as shown in the above diagram. Not only that but also these electrons are equally shared to form a covalent bond.

**Octet Rule and Duet Rule:** An atom, other than hydrogen, tends to form bonds until it acquires 8 electrons in the valence shell (Octet rule). Whereas, hydrogen atom tends to bond until it has 2 electrons in the valence shell (Duet rule). These situations are indicated by the circles in the above diagrams.

Atoms can form different types of covalent bonds – **single bond, double bond or triple bond**. One single bond equal to two electrons (one electron pair), double bond equal to four electrons (2 electron pairs), and triple bond equal to six electrons (3 electron pair). The double and triple bonds are collectively called as **multiple bonds**. In the following examples, the bond between H and H is a single bond (sharing of two electrons), the bond between O and O is a double bond (sharing of four electrons), and the bond between N and N is a triple bond (sharing of six electrons).



Note that H obey the duet rule (rule of 2) and O and N obey the octet rule.