

## Chemical Bonding

Bonding is joining. Atoms join to form compounds, molecules, crystals, metals and gases. The type of bonding dictates the structure and the bulk properties of matter. In order to understand the different type of bonding, it is good to be familiar with the periodic table.

I	II	TRANSLATION METALS		III	IV	V	VI	VII	VII

Atoms loss or gain electron to become ions. Ions are charged atoms. Positively charged ion are called **cation**, a negatively charged ion are **anion**. Metals in group I, II and III easily lose electrons to become cations. Non-metals in group VII, VI and V easily gain electrons to become negatively charged anion.

The outer ring or shell or energy level is also known as the valence ring. The number of electrons in the valence ring determines the electrical behaviour of an element – conductor or insulator.

The octet rule- for an atom to be stable, it must have eight electrons in their outer ring. Some elements require electrons to be added to make them stable while others require an electron to be removed to make it stable.

There are three types of bonds; Ionic, Covalent and Metallic.

### Ionic bonds (electrovalent bonding)

They are formed between two ions with opposite charges. Example Na lose its outer electron to become  $Na^+$ . Chloride gain one electron to become  $Cl^-$ .



The electrostatic force keeps the atoms together. Ionic bonds are formed between elements that readily lose electrons and others gain electrons. They result into a regular arrangements of atoms known as lattice.

### Group one (Alkali metals)

I	II
H	
Li	
Na	
K	

Their outer shells have one electron. They lose it fairly easy to form monopositive cations. ( $Na^+$ ) and ( $K^+$ ).

Group VII (fluorine (F) and chlorine (Cl))

They easily gain one electron to form mononegative ions. ( $F^-$ ) and ( $Cl^-$ )

Group one and group VII elements bond to form ionic bonding.

Group II ( Magnesium (Mg) and Calsium (Ca))beryllium(Be)

They are alkaline earth metals.

I	II
	Be
	Mg
	Ca

They contain soft silver metals that are less metallic. They form compounds through ionic bond.

They lose their two outer electrons to form double positive ions. E.g ( $Mg^{++}$ ) and ( $Ca^{++}$ ). They bond with group VI elements E.g (Oxygen and Sulphur) to form ionic bonding. Ions with opposite charges mutually attract one another.

Ionic bond is formed when there is complete transfer of valence electrons from one atom to another resulting in two ions with opposite charges. Metals and non-metals react to form ionic compounds.

### **Properties of ionic compounds**

Dissolve in water – they are made-up of oppositely charged ions which are attracted by the polar water molecules.

High melting points – ionic bonds are strong and require a lot of heat to break the bonds.

Poor conductor of electricity in solid state – electrons forming the bonds are not mobile. They are strongly held in specific positions in the structure.

Good conductor of electricity in molten and aqueous solution – ions are mobile and therefore conduct.

Hard – particles cannot slide over the others

Brittle – they cannot deform

### **Question**

1. Name three compound that are formed through ionic bonding.

#### **Solution**

Sodium chloride, potassium fluoride magnesium oxide and magnesium chloride

2. Explain why ionic compounds conduct electricity in their molten or aqueous state but not in the solid state.

#### **Solution**

Ions are fixed in specific location in solid state but they are mobile in molten and aqueous state.

3. Use a diagram to illustrate how sodium chloride is formed from sodium and chlorine.
4. State octate rule.

### **Solution**

The outer ring of an atom must have eight electrons for an atom to be stable.

5. Define the term cation and anion.

### **Solution**

Positively charged ion are called **cation**, a negatively charged ion are **anion**

6. What is a crystal?

### **solution**

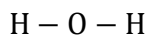
A crystal is a solid form of a substance in which the particles are arranged in definite pattern repeat regularly in three dimensions.

## **Covalent Bonding**

A type of bond formed when atoms share electrons. The mother nuclei attract the shared electrons. E.g. two hydrogen atoms combine to form hydrogen molecules. A molecule is a group of atoms (two or more) of the same or different elements that are held together by strong covalent bonds. Molecules further combine to form molecular substances. E.g. water, most gases etc. molecules are held together by weak van der waals forces.



A single covalent bond in hydrogen gas. The bar represent a single pair of shared electrons.



Double covalent bond in water. The combination of atoms could be from the same element or different elements.

## **Allotrope**

Different forms of an element in the same state. Diamond is an allotrope of diamond.

Covalent bonds are common in non-metals. Carbon, Silicon, Germanium in group IV.

### **Properties of materials having covalent bond**

Low melting and boiling points – most of them have few atoms. The more the atoms the higher the melting and boiling point.

Good insulators – electrons are tightly held and equally shared by the participating atoms.

### **Questions**

1. List down four substances that are formed by covalent bond.

#### **Solution**

Hydrogen gas ( $H_2$ ), water molecule ( $H_2O$ ), chlorine molecule ( $Cl_2$ ), nitrogen ( $N_2$ ), ammonium ( $NH_3$ ), carbon (IV) oxide molecule ( $CO_2$ ).

2. Explain why molecules formed through covalent bonds are transparent.

#### **Solution**

Their electrons are tightly held and shared by atoms hence they do not intercept light rays.

3. Explain why diamond is the hardest known substance.

#### **Solution**

All the bonds in diamond are strong covalent bonds and atoms are closely packed.

4. Graphite and diamond are both allotropes of carbon. Diamond is an insulator while graphite is a conductor of electricity. Explain.

#### **Solution**

The structure of graphite has a delocalized electron, which makes it a good electricity conductor. While all the valence electrons of each carbon atom are used in bonding.

## **Metallic bonding**

Atoms are held together by many nuclei attracting a sea of valence electrons. Nuclei are positively charged hence attract the electrons. The delocalized electrons hold the nuclei together. The valence electrons leave the individual atoms and become part of the "electron cloud". The delocalised electrons makes metals to conduct electricity. Metals with a higher number of valence electrons are better electric conductors than those with a fewer valence electrons.

Metals can be deformed as atoms can slide over each other. They are ductile.

They are opaque. Light cannot pass through them. The delocalised electrons intercept the light rays.

## **Questions**

1. Explain why metals are good conductors of electricity.

### **Solution**

They have free valence electrons

2. Aluminium is a better electrical than magnesium. Explain.

### **Solution**

Aluminium has three valence electrons and magnesium has two valence electrons. Thermal and electrical conductivity increases with the increased number of delocalised electrons.

3. Metals have high melting point. Explain.

### **Solution**

They have strong bonds