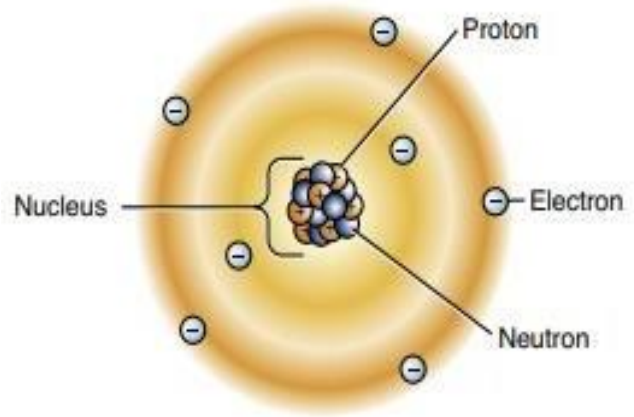
Structure of Solids and Interatomic Bonds

All materials are made up of atoms. If the reaction of a material and its properties are to be predicted, a basic knowledge of matter is essential. All dental restorations, whether they be ceramic, plastic or metal, are built from atoms.

Atom: is the smallest unit of matter that defines the chemical elements.

Atoms consist of three particles, a negatively charged electron, a positively charged proton, and an electrically neutral neutron.



- If the number of protons and electrons are equal, that atom is electrically neutral.
- An atom becomes a negative ion when it gains an electron(s) or a positive ion when it loses an electron(s).

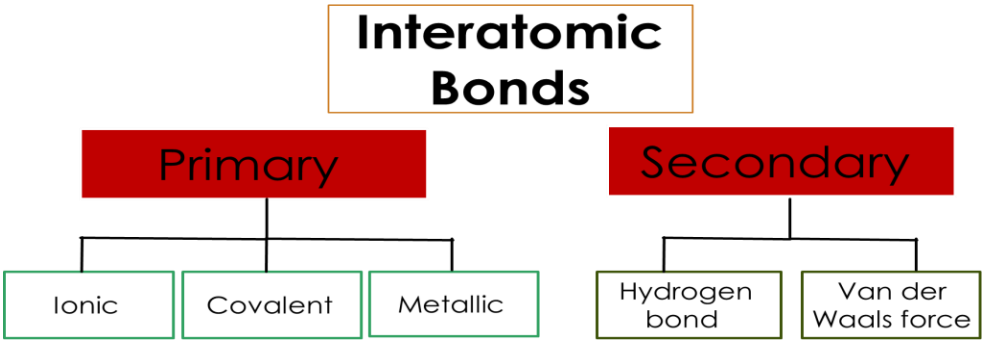
Molecule: is two or more atoms connected by chemical bonds.

The attraction between atoms within a molecule is strong, whereas the attractions between molecules are weaker.

Water as an example. The basic unit of water is a molecule made of two hydrogen atoms and one oxygen atom. If each molecule has a kinetic energy (the energy of motion) that is higher than the attraction between these molecules, they appear in vapor form.

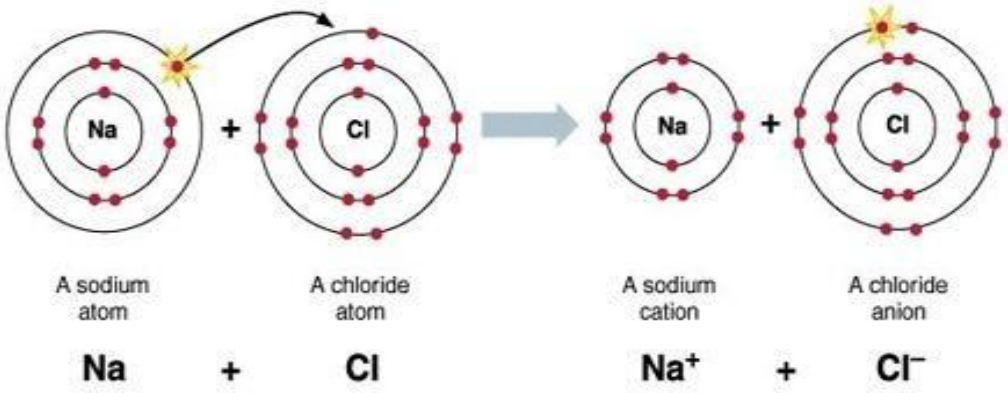
When the surrounding temperature decreases, the level of kinetic energy of the molecules decreases, and the attraction between them becomes more prominent so that they condense to liquid form. more cooling results in a solid mass called ice.

Interatomic bonds:

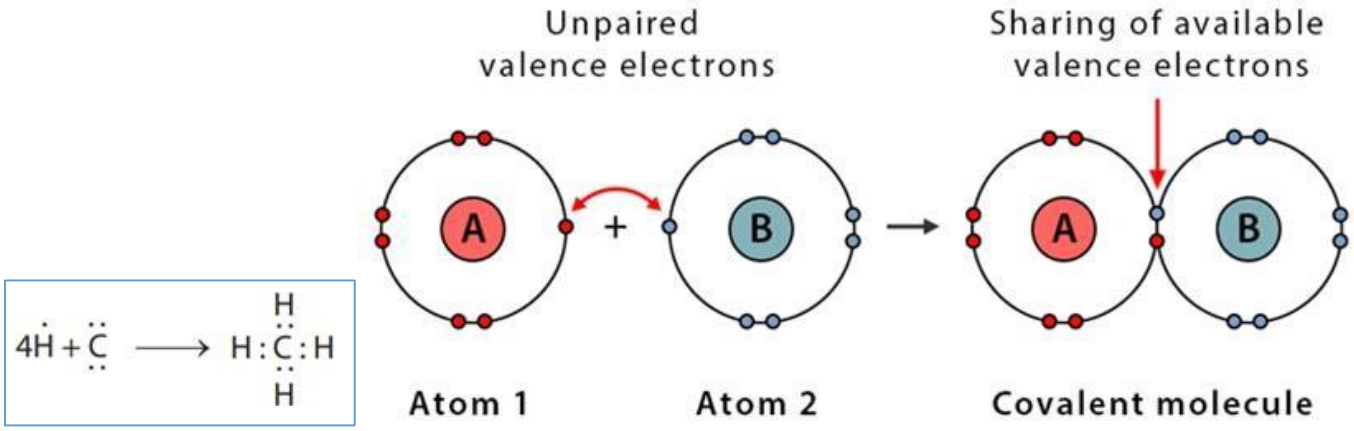


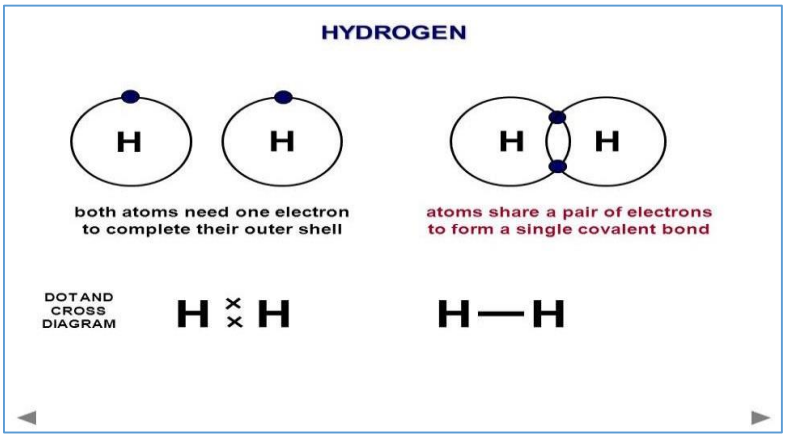
Primary bonds:

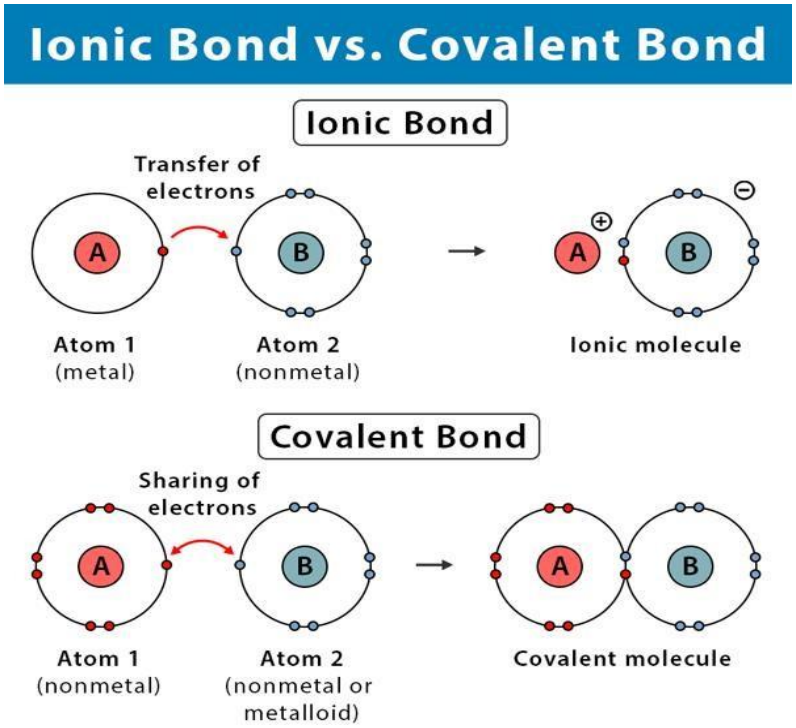
1. Ionic Bonds: These are simple chemical bonds, resulting from mutual attraction of positive and negative charges, such as sodium chloride $Na^+ Cl^-$.



2. Covalent Bonds: In many chemical compounds, two valence electrons are shared. Such as methane (CH_4). The carbon atom has 4 valence electrons that can be stabilized by joining with hydrogen.

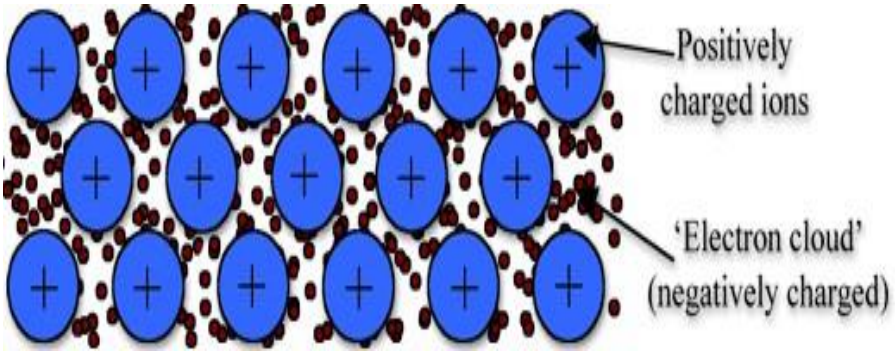






3. Metallic Bonds:

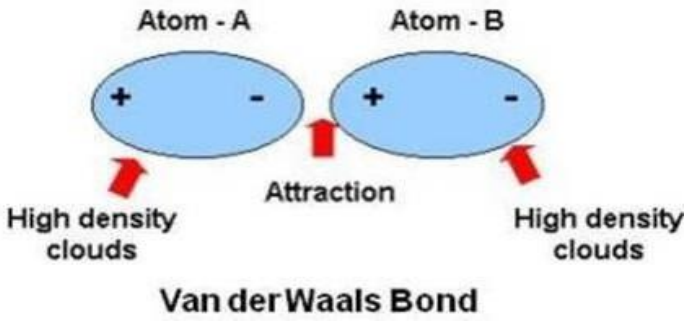
One of the characteristics of a metal is its ability to conduct heat and electricity and this conduction is due to the mobility of the free electrons in the metals. The outer electrons can be removed easily from the metallic atom leaving the balance of the electrons tied to the nucleus, thus forming a positive ion.



Secondary Bonds (Van Der Waals Forces)

They are also known as ***van der Waals forces***. In contrast to primary bonds, secondary bonds do not share electrons between molecules. Instead, the asymmetrical distribution of electrons within each molecule induces dipole forces that attract molecules together.

These forces are quite weak compared with the primary bonds.



Van der Waals Bond

All materials we use consist of trillions of atoms. They are attracted to each other and retain a physical appearance.

1. Crystalline Structure:

A space lattice or crystal can be defined as any arrangement of atoms in space in which every atom is situated similarly to every other atom (arranged in repeated regular crystalline organization of atoms). Space lattice may be the result of primary or secondary bonds. Example of crystalline solids include salt (sodium chloride), metals, sand, and carbon (graphite, diamond).

2. Noncrystalline Structure:

In noncrystalline structures or amorphous structures, e.g., waxes, the arrangement of atoms in the lattice is disorderly and distributed at random.