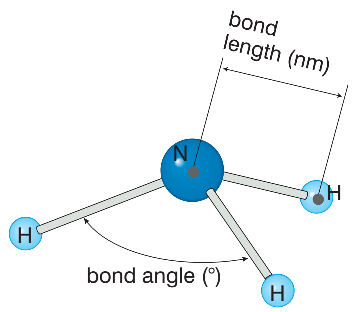
Summing-up

To complete the discussion of the covalent bond, it is also important to consider two other features: the *bond length* and the *bond angle*.

The **bond length** is the distance between the centres of the nuclei of two bonded atoms.

The **bond angle** is the angle formed by two imaginary lines obtained by joining, two by two, the centres of the nuclei of three bonded atoms.



The shape of the molecules can be explained by the **valence shell electron pair repulsion theory** (VSEPR): according to which, when an atom is bound to other atoms, pairs of valence shell electrons tend to repel each other and arrange themselves as far away as possible from each other, giving rise to a well defined geometric structure.

The fundamental geometric structures that can form from three pairs of electrons are: **linear structure** (with bond angles of 180°), **trigonal structure** (with bond angles of 120°) and **tetrahedral structure** (with bond angles of 109.5°). Depending on bonded atoms, these structures can present sligthly different bond angles.

The physical properties of molecular substances are strictly related to their constituent molecules: these molecules can be **polar molecules** or **nonpolar molecules**. To predict whether a molecule is polar (i.e. a *dipole*), or not, one must be able to identify the *type of covalent bond* (polarised or not) that unites the atoms, and the shape or geometry of the molecule (i.e. the reciprocal arrangement of atoms) which determines the *distribution of electric charge*.

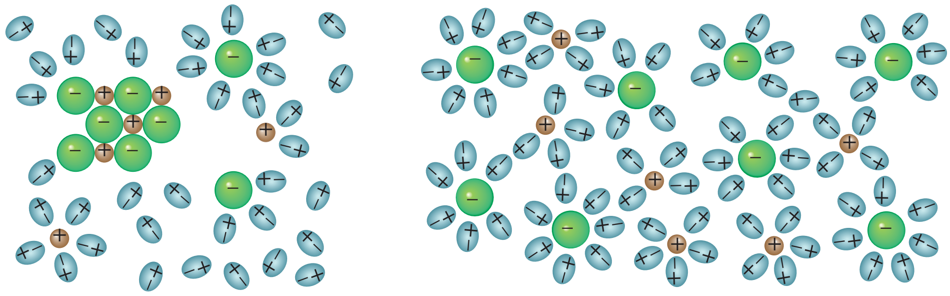
The forces that hold together the molecules or **intermolecular forces** are electric in nature and are basically of two types: **dipole-dipole attractive forces** (between polar molecules) and **London dispersion forces** (between nonpolar molecules). When the molecules of a compound contain hydrogen atoms attached to atoms of oxygen, fluorine or nitrogen, the interactions that form between the molecules are called **hydrogen bonds**.

These models of intermolecular forces also enable the interpretation, on the level of the particles themselves, of what happens when you mix different substances: if a polar solid melts or a polar liquid mixes with a polar liquid, such as water, dipole-dipole attractive forces or hydrogen bonds are established between the molecules of the solute and the solvent.

Similarly, if a nonpolar substance melts or mixes in a nonpolar liquid, London forces are established between the molecules of the solute and the solvent.

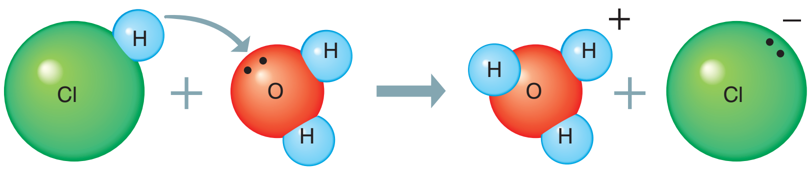
The dissolution of an ionic compound in water is called **ionic dissociation**: the ions that make up the solid are detached from the crystal lattice and bind to a certain number of solvent molecules through **ion-dipole bonds**. Solutions of this kind, because they contain ions that are free to move, conduct electricity.

For example, solutions obtained by dissolving sodium chloride containing Na^+ ions and Cl^- ions, all hydrated, that is surrounded by a number of water molecules.



$$NaCl(s) \xrightarrow{\text{water}} Na^+(aq) + Cl^-(aq)$$

Some polar molecular substances give rise to aqueous solutions that conduct electricity because the molecules of the compound react with water molecules to form ions: in which case they are termed **ionisation reactions**.



In general, all solutions that contain ions are called **electrolytic solutions** and the solutes that are dissociated or ionised are termed **electrolytes**.