

The bonding spectrum

Pure covalent bonding and ionic bonding can be considered as opposite ends of a **bonding continuum**, or **spectrum**.

In a **covalent bond**, atoms share pairs of electrons. The covalent bond is the result of two positive nucleuses being held together by their common attraction for the shared pair of electrons. The ionic bond is the **electrostatic attraction** between **positive and negative ions** within a **crystal lattice**.

Electronegativity

Electronegativity is a measure of the attraction between an atom involved in a bond and the electrons of that bond. The trends in electronegativity across the periods and down the groups of the periodic table can be explained in terms of **covalent radius**, **nuclear charge** and the **screening effect of inner shell electrons**.

Apart from **simple covalent bonding** between atoms of the same element, all bonds have some degree of covalent and ionic character. The larger the difference in electronegativities between bonded atoms, the more **polar** the bond will be and the greater the ionic character of the bond.

When the difference is very large, the movement of bonding electrons from the element of lower electronegativity to the element of higher electronegativity is complete, resulting in the formation of ions. Therefore, rather than isolated categories of bonding we have a **bonding continuum**.

Intermolecular forces

As the difference in electronegativity between the atoms in a bond goes from low to high, the strength of the forces between molecules increases. (**Note:** this explanation is limited to simple covalent bonding and does not include **giant covalent molecules** such as diamond, graphite or silica dioxide.)

- **London dispersion forces**, also known as **van der Waals forces**, are the weakest intermolecular forces. They arise when the movement of electrons creates a **temporary dipole** in a molecule. This can then induce a dipole in a neighbouring molecule. The two dipoles are attracted to one another. These forces occur between molecules where there is very little or no difference in electronegativity between the atoms in a bond.
- **Permanent dipole–dipole forces** occur between **polar covalent bonds** which are formed when the **electronegativity** of the bonding atoms is different. This results in an uneven distribution of charge, giving rise to a **permanent dipole** as atoms have partial charges (δ^+)(δ^-).
- **Hydrogen bonds** form between molecules that have hydrogen atoms bonded to **electronegative atoms**, such as nitrogen, oxygen and fluorine which also contain

a lone pair. These bonds are particularly strong as hydrogen atoms are very small and are attracted to the lone pair of electrons on the adjacent molecule.

- **Ionic bonds** are electrostatic attractions between positive and negative molecular ions. The ions are arranged so the attractive forces between oppositely charged ions are stronger than the repulsive forces between same-charged ions.

Did you know ...?

Hydrogen bonding is responsible for holding together macromolecules such as DNA, proteins and cellulose. It also accounts for water's unique, life-sustaining properties as well as explaining the different boiling points of isomeric amines.