ATOMS

In chemistry and physics, an atom is the smallest particle characterizing a chemical element. An atom consists of a dense nucleus of positively charged protons and electrically neutral neutrons, surrounded by a much larger electron cloud consisting of negatively charged electrons. When the number of protons matches the number of electrons, an atom is electrically neutral; otherwise it is an ion and has a net charge. The total protons in an atom defines the chemical element to which it belongs, while the number of neutrons determines the isotope of the element.

Atoms are minuscule objects with proportionately tiny masses. More than 99.9% of an atom's mass is concentrated in the nucleus, with protons and neutrons having about equal mass. Depending on the number of protons and neutrons, the nucleus may be unstable and subject to radioactive decay. The electrons surrounding the nucleus occupy a set of stable energy levels, or orbitals, and they can transition between these states by the absorption or emission of photons that match the energy differences between the levels. The electrons determine the chemical properties of an element, and strongly influence an atom's magnetic moment.

The 92 basic kinds of elements have built-in tendencies to join in various combinations.

The element sulphur is one of the very few substances found in nature whose atoms are all of one kind. The majority of substances are found as the merging of two or more elements; such combinations are called compounds.

When two elements merge, atoms of one join with atoms of the other. An atom consists of a nucleus (its central core) and a number of particles called electrons. The electrons are very small indeed and whirl around the nucleus at some distance from it. They play an essential part in joining one atom to another. Two atoms combine together if the outermost electrons are shared between both atoms, with the shared electrons moving around both nuclei.

A combination of atoms like this (although it does not have to be just two atoms) is called a molecule. Two atoms of oxygen can be made to share their outermost electrons with an atom of carbon. The result is a molecule of carbon dioxide. In joining together the atoms merge and entirely lose their individual properties. The molecule is unlike the two kinds of atoms of which it is formed.

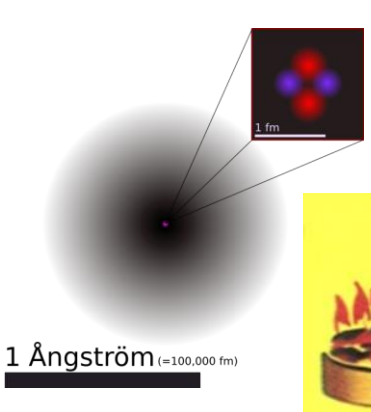
Since the 'recipe' for carbon dioxide is two atoms of oxygen to one of carbon we might expect that it contains twice as much oxygen (by weight) as carbon. But

in fact this is not so. If we took 44 grams of carbon dioxide and split it up we should obtain 32 grams of oxygen and only 12 grams of carbon. The reason is simply that a carbon atom weights less than an oxygen atom. Practically the whole weight of an atom is concentrated in its nucleus. The nucleus of a hydrogen atom (the lightest one) is a single particle called a proton; the nucleus of any other atom is a mixture of two sorts of particles-protons and neutrons. These particles are very nearly equal in weight, the difference between them is that a proton carries a positive charge of electricity while a neutron is uncharged (neutral). The nucleus of an oxygen atom contains 8 protons and 8 neutrons making a total of 16 particles. It is therefore 16 times as heavy as the nucleus of a hydrogen atom. Since the true weight of any atom is incredibly small when measured in grams or ounces, we prefer to use an altogether different scale of weights on which the proton weighs one unit; an atom of oxygen with its 16 particles has a weight of 16 units. Carbon has 12 particles (12 units) in the nucleus of each of its atoms, it therefore has an 'atomic weight' of 12.

To provide equal numbers of carbon atoms and oxygen atoms we should need to take 12 grams of carbon for every 16 grams of oxygen. Since the carbon dioxide recipe calls for twice as many oxygen atoms as carbon atoms we should in fact need 2 x 16 = 32 grams of oxygen. This would combine completely with our 12 grams of carbon giving 32+12 = 44 grams of carbon dioxide.

As a further example, let us take the gas sulphur dioxide, which is responsible for the choking odour of burning sulphur. This compound is formed when sulphur combines with oxygen. Its 'recipe' is one atom of sulphur to two atoms of oxygen, so if we are going to make it directly by burning sulphur in oxygen we must put one measure of sulphur with two measures of oxygen. But a measure of sulphur (atomic weight 32) is not the same as a measure of oxygen (atomic weight 16). For every 32 grams of sulphur we need 2x16 = 32 grams of oxygen to combine completely with it. The product will be 32+32 = 64 grams of sulphur dioxide. If too much of either oxygen or sulphur is used it will be left over, unused, at the end of the experiment.

The number of particles in the nucleus of each atom is its 'atomic weight' as a round number. The largest atoms are not necessarily the heaviest, the size is decided by the arrangement of the electrons.



Sulphur Atom