Editor's Introduction

Lavoisier's *Elementary Treatise on Chemistry* knits together an astonishingly wide range of topics, including the fundamentals of his *caloric* theory, an encyclopedic survey of known chemicals, and a meticulous description of chemical apparatus and techniques. It is a sprawling work in many respects; but the first eight chapters stand remarkably on their own. Together they constitute a train of argument leading from the apparent nature of acids to Lavoisier's demonstration that water is no simple substance, but a composition of oxygen (the "acid-maker") and hydrogen (the "water-maker"). The title "Oxygen, Acids, and Water," though not Lavoisier's own, conveys, I think, the focus of his thinking in these chapters.

Not so very long ago, a typical college introductory course in chemistry might be experienced as a dismal mass of facts, imperfectly organized according to principles which themselves rested on imperfect foundations. By contrast, what a splendid edifice was offered by *physics*, which from the outset presented a complete logical structure based on simple, universal, and intelligible laws! The example of physics did much to cement the extraordinarily influential idea that knowledge becomes *science* when, and only when, it is organized in the form of laws—preferably, mathematical ones.

Academic chemistry during much of the twentieth century did not stand up very well to such a criterion; and "physics envy" was an affliction with which theoretical chemists, not to mention social scientists, had often to contend. But chemistry springs from a tradition that cultivated a very different conception of knowledge: knowledge as *direct apprehension* more than subordination to demonstrative logic.

Reading Lavoisier's *Elementary Treatise on Chemistry*, we feel his abiding awareness that *matter has powers*; and we can participate in his desire to know those powers firsthand. Laws—especially laws aiming for universality—are largely beside the point; for Lavoisier's awareness is far more attuned to the distinctiveness of different kinds and classes of substances.

For that reason it is rewarding to pay attention to Lavoisier's verbs. When does he use terms like "release" (*dégager*), as distinguished from "remove" (*enlevèr*, *retirer*) or "extract" (*extraire*)? Lavoisier seems constantly trying to infer exactly what each substance is doing in relation to the other substances in each chemical reaction. When he cannot deduce, he *conjectures*—because his interest is in figuring out how each substance acts, more than in demonstrating how it conforms to an overall pattern. To be sure, he loves those large patterns when he finds them; but they are always welcomed as gifts, as prized fruits of study and labor—never as the substance of knowledge itself.

Studying Lavoisier, like studying the early works of any science, will be most rewarding if we can temporarily set aside concepts that our schooling offered to us ready-made, and let them instead become live questions. By doing so we can appreciate, and even take part in, the working-out of those concepts by the great founding thinkers.

Consider, for example, Lavoisier's understanding of heat as being a *substance,* which he calls "caloric"—a view which modern textbooks too often treat with condescension or even ridicule. Heat, as we all now know, is no substance, but rather a form of energy. But readers who can step back from "what we all now know" are regularly astonished to discover just how strong was Lavoisier's evidence for the existence of caloric, and what a rich explanatory power that concept had in Lavoisier's hands. It does no honor to later investigators if we think the theories they superseded were merely silly. If we really want to appreciate the modern concept of heat, we will want to understand the potency and utility of the theory it supplanted.

Along with ready-made concepts, we will do well to forego the standardized *terminology* in which those concepts are embedded. This is particularly appropriate for Lavoisier, as *names* were of central importance to him. The "Preliminary Discourse" which begins this volume is his compelling call to name substances according to *what we actually know* about them, not just what convention dictates or what practice has ordained.

As knowledge becomes more and more widely accepted, technical terms tend to migrate into ordinary speech, even to the point where we may forget that they *are* technical terms—and that they therefore embody a host of assumptions and suppositions that were once open questions. We, to a far greater extent than Lavoisier's contemporary readers, need to be aware of this.

Consider the term "molecule," for example, which for us denotes a definite cluster of fundamental substantial units. But Lavoisier's *molécules* are, literally, no more than *small masses* of the substance in question; he has no reason to suppose that these bits of matter are equal to one another, even in the same substance. Such intimate details of the constitution of bodies appear to be out of reach of Lavoisier's methods; but readers are invariably surprised and delighted to discover how much one *can* know about materials, and how interesting they can be, even when their minute constitution remains a mystery.

Commensurate with Lavoisier's striking scrutiny of the vocabulary of chemistry was the scrupulous attention he devoted to its physical apparatus. Chemistry, like other sciences, cultivates a highly disciplined brand of experience that requires highly specialized equipment to produce. Lavoisier worked at a time when not only the basic concepts of chemistry were in flux, but even its instruments and procedures were not standardized. While certain articles of glassware—retorts, flasks, and the like—had long been associated with chemical and alchemical work, even these had to be made more or less on an as-needed basis rather than produced as stock items. The balance had long been used in trade and commerce, but Lavoisier made it an indispensable instrument for chemistry by demonstrating the need for greater precision than ordinary instruments could deliver. The exceptionally capable Fortin balance (page 47), which he commissioned, brought that familiar appliance to new standards. On the other hand, instruments like Lavoisier's gasometer (page 88) were wholly new.

To what degree of knowledge can chemistry realistically aspire? In contrast to the demonstrative paradigm, Lavoisier knows that conclusive answers are not the only valuable ones. His science is not a "method" that guarantees truth; instead, as we shall see, it generates *experience* that can either clarify or overthrow predominating conceptions.