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ANTOINE LAURENT LAVOISIER

1743-1794

The great French scientist Antoine Laurent Lavoisier was the most important figure in the development of chemistry. At the time of his birth, in Paris, in 1743, the science of chemistry lagged far behind physics, mathematics, and astronomy. Large numbers of individual facts had been discovered by chemists, but there was no adequate theoretical framework in which to fit these isolated bits of information. At that time, it was incorrectly believed that air and water were elementary substances. Worse still, there was a complete misunderstanding of the nature of fire. It was believed that all combustible materials contained a hypothetical substance called "phlogiston," and that during combustion the inflammable substance released its phlogiston into the air.

In the interval from 1754 to 1774, talented chemists such as Joseph Black, Joseph Priestley, Henry Cavendish, and others had isolated such important gases as oxygen, hydrogen, nitrogen, and

carbon dioxide. However, since these men accepted the phlogiston theory, they were quite unable to understand the nature or significance of the chemical substances they had discovered. Oxygen, for example, was referred to as dephlogisticated air, i.e., air from which all the phlogiston had been removed. (It was known that a sliver of wood burned better in oxygen than in ordinary air; presumably, this was because dephlogisticated air could more readily absorb phlogiston from the burning wood.) Obviously, real progress in chemistry could not be made until the fundamentals were correctly understood.

It was Lavoisier who managed to put the pieces of the puzzle together correctly, and to get chemical theory started on the correct path. In the first place, Lavoisier said, the phlogiston theory is completely incorrect: there is no such substance as phlogiston. The process of combustion consists of the chemical combination of the burning substance with oxygen. In the second place, water is not an elementary substance at all but a chemical compound of oxygen and hydrogen. Air is not an elementary substance either, but consists primarily of a mixture of the two gases, oxygen and nitrogen. All of these statements seem quite obvious today. However, they were not at all obvious to Lavoisier's predecessors and contemporaries. Even after Lavoisier formulated his theories and presented the evidence for them, many leading chemists refused to accept his ideas. But Lavoisier's excellent textbook, *Elements of Chemistry* (1789), so clearly presented his hypotheses, and so convincingly marshalled the evidence in their behalf, that the younger generation of chemists was quickly convinced.

Having shown that water and air were not chemical elements, Lavoisier included in his book a list of those substances that he did believe to be elementary. Although his list contains a few errors, a modern list of the chemical elements is basically an enlarged version of Lavoisier's table.

Lavoisier had already (in conjunction with Berthollet, Fourcroi, and Guyton de Morveau) devised the first well-organized system of chemical nomenclature. In Lavoisier's system (which

forms the basis of the one used today), the composition of a chemical is described by its name. The adoption, for the first time, of a uniform system of nomenclature enabled chemists throughout the world to clearly communicate their discoveries to each other.

Lavoisier was the first person to clearly state the principle of conservation of mass in chemical reactions: A chemical reaction might *rearrange* the elements present in the original substances, but no matter is destroyed thereby, and the end products weigh the same as the original components. Lavoisier's insistence on the importance of carefully weighing the chemicals involved in a reaction helped turn chemistry into an exact science, and prepared the way for much of the subsequent progress in chemistry.

Lavoisier also made some minor contributions to the study of geology, and a major contribution in the field of physiology. By careful experiments (working in conjunction with Laplace), he was able to show that the physiological process of respiration is basically equivalent to a slow combustion. In other words, human beings and other animals derive their energy from a slow, internal burning of organic material, using the oxygen in the air they inhale. That discovery alone—which is perhaps comparable in significance to Harvey's discovery of the circulation of the blood—might well entitle Lavoisier to a place on this list. Still, Lavoisier is primarily important because his formulation of chemical theory started the science of chemistry firmly on the correct path. He is generally referred to as "the father of modern chemistry," and he richly deserves that title.

Like quite a few other persons on this list, Lavoisier studied law as a young man. Although he received a law degree and was admitted to the French bar, Lavoisier never practiced law. He did, though, engage in much administrative work and public service. He was active in the French Royal Academy of Sciences. He was also a member of the *Ferme Générale*, an organization involved in the collection of taxes. As a consequence, after the French Revolution in 1789, the Revolutionary government was

very suspicious of him. Eventually, he was arrested, along with twenty-seven other members of the *Ferme Générale.* Revolutionary justice may not have been too accurate, but it was certainly speedy. On a single day (May 8, 1794), all of the twenty-eight persons were tried, convicted, and guillotined. Lavoisier was survived by his wife, a brilliant woman who had assisted him in his researches.

At the trial, an appeal was made to spare Lavoisier, citing his numerous services to his country and to science. The judge rejected the plea with the curt remark that, "The Republic has no need of geniuses." Somewhat closer to the truth was the remark of his colleague, the great mathematician Lagrange: "It took but a moment to sever that head, though a hundred years may not produce another like it."

Lavoisier in his laboratory at the Royal Arsenal.