

Module-11: Ionic and Covalent Bonding

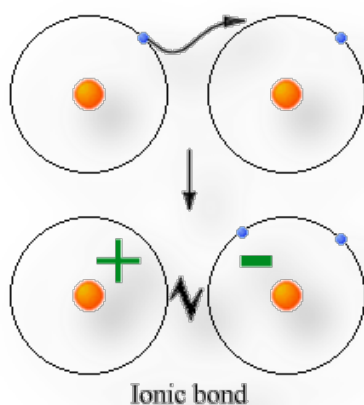


THE CHEMICAL BONDING

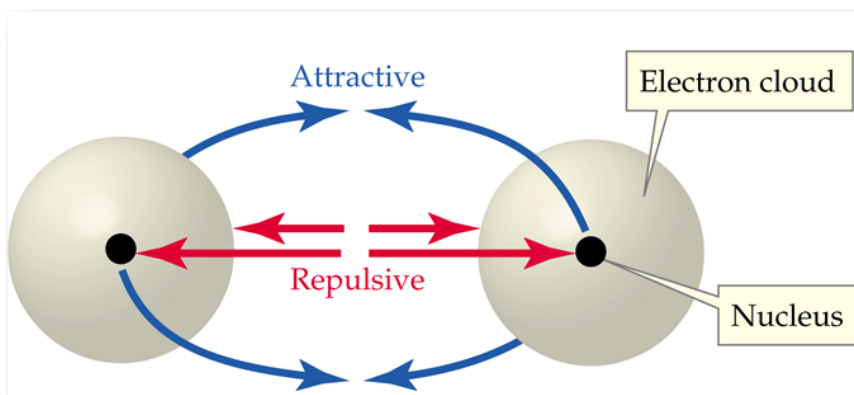
- Chemical bonds are described as the attractive forces that exist between atoms and between ions in chemical compounds.
- Chemical bonds are broadly classified into three classes: Covalent bonding, ionic bonding and metallic bonding. The type of bonding found in chemical compounds can be determined in most instances from the nature of the elements that form the bonds.

Nature of Atoms	Type of Bond	Bond Characteristic
Metals to nonmetals	Ionic	Electrons transferred
Nonmetals to nonmetals	Covalent	Electrons shared
Metal to metal	Metallic	Electrons pooled

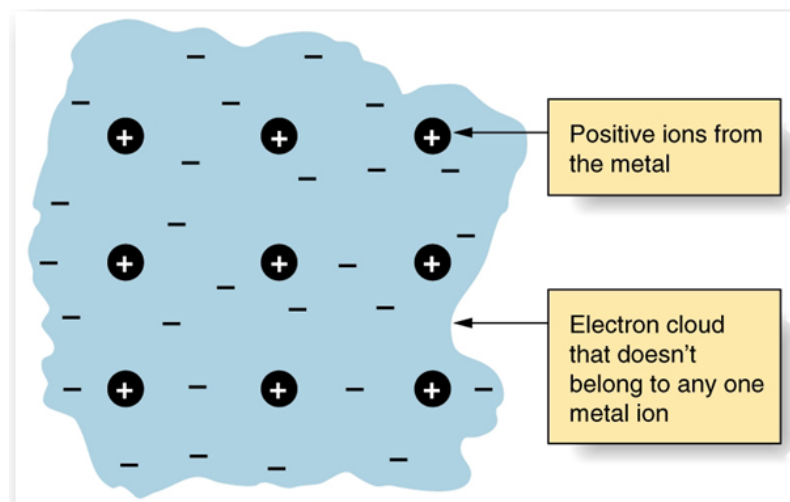
- Ionic compounds form when metals and nonmetals react. The attraction between positive and negative ions is called an **ionic bond**.



- Covalent bonding is formed by equal sharing of electrons between atoms of nonmetals. Nucleus-electron attractions are greater than the nucleus-nucleus and electron-electron repulsions. The net attractive force holds the atoms together.

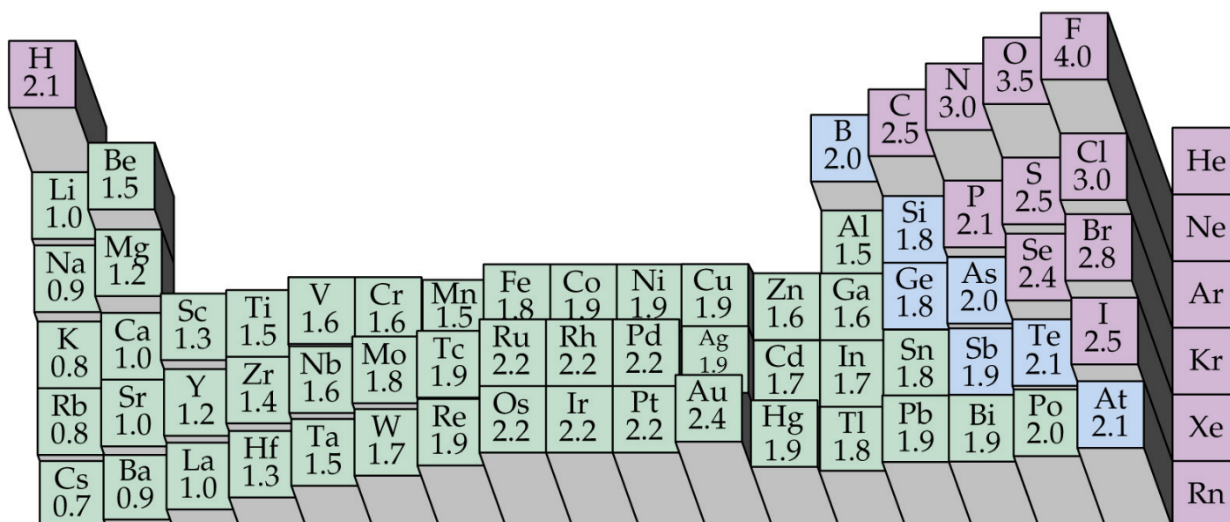


- Metallic bonding occurs only in metals and not in compounds between metals and nonmetals. All metal atoms in a lattice pool their electrons to form electron sea and this model explaining the bonding in metals and is called electron sea model.

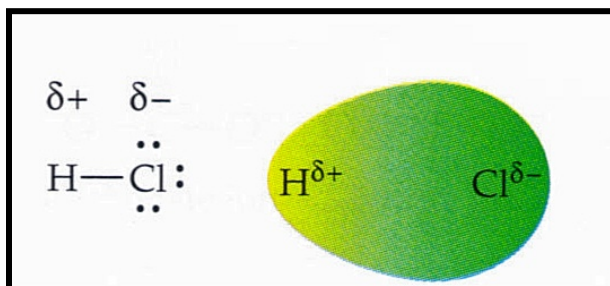


ELECTRONEGATIVITIES AND BOND POLARITIES

- Electronegativity: Electronegativity is a measure of the tendency of a particular atom in a molecule to attract a bonding pair of electrons.
- Fluorine (the most electronegative element) is given a value of 4.0, and values range down to cesium and francium which are the least electronegative at 0.7.



- Electronegativity values can be used as the basis to describe bond polarities. In the HCl molecule, the more electronegative chlorine atom holds the shared electrons closer to itself, and it results in chlorine end being more negative than the hydrogen end.



- The bond in hydrogen chloride is described as a **polar covalent bond**. The symbols, δ^+ and δ^- , signify respectively, which end is partially positive and which end is partially negatively charged. Note: it is not a complete charge separation, which occurs only in ionic compounds like NaCl.

- When the electronegativity between two atoms are zero or very small (less than 0.4), the covalent bonds are formed. Chemical compounds with this type bonding are described as molecular compounds.

Atom-1 (Electronegativity)	Atom-2 (Electronegativity)	Electronegativity Difference	Molecule formed- Nature of the bond
H (2.1)	H (2.1)	0	H ₂ -Covalent
Cl (3.0)	Cl (3.0)	0	Cl ₂ -Covalent
Cl (3.0)	Br (2.8)	0.2	BrCl-Covalent

- When electronegativity difference between two atoms is very large (more than 2.0) ionic bonds are formed. Compounds that contain ionic bonds are named ionic compounds.

Atom-1 (Electronegativity)	Atom-2 (Electronegativity)	Electronegativity Difference	Molecule formed- Nature of the bond
K (0.8)	F (4.0)	3.2	KF-Ionic
Na (0.9)	Cl (3.0)	2.1	NaCl-Ionic
Na (0.9)	F (4.0)	3.1	NaF-Ionic
K (0.8)	Cl (3.0)	2.2	KCl-Ionic

- When electronegativity difference between two atoms is between 0.5 and 2.0, a polar covalent bond is formed.

Atom-1 (Electronegativity)	Atom-2 (Electronegativity)	Electronegativity Difference	Molecule formed- Nature of the bond
H (2.1)	Cl (3.0)	0.9	HCl-Polar Covalent
H (2.1)	Br (2.8)	0.7	HBr-Polar Covalent
Br (2.8)	F (4.0)	1.2	BrF- Polar Covalent
Cl (3.0)	F (4.0)	1.0	ClF- Polar Covalent

Practice Problems

- A bond in which an electron pair is unequally shared by two atoms is
 (A) polar covalent. (B) ionic bond
 (C) nonpolar covalent (D) metallic
- Which pair of elements would form a covalent bond that is the least polar?
 (A) S and Li (B) Al and N
 (C) O and F (D) O and H
- Which of the following bonds would be the least polar yet still be considered polar covalent?
 (A) Mg–O (B) N–O (C) C–O (D) O–O
- Solid ionic compounds are associated with,
 (A) low melting points (B) high conductivity
 (C) high volatility (D) crystalline structures
- Which one of these ions listed with **incorrect** number of electrons?

	Ion	Number of electrons
(A)	Mo^{3+}	39
(B)	I^-	54
(C)	S^{2-}	14
(D)	Fe^{2+}	24

- Identify the **metal ion** which has 3+ charge in one the following compounds.
 (A) $\text{Ca}_3(\text{PO}_4)_2$ (B) $\text{Fe}_2(\text{SO}_4)_3$ (C) BaCO_3 (D) PBr_3

7. All of the following compounds are properly classified except,

	Compound	Classification
(A)	CH ₄	Covalent
(B)	KBr	Ionic
(C)	CsCl	Ionic
(D)	NH ₄ Cl	Covalent

8. By referring to the electronegativity values identify the bond that is most polar.

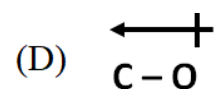
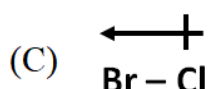
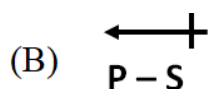
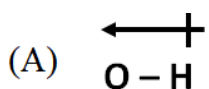
(A) S-H

(B) N-I

(C) C-Br

(D) Si-Cl

9. Which option appropriately represents the bond polarity?



10. In which one of the compounds manganese has the highest number of positive charges?

(A) MnO₂

(B) KMnO₄

(C) MnCl₂

(D) K₂MnO₄