VALENCY

When atoms merge together to form molecules they do so according to very defined recipes. For example when hydrogen combines with chlorine each chlorine atom merges with one hydrogen atom, never two or three but always one. The resulting merged pair of atoms is a molecule of hydrogen chloride (hydrochloric acid gas). When hydrogen combines with oxygen to form water it always does so in the ratio of two hydrogen atoms to one oxygen atom. When hydrogen combines with nitrogen to form ammonia it always does so in the ratio of three hydrogen atoms to one nitrogen atom. And when hydrogen combines with carbon to form methane (marsh gas) it always does so in the ratio of four hydrogen atoms to one carbon atom.

So the atoms of different elements combine with different numbers of hydrogen atoms. The number of hydrogen atoms which one atom of an element will combine with is known as the valency of the element. In the examples quoted above chlorine has a valency of 1 since one atom of chlorine combines with one atom of hydrogen. Oxygen has a valency of 2 since one atom of oxygen combines with two atoms of hydrogen. Nitrogen has a valency of 3 since one atom of nitrogen combines with three atoms of hydrogen. Carbon has a valency of 4 since one atom of carbon combines with four atoms of hydrogen.

An atom having a valency of 1 can only join with another atom of valency 1. An atom having a valency of 2 can either join with another atom of valency 2, or it can join with two atoms of valency 1.

The joining power of one atom of an element is simply the number of electrons it can lose or gain, as is explained below. Therefore the basic unit of valency is one electron. Hydrogen is the simplest element, it has only one electron. This is one reason why valency is called '' the number of hydrogen atoms that will join with one atom of the element in question ''.

To understand why an atom has a definite valency or '' capacity for combining '', we must examine the ways in which atoms merge together. Each atom consists of a fairly massive central nucleus that is positively charged with electricity. Outside the nucleus are a number of tiny particles called electrons negatively charged with electricity. These move at high speed round and round the nucleus and their orbits lie in a series of ''shells''. The electrons in the outermost shell are the ones which take part in the merging of atoms.

The outermost shell can hold no more than eight electrons. Atoms which have a full outer shell of eight electrons (and the very simple atoms with a single shell

of two electrons) are particularly stable and not easily changed. Neon, argon, krypton and xenon, known as the inert gases because they are totally unreactive, all have full outer shells of eight electrons to their atoms. Atoms which do not have full outer shells tend to combine together if by so doing they acquire full outer shells. Atoms can acquire full outer shells by gaining electrons from other atoms, or giving electrons to other atoms, or by sharing electrons with other atoms. Some atoms have more than one valency. This is partly due to electrons in the inner shells.

A chlorine atom has seven electrons in its outer shell. It therefore needs an extra electron to give it a complete outer shell. A pair of chlorine atoms can gain complete outer shells by sharing electrons. Two electrons, one from each of the atoms, form a pair which orbit around both of the atoms binding them securely together. This type of merging is called a covalency and the atoms are said to be joined by a covalent bond. Chlorine gas is in fact made up of molecules, or pairs of atoms merged together, and not individual atoms as might be expected.

The other important type of combination is called an electrovalency and the atoms are said to be joined by an electrovalent or ionic bond. Sodium chloride (common salt) is a familiar example of substances held together by ionic bonds. It contains chlorine atoms (each of which has seven electrons in its outer shell) and sodium atoms (each of which has one electron in its outer shell).

A sodium atom can acquire a complete shell of eight electrons by losing its single outer electron. But when it has lost a negatively charged electron the positive charge on the nucleus will be greater than the negative charges carried by the remaining electrons and the atom as a whole will be positively charged. The charged sodium atom is called a positive ion. A chlorine atom can acquire a complete shell of eight electrons by gaining one extra. But the extra electron makes the atom as a whole negatively charged. The charged chlorine atom is called a negative ion. On balance we can say that the sodium ion has given one electron to the chlorine ion. The ions are held together by the natural force of attraction existing between unlike charges. We should not think of the sodium ion and the chlorine ion as forming a true molecule, for they are not fixed in pairs, as was the case in the molecule of chlorine described earlier.

An atom with a full outer shell of electrons has a valency of 0. An atom with one electron in its outer shell has a valency of 1: so has an atom with one electron short of a full outer shell. An atom with two electrons in its outer shell or two electrons short of a full outer shell has a valency of 2.