32 JOHN DALTON

1766-1844

John Dalton was the English scientist who, in the early nineteenth century, introduced the atomic hypothesis into the mainstream of science. By so doing, he provided the key idea that made possible the enormous progress in chemistry since his day.

To be sure, he was not the first person to suggest that all material objects are composed of vast numbers of exceedingly small, indestructible particles called atoms. That notion had been suggested by the ancient Greek philosopher, Democritus (460-370 B.C.?), and probably even earlier. The hypothesis was adopted by Epicurus (another Greek philosopher), and was brilliantly presented by the Roman writer, Lucretius (died: 55 B.C.), in his famous poem *De rerum natura (On the Nature of Things)*.

Democritus's theory (which had not been accepted by Aristotle) was neglected during the Middle Ages, and had little effect on modern science. Still, several leading scientists of the seventeenth century (including Isaac Newton) supported similar notions. But none of the earlier atomic theories were expressed quantitatively, nor were they used in scientific research. Most important, nobody saw the connection between the philosophical speculations about atoms and the hard facts of chemistry.

That was where Dalton came in. He presented a clear, quantitative theory, which could be used to interpret chemical experiments, and could be precisely tested in the laboratory.

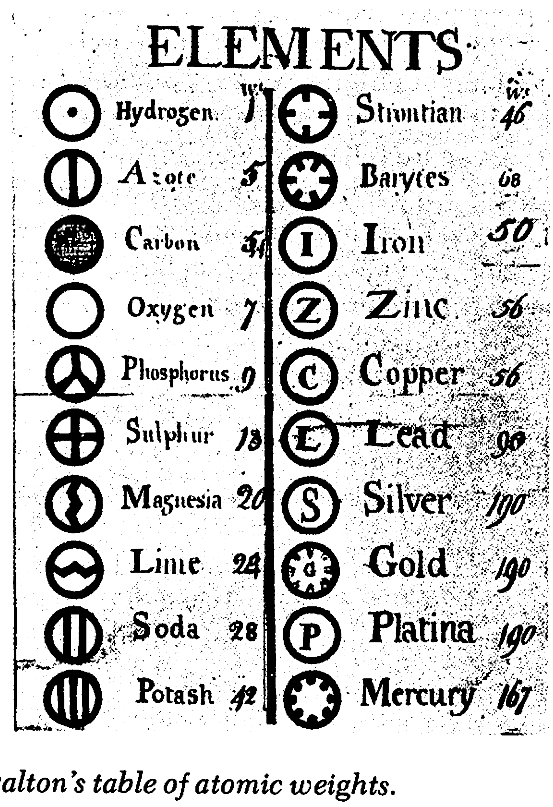
Though his terminology was slightly different from the one we use now, Dalton clearly expressed the concepts of *atoms*, *molecules*, *elements*, and *chemical compounds*. He made it clear that although the total number of atoms in the world is very large, the number of different *types* of atoms is rather small. (His original book listed twenty elements, or species of atoms; today, slightly over a hundred elements are known.)

Though different types of atoms differ in weight, Dalton insisted that any two atoms of the same species are identical in all their properties, including mass. (Sophisticated modern experiments show that there are exceptions to this rule. For any given chemical element there exist two or more types of atoms—called *isotopes*—which differ slightly in mass, though their chemical properties are almost identical.) Dalton included in his book a table listing the relative weights of different kinds of atoms—the first such table ever prepared, and a key feature of any quantitative atomic theory.

Dalton also stated clearly that any two molecules of the same chemical compound are composed of the same combination of atoms. (For example, each molecule of nitrous oxide consists of two atoms of nitrogen and one atom of oxygen.) From this it follows that a given chemical compound—no matter how it may be prepared, or where found—always contains the same elements in exactly the same proportion by weight. This is the "law of definite proportions," which had been discovered experimentally by Joseph Louis Proust a few years earlier.

So convincingly did Dalton present his theory that within twenty years it was adopted by the majority of scientists. Furthermore, chemists followed the program that his book suggested: determine exactly the relative atomic weights; analyze chemical compounds by weight; determine the exact combination of atoms which constitutes each species of molecule. The success of that program has, of course, been overwhelming.

It is difficult to overstate the importance of the atomic hypothesis. It is the central notion in our understanding of chemistry.



Dalton's table of atomic weights.

In addition, it is an indispensable prologue to much of modern physics. It is only because atomism had been so frequently discussed before Dalton that he does not appear even higher on this list.

Dalton was born in 1766, in the village of Eaglesfield, in northern England. His formal schooling ended when he was only eleven years old, and he was almost entirely self-taught in science. He was a precocious young man, and when he was twelve years old he became a teacher himself. He was to be a teacher or private tutor for most of his remaining years. When he was fifteen, he moved to the town of Kendal, and when he was twenty-six he moved to Manchester, where he dwelled until his death in 1844. He never married.

Dalton became interested in meteorology in 1787, when he was twenty-one years old. Six years later, he published a book on the subject. The study of air and the atmosphere aroused his interest in the properties of gases in general. By performing a series of experiments, he discovered two important laws governing the behavior of gases. The first, which Dalton presented in 1801, states that the volume occupied by a gas is proportional to its temperature. (It is generally known as Charles's law, after the French scientist who had discovered it several years before Dalton, but who had failed to publish his results.) The second, also presented in 1801, is known as Dalton's law of partial pressures.

By 1804, Dalton had formulated his atomic theory and prepared a list of atomic weights. However, his principal book, *A New System of Chemical Philosophy,* did not come out till 1808. That book made him famous, and in later years, many honors were accorded him.

Incidentally, Dalton suffered from a form of color blindness. Characteristically, the condition aroused his curiosity. He studied the subject and eventually published a scientific paper on color blindness—the first ever written on the topic!