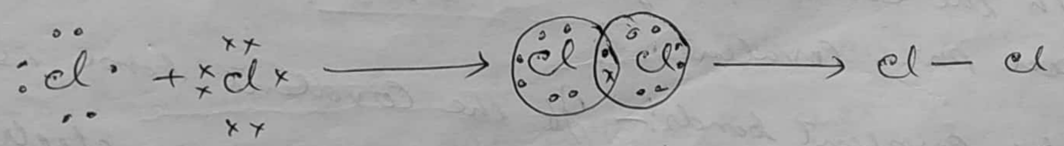
# COVALENT BONDING

When two atoms combine by the sharing of electrons in their outer most orbits, the bond formed between them is called Covalent bond.

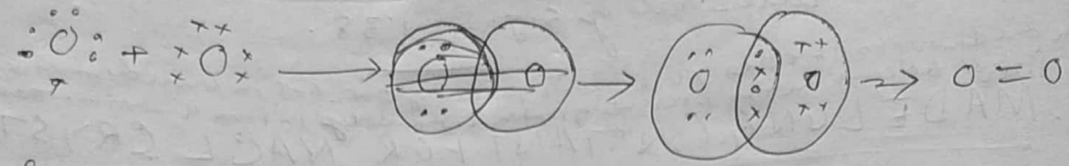
Example. (i) The formation of chlorine molecule $Cl_2$ is given by



If one atom of chlorine combines with another atom of chlorine, octet of both Cl-atoms are completed by sharing of one electron each.

Hence the bond formed by mutual sharing of two electrons is called single co-valent bond and denoted by (

(ii) The formation of oxygen molecule is given below




When two atoms of oxygens combine with another, two electrons pair are shared by both the atoms as shown in the fig. As two pairs of electrons have been shared by both the oxygen atoms, it is called double co-valent bond and denoted by double dash (=)

Types of Co-valent bonds:- There are two types of Co-valent bonds.

(i) Non-polar Co-valent bonds

(ii) Polar Covalent bonds

(i) Non polar Co-valent bonds:- If the bonds are formed by the combination of two like atoms, the electrons are equally distributed in both the atoms and the electronegativity (i.e capacity of pulling the electrons) of both the atoms are equal, then such bonds are called non-polar covalent bond. The bonds in $H_2$, $Cl_2$ etc. are non-polar.

$$H^{\cdot} + H^{\cdot} \longrightarrow H:H$$

$$:\ddot{Cl}\cdot + \cdot\ddot{Cl}: \longrightarrow :\ddot{Cl}:\ddot{Cl}:$$

The electrons taking part in sharing are at the middle of both the homonuclear atoms. These molecules are neutral because the centre of positive charge coincides with the centre of negative charge. Such molecules are called pure covalent.

(ii) Polar Covalent bonds:- If the covalent bond is formed between two dissimilar atoms the electron pair is not equally shared by both the atoms. The bonded electron pair is drawn more towards more electronegative atom and develops some

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partial negative charge ($\delta^-$) on it. The equal amount of partial positive charge ($\delta^+$) also accumulates on the less electronegative atom. Hence the bond become polar. Such a bond is known as polar covalent bond.

Example

| Compound. | Displacement of electron pair | partial charge. |
|---|---|---|
| HCl | H:Cl: | $\overset{\delta^+}{H}-\overset{\delta^-}{Cl}$ |
| HBr | H :Br: | $\overset{\delta^+}{H}-\overset{\delta^-}{Br}$ |
| $H_2S$ | H:S: (H) | $\overset{\delta^+}{H}-\overset{\delta^=}{S}-H^{\delta^+}$ |
| ~~H₂O~~ | H :Ö: (H, H) | $H^{\delta^+}-O^{\delta^=}-H^{\delta^+}$ |

properties of Co-valent bonds.

(i) These compounds may be solids, liquids, or gases. The substances having high nuclear weight exist as solids. These solids are hard and brittle.

(ii) Since atoms and molecules are arranged in a regular pattern in three dimensions in these solids, hence they have crystalline structure. Silicon, germanium, carbon etc are the example of such solid.

(iii) They are generally insoluble in water because $H_2O$ is polar. They are soluble in organic ~~[struck out]~~ solvents like benzene.

(iv) Since the valence electrons are tightly bound in these solids hence they are good insulators. But when certain amount of impurities are added to such solids, the ~~electricity~~ electrical conductivity will increase and the resulting material is called semiconductors.

(v) Because intermolecular binding force is weak, hence the melting point and boiling point are low.

## Vander Waal bonding :—

This is a molecular bonding. When many individual Covalent molecules are composed, they form compound either amorphous or molecular crystals. In such compounds each individual molecules is held together in a crystal by inter molecular forces. This binding force is called Vander Waal's force of attraction.

Since the atoms of inert gases (Ar, Ne, He etc) are spherically symmetrical and valence electrons are not available, hence they can't form any bond, the atoms in the molecules like $CH_4$, $O_2$ $N_2$ etc also attain inert gas configuration. These molecules are condensed to liquid and solid state with decrease of energy. In order to explain this, Vander Waal suggested some attractive forces acting between these molecules and ~~also~~ also between the atoms of inert gases. These attractive forces are weak.

If $r$ is the distance between molecules, the Vander Waal attraction is proportional to $r^{-7}$. Hence it is a short range force and it decreases as the distance between them increases. As the number of electrons in an atom increases, the Vander Waal attraction will increase. In all substances Vander Waal attraction is present. ~~It~~ Vander Waal attraction is due to dipole induced dipole attraction. The Vander Waal's forces are also known as London force.

## HYDROGEN BONDING:-

The Compound formed by the Combination of Hydrogen (H) and Flourine (F), Oxygen (O) or Nitrogen (N) are polar. For example HF, $H_2O$, $NH_3$ etc are polar molecules. In HF molecules H is electropositive and F is electronegative. Hence in the Covalent bond between H and F, the electron-pair is drawn towards F. Thus some negative charge ($\delta^-$) develops on F-atom and some positive charge ($\delta^+$) accumulates on H-atom.

$$H^{\delta+} — F^{\delta-}$$

Hence the positive end of one HF-molecule is attracted by the negative end of another HF-molecule.

$$\ldots H^{\delta+} — F^{\delta-} \ldots\ldots H^{\delta+} — F^{\delta-}$$

This attraction between two HF-molecules form a bond and the bond is called Hydrogen bond or Hydrogen bridge. In this way different molecules of HF joined together and form a molecule $(HF)_x$.

$$(\ldots H - F \ldots H - F \ldots H - F \ldots)_x$$

Hydrogen bond is weaker than Covalent bond and so F---H bond is weaker than H-F bond. Example of this crystals are $H_2O$ (ice), $NH_3$ and HF. These bonds are stronger than vander Waal bond and weaker than ionic bond.

## METALLIC BOND:-

Metalic bonds are formed by the sharing of valence electrons of all the atoms of metals. The atoms in a metal are held together by these bonds. The valence electrons are loosely bound to their individual atoms and they move randomly in different directions and are called free electrons. It is matter to notice that except free electrons, all the electrons are tightly bound to the nuclei.

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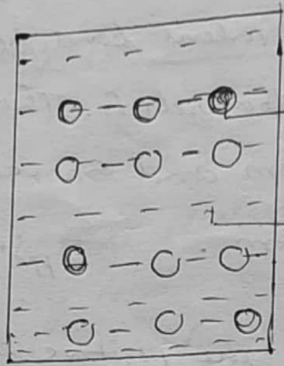
Let us Consider Copper atom. It has 29 electrons. The 28 electrons of it are tightly bound to the nuclei and one electron is free. When the copper atom loses this free electron, it become +vely charged ion. These free electrons formed a free electron cloud in metals. In this way the metal consist of +vely charged ions and free electron cloud as shown in the fig below.

Thus the +ve ions and the free electrons binds them together.




The metallic binding depends upon different types of forces. These are classified as follows.

(i) The force of attraction between the +ve ions and free electron (negative ions)

(ii) The force of mutual repulsion of the free electrons

(iii) The force of mutual repulsion of positive ions.

The important properties of metallic ~~bonds are~~ crystals formed by metallic bonding.

(i) Since the free electrons are available in the metals hence they are good Conductors of electricity.

(ii) The metals are good Conductor of heat because free electrons are treated as the carriers of heat.

(iii) The metallic crystals are opaque and strongly reflecting due to presence of free electrons.

(iv) These bonds are weaker than ionic and Covalent bond.

(v) Metal crystals are of unlimited size due to the unsaturated nature of the bond.

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