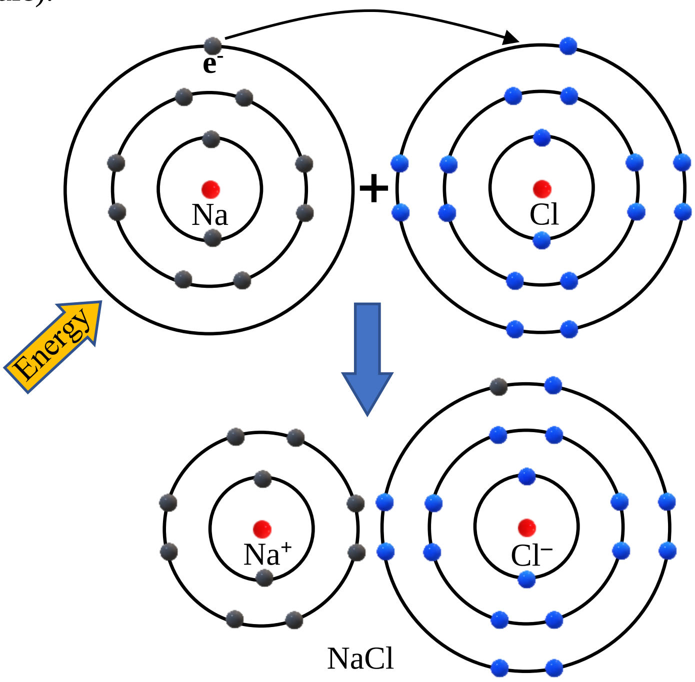
Ionic bond:

It also occurs between atoms and between molecules. It is a special case of covalent bond. Instead of electrons being shared equally, they share unequally. Ionic bonds occur when an atom donates an electron to another atom. The donor becomes a positive ion (or cation), while the acceptor becomes a negative ion (anion). Ionic bonds arise from the Coulomb (or electrostatic) force between positive cations and negative anions. (Example: Na^+ and Cl^- in a NaCl molecule).



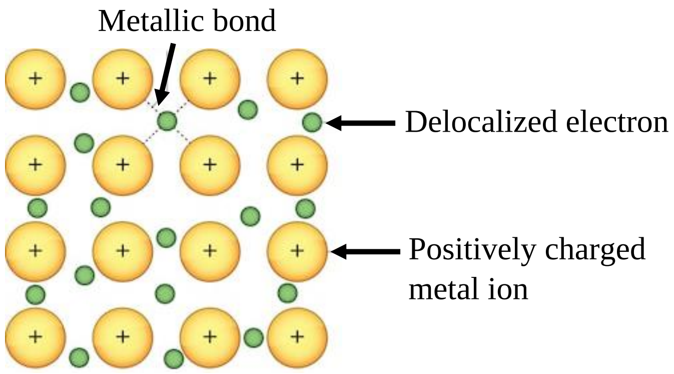
The electronic structure of Na is $1s^2\ 2s^2\ 2p^6\ 3s^1$. A neutral Na atom contains 11 electrons, 10 of which form closed shells ($1s^2\ 2s^2\ 2p^6$) and shield the nucleus. Hence the last electron in the 3*s* orbital, which lies beyond these closed shells, experiences attraction by a net charge of +1e.

On the other hand, the electronic structure of Cl is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$. A neutral Cl atom contains 17 electrons, 12 of which form closed shells ($1s^2\ 2s^2\ 2p^6\ 3s^2$) and shield the nucleus. Hence Na would share its 3*s* valence electron with Cl's single 3*p* valence electron ($3p_x^2\ 3p_y^2\ 3p_z^1$), implying covalent bonding. However, because its nucleus contains more protons, Cl has a much greater affinity for electrons than Na. It is more electronegative. As a result, the electron is essentially transferred from Na atom to Cl atom and end up with a Na^+ ion joined to a Cl^- ion forming Na^+Cl^- or NaCl.

Metallic bond:

It is the bonding within metals. It involves the delocalized sharing of free electrons among the lattice of metal atoms. Metal atoms typically contain a high number of electrons in their outermost shell. These electrons become delocalized and form a sea (or cloud) of electrons surrounding a giant lattice of positive ions. When Na atoms ($1s^2\ 2s^2\ 2p^6\ 3s^1$) come together, the electron in the 3*s* atomic orbital of one Na atom shares space with the corresponding electron on a neighboring atom, similar to the way that a covalent bond is formed.

The difference is that each Na atom is connected to eight other Na atoms, and the sharing occurs between the central atom and the 3*s* orbitals on all of the eight other Na atoms. And each of these eight is in turn connected to another eight Na atoms and so on, until all the atoms form a lump of Sodium. All of the 3*s* orbitals on all of the atoms overlap to give a vast number of molecular orbitals which extend over the whole piece of metal. The electrons can move freely within these molecular orbitals, and so each electron become delocalized from its parent atom. The metal is held together by the strong forces of attraction between the positive nuclei and the delocalized electrons.



Van der Waals bond and Hydrogen bond:

The binding energy for covalent and ionic bonds is typically 2 to 5 eV. As such, these bonds are often known as strong bonds. Weak bonds, otherwise known as Van der Waals bonds, refer to attachment between molecules due to simple electrostatic attraction. Van der Waals bonds are usually the result of attraction between dipoles. This can be between molecules with permanent dipole moments or induced dipole moments.

When one of the atoms involved in a weak bond is hydrogen then it is called a hydrogen bond. A hydrogen bond is considered 'strong' among weak bonds. This is because the hydrogen atom is the smallest atom and thus can be approached more closely. A hydrogen bond also has partial 'covalent' character, thus making it stronger.

Hydrogen bonding is very crucial for life on Earth. For example, it is responsible for zipping together the double helix of DNA. Also, if water molecules were linked by Van der Waals forces alone, water would boil at about -73^{o}C. the hydrogen bonds between neighboring water molecules are what raises the boiling point and allow water to be liquid at temperature that prevail on Earth.