Bonding

History: In 55 BC, the Roman poet and philosopher Lucretius stated that a force of some kind holds atoms together. He wrote that certain atoms when they collide, "do not recoil far, being driven into a closer union and held there by the entanglement of their own interlocking shapes." This was an early attempt to define the chemical bond.

Historically, the most difficult problem was in understanding the nature of the force of attraction between atoms in chemical compounds. To solve this problem, it was necessary to discover how electrons are arranged in atoms of different elements.

It is now known that chemical bonds tend to form and chemical reactions tend to take place so that substances are more stable than the original substances.

Chemical bonding between atoms involves the interaction of the electrons in the valence shells of the atoms.

There are **three fundamental types of chemical bond**:

1. ionic
2. covalent
3. metallic,

although there are examples of bonds intermediate between these.

The bond type depends on the attraction for electrons of the atoms involved, i.e. their electronegativity. If the elements have *very different electronegativities* then ionic bonding results.

If both of the elements have quite *high electronegativities* then the bonding will be covalent, whereas if they both have *low electronegativities* they form a metallic bond.

Each type of bonding gives rise to distinctive physical properties for the substances formed.

IONIC BONDS

How do these work?

Metals have large atomic radii, low ionisation energies, therefore give up their valence electrons, non-metals with their small atomic radii and high electron affinities gain electrons easily, thus combine with metals readily.

			transfer of electrons	
metal	+	non-metal	——————→	$metal^{+}$ + $non\text{-}metal^{-}$
low IE		High IE		(isoelectronic with noble gas)
low EA		High EA		

An ion is a charged sphere surrounded by a uniform electric field and therefore attracts oppositely charged spheres in all directions – no particular orientation is favoured, thus ionic bonding is considered **non-directional**, i.e. the forces of attraction are non-directional.

Ions tend to cling together in large clusters known as **ionic crystal lattices** (**ionic giant structures**, ionic crystals).

Ionic lattices are made up of a regular array of positively and negatively charged ions, held together by electrostatic attraction.

The lattice extends in **three dimensions**. The particular arrangement of ions depends on the relative charges and sizes of the ions.