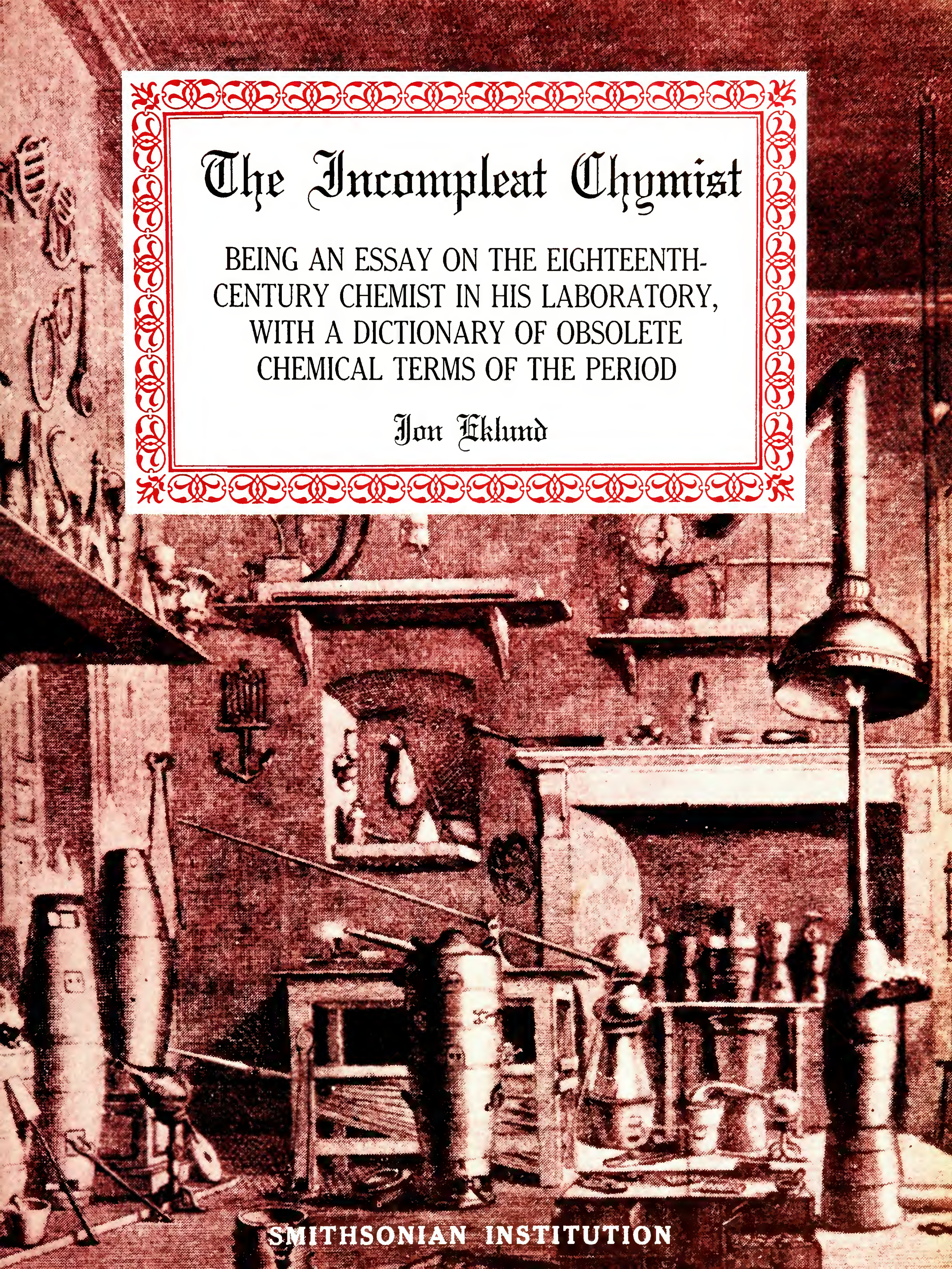


The Incompleat Chymist

BEING AN ESSAY ON THE EIGHTEENTH-CENTURY CHEMIST IN HIS LABORATORY, WITH A DICTIONARY OF OBSOLETE CHEMICAL TERMS OF THE PERIOD

Jon Eklund

SMITHSONIAN INSTITUTION

SMITHSONIAN STUDIES IN HISTORY AND TECHNOLOGY • NUMBER 33

The Incompleat Chymist

BEING AN ESSAY ON THE EIGHTEENTH-CENTURY CHEMIST IN HIS LABORATORY, WITH A DICTIONARY OF OBSOLETE CHEMICAL TERMS OF THE PERIOD

Jon Eklund

SMITHSONIAN INSTITUTION PRESS
City of Washington
1975

ERRATA

(SMITHSONIAN STUDIES IN HISTORY AND TECHNOLOGY, NUMBER 33)

Page 30, column 2, line 12 from top: "Liravius" should read "Libavius."

Page 44, column 1, line 8 from bottom: "Vitriolic Ether. . . should read "Vitriolic Acid Air: Sulfur dioxide (SO_2)."

Page 49, column 1, top line: "marim" should read "marin."

SMITHSONIAN STUDIES IN HISTORY AND TECHNOLOGY • NUMBER 33

The Incompleat Chymist

BEING AN ESSAY ON THE EIGHTEENTH-CENTURY CHEMIST IN HIS LABORATORY, WITH A DICTIONARY OF OBSOLETE CHEMICAL TERMS OF THE PERIOD

Jon Eklund

SMITHSONIAN INSTITUTION PRESS
City of Washington
1975

OFFICIAL PUBLICATION DATE is handstamped in a limited number of initial copies and is recorded in the Institution's annual report, *Smithsonian Year*. SI PRESS NUMBER 5214.

Library of Congress Cataloging in Publication Data
Eklund, Jon.
The incompleat chymist.
(Smithsonian studies in history and technology, no. 33)
Supt. of Docs. no.: SI 1.28:33
1. Chemistry—History. 2. Chemistry—Dictionaries. I. Title. II. Series: Smithsonian Institution. Smithsonian studies in history and technology, no. 33.
QD14.E38 540'.9'033 74-13368

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402—Price $1.35
Stock Number 047-001-00125-7

The Incompleat Chymist

BEING AN ESSAY ON THE EIGHTEENTH-CENTURY CHEMIST IN HIS LABORATORY, WITH A DICTIONARY OF OBSOLETE CHEMICAL TERMS OF THE PERIOD

Jon Eklund

Introduction

It would be preferable to be able to call this work "The Compleat Chymist," but the existing title reflects an unfortunate reality. The truth is that our knowledge of the aspirations and activities of chemists in the eighteenth century is woefully incomplete. That this is so suggests first that we have an insufficient number of interested historians of chemistry; and if this remains so it may signify something unfortunate about current historiographic trends.

Specifically, there has been a tendency of late to treat eighteenth-century chemistry as an almost exclusively cerebral science. This is in part an understandable reaction to an earlier historiographic mode which is perhaps best described as Whig-inductivist. Although there were variations, the chemical variety of the basic Whig-inductivist scheme was to describe the experiment, give its contemporary interpretation, translate the phenomenon into modern terms, give the modern interpretation, and then make a normative judgment on the basis of the closeness of fit between the original and the modern interpretation. Sometimes the judgment was omitted, and the work became primarily a series of descriptions of important reactions. Even here, however, there was an implicit judgment in the selection process—those experiments most relevant to modern textbook schemes were the ones chosen for exegesis.

Surely it isn't necessary here to once again beat down the presumed phoenix of Whig-inductivism, as its evils seem well understood and agreed upon. But to be repelled by the narrow normative excesses of an earlier historiography is one thing; to shun all its practices uncritically is quite another. Thus, it seems to me a non sequitur to arrive at the idea that narratives of experiments are necessarily bad or that all translations of the results into modern terms (assuming one can avoid the all-too-obvious pitfalls) are useless.

More dangerous still is the tendency for historians to largely ignore the details of practice. Without doing an injustice to the intellectual content of the chemistry of that time, such an oversight seems to me to create a serious historical imbalance. Indeed, for historians to assume that the chemists of the eighteenth century were primarily concerned with theory may be to ignore most of their working hours. Certainly by far the greatest portion of the literature in contemporary journals was not concerned with theories of matter but with specific empirical problems related to the determination of chemical composition. Since they were personal vehicles which allowed greater depth, even treatises which one logically would expect to contain discussions of a more philosophical nature were composed, for the most part, of the details of chemical experiments. Surely we must characterize the chemistry of that period in

---

Jon Eklund, Department of Science and Technology, National Museum of History and Technology, Smithsonian Institution, Washington, D.C. 20560.

accordance with the actual record left by the chemists of the time.

Although this work is concerned principally with the laboratory settings, equipment, and practices of French and British chemists of the period 1690–1770, nothing seen in the chemical literature of any country seriously weakens the remarks made above. On the contrary, the more one reads, the more one realizes that to overemphasize the theoretical in this chemistry is to commit an anachronism. Those who felt themselves to be primarily concerned with chemistry were insistent on the importance of the operations of chemistry; indeed, they were virtually unanimous in stressing the active, operational nature of their science. Thus, for example, the well-known seventeenth-century French chemist Nicolas Le Févre (1615–1669) grandly defined chemistry as "the Art and Knowledge of Nature itself," and he made its operative aspects definite by adding that it was "A practical and operative science of things natural" and by pointing out that "by her means we examine the principles out of which natural bodies do consist and are compounded." [1] The great German chemist and physician and author of the phlogiston concept, Georg Ernst Stahl (1660–1734), saw chemistry as "the art of resolving *mixt, compound* or *aggregate* Bodies into their Principles and of [re]composing *such bodies* from those *Principles.*" [2] The author of the most successful French chemistry text of the late seventeenth century and early eighteenth century, Nicolas Lemery (1645–1715), called chemistry "an art which teaches how to separate the different substances which are found in a compound." [3]

This emphasis on the operations of chemistry continued into the eighteenth century. Wilhelm Homberg (1652–1715) of the French Academy of Sciences characterized chemistry early in the century as "the art of reducing compounds into their principles by means of fire, and composing new substances in the fire by the mixture of different materials." [4] The great Dutch physician and chemist Herman Boerhaave (1668–1738) was more prolix but less specific when he defined chemistry as

> . . . that Art, that teaches us how to perform certain physical operations, by which bodies that are discernible by the senses . . . may by suitable instruments be so changed, that particular determin'd effects may be thence produced, and the causes of those effects understood by the effects themselves.[5]

But in beginning his volume on the practice of chemistry Booerhave insisted that "natural constituent parts . . . only should be extracted, which being afterwards properly compounded together . would again produce exactly the very same body." [6]

Although he greatly admired Boerhaave, the English physician and chemist Peter Shaw (1694–1763) was more definite than the continental chemist in his view that chemistry was an active empirical discipline:

> *Philosophical Chemistry* we define, a rational Art of (1) dividing or resolving all the Bodies within our Power (2) by means of all the Instruments we can procure; (3) as well into integrant as constituent parts; and (4) joining these parts together again; (5) so as to discover the Principles, Relations, and Changes of Bodies; (6) make various Resolutions, Mixtures and Compositions; (7) find out the Physical causes of physical Effects; and (8) hence improve the State of natural Knowledge, and the Arts thereon depending.[7]

While Shaw suggested the importance of synthesis in chemical analysis in the phrases which he numbered (4) and (5), later chemists in France such as G. F. Rouelle (1703–1770), P.-J. Macquer (1718–1784), and Antoine Baumé (1728–1804) were even more insistent on synthesis as both a criterion for proper analysis and an integral part of their definition of chemistry. Rouelle's definition made this particularly clear:

> Chemistry is a physical art which, by means of certain operations and instruments, teaches us to separate the various substances which enter into the composition of bodies, and to recombine these again, either to reproduce the former bodies, or to form new ones from them.[8]

In order that no one missed his point, Rouelle quickly gave an example of the proper way that chemistry seeks its facts:

> If, for example, one asks [of chemistry], "What is cinnabar?" it responds that [cinnabar] is a compound (composé) of sulfur and mercury. To prove it, [chemistry] extracts these two substances from [cinnabar], and shows them separated. It does more—it composes a true cinnabar with sulfur and mercury.[9]

Macquer was as adamant as Rouelle on the importance of chemical analysis as he described his own conception of chemistry in the first edition of his *Elemens de chimie theorique*:

> The object and principle end of chemistry is to separate the different substances that enter into the composition of bodies; to examine each [of these substances] separately; to discover their properties and relations; to decompose, if possible, these [component] substances; to compare them to-

> gether, and combine them with others; and to reunite them into the original substance with all of its properties.[10]

Baumé concurred in this opinion. Noting that chemistry involved *both* decomposition and recomposition, he added that "analysis [in the narrow sense of "decomposition"] has as its goal the separation of the principles which make up a substance, and composition, on the contrary, has as its object the reunification of principles which have been separated by analysis, to reform the compounds just as they were before." [11] Baumé saw the goal of nature itself as composition and recomposition, so it was natural that human art should follow in nature's wake in attempting to understand the nature and properties of natural bodies.[12]

Macquer's definition was the most specific and, at the same time, most comprehensive of all. It seems peculiar the first time it is seen, for the modern reader will tend to interpret it not as a definition of chemistry but of chemical analysis in the modern sense of that term.[13] Taken literally, Macquer's definition would have kept every chemist at his table and furnace throughout the working day, busy at the task of determining the chemical composition of all known substances and synthesizing new ones.

As the above definitions demonstrate, the practice of chemistry with its apparatus and operations must somehow be made an integral part both of narrative and of interpretation in the history of that science in that time. No more is attempted here than to encourage solution to the problem by making the reader more familiar with this aspect of eighteenth-century chemistry. It is a beginning, not the end, of a more fitting equilibrium between theory and practice in the history of chemistry.

I do not wish to create the impression that the drift away from the empirical is due to purely arbitrary or perverse decisions by historians. It seems to me that there are at least two reasons for that drift. First of all, the circumstance that impelled the chemist-historians of previous generations toward a recounting of the empirical was their own professional experience, and most of them were experimentalists. In contrast, the general background and specific professional training of most historians—including historians of science—are seldom long on laboratory experience. Bottles and boltheads seem dull stuff next to visions of atoms, thus, and the unpalatable inductivism of the traditional studies adds additional impetus away from the unfamiliar.

The second reason for the drift from the empirical is a fact of history rather than an accident of biography. Prior to the reform of chemistry by Antoine Lavoisier (1743–1794) and his followers in the last quarter of the eighteenth century, the nomenclature of chemistry was a hodgepodge of idiosyncratic practices and the residue of alchemy. Often, for example, there were several names for the same substance and, worse, each name was thought to represent something different. Thus, one requires a great deal of additional research in the nomenclature before he can read even the most basic literature with comprehension, if not ease.

To encourage others, then, to attempt the further studies of eighteenth-century chemistry that are so desperately needed, this essay attempts to provide a reasonably accurate impression of the activities typical of a chemist of the period and to describe in terms of his apparatus, operations, and, to some extent, his own feelings of what it was like to really practice chemistry at that time. The basic terminology associated with chemical experiments is presented in a context of chemical operations as they were likely to occur in chemical analysis. For further clarification, several actual contemporary research efforts are analyzed to give substance and meaning to the terms introduced and discussed in the body of the text.

Finally, appended to the essay is a short dictionary of the most common chemical terms used in Britain during the eighteenth century. These terms include a number of Latin words, a reflection not only of the still important (though declining) place of Latin in science during this period but also of the long-term relationships among chemistry, medicine, and pharmacy. Readers interested in French and German equivalents for the terms given here are advised to consult Macquer's important *Dictionnaire de Chemie* in the original editions (1766, 177-) or Leonardi's heavily annotated German translation.[14]

THE EIGHTEENTH-CENTURY CHEMIST IN HIS LABORATORY

Pierre-Joseph Macquer has left us a graphic description of what it was like to pursue actively the art of chemistry in the eighteenth century. The first requirement, of course, is to have a place in which to work—a laboratory. Almost all contemporary illustrations of eighteenth-century laboratories usually reveal a confusing conglomeration of furnaces, bric-a-brac, vessels, etc. While some of the confusion shown in such sources may be attributed to artistic license, Macquer tells us that the eighteenth-century chemist, absorbed by his work, was likely to have a laboratory as disorderly as that of a chemist of any other era:

> It is true that it is extremely disagreeable and difficult to continually stop in the midst of the most interesting researches, and to use considerable precious time in cleaning vessels, arranging them, putting on inscriptions etc. These things are quite capable of cooling or retarding the progress of genius. They are tedious and disgusting, but they are necessary.[15]

For purely practical reasons, however, no chemist can long afford such careless lapses. As the work progresses, the amount and kinds of accumulation—and thus confusion—increase. In the midst of his efforts, moreover, our hero is likely to forget possible complications:

> He thinks he shall easily know again the products of previous operations, so he takes no time to put them in order. He pushes on with the latest experiments, but the vessels used, the glasses, the bottles filled so multiply and accumulate that the laboratory is full of them. He can no longer distinguish them or at least there is doubt and uncertainty about many of the earlier products. It is even worse if a new work suddenly spreads through the laboratory or if other occupations oblige him to leave the laboratory for some time. All is confused and falls more and more into ruin. From this it often happens that he loses the fruits of much labor and throws away almost all the products of his experiments.[16]

In the midst of exciting research, of course, this carelessness may be understood, if not forgiven:

> When one has a certain ardor, the experiments follow one after the other rapidly. Some are found to be striking and appear to decide the question or give birth to new ideas. He cannot stop himself from making [these experiments] immediately and he is led, without thinking, from one to the other.[17]

Then, as now, such high points were unusual. The days in the laboratory were not always so pleasant. Indeed, there probably were a greater number of days in which the work seemed "tedious and disgusting."

If the time in the laboratory was to be as pleasant and profitable as possible, a number of technical problems had to be solved. Laboratories on the ground-floor level, for example, often had serious problems with moisture. Upper-floor installations had an inconvenience in that water had to be transported up somehow, but they were preferable since the ventilation was usually better, especially if the chimney had a good draught.

Given good ventilation and freedom from moisture, the next requirement was a convenient and sufficient surface area for work. A large central table for general use, one or more small movable tables, and perhaps a bench or stool provided the basic furnishings. Over time, the active chemist would fit up the remainder of the room with those vital trifles which allowed him to retain his sanity while carrying out experiments: pegs, hooks, and shelves for the storage of chemicals, apparatus, and bottles full of half-completed reactions.[18]

An illustration (Figure 1) from the *Commercium Philosophico-Technicum* of William Lewis gives an idea of the wide range possible in the chemist's laboratory. The laboratory as shown here seems less than ideal for general chemical work as the surface area for work or storage seems inadequate. This facility, which at least approximates his own laboratory, reflected Lewis' interest in applied chemistry.[19] It was especially suited for assaying and for metallurgical and mineralogical work since it included a wide variety of furnaces and weighing apparatus but relatively little glassware.

Given the place in which to work, the eighteenth-century chemist's next requirements, aside from material on which to experiment, were methods or devices for effecting chemical change. As Homberg's definition of chemistry (quoted above) implies, the primary method or "instrument" was fire. The use of fire to effect chemical change probably has been the most constant characteristic of chemistry. In the heyday of alchemy one of the primary requirements of the adept was that he know his heats, both high and low.[20] Le Févre calls fire "the most potent Agent that Nature hath furnished us withall under Heaven, to perform the Anatomy [decomposition] of Mixt Bodies [compounds]." [21] Although Robert Boyle had attacked the slavish reliance on fire of chemists in the late seventeenth century, Nicolas Lemery defended its use, noting that "indeed, almost all of the chemical operations are made to occur by means of fire." [22] Boerhaave and Macquer were somewhat more sophisticated in their admiration of the efficacy of fire. Boerhaave, in particular, noted the many pitfalls for the unwary in the use of fire, particularly its ability to produce contradictory

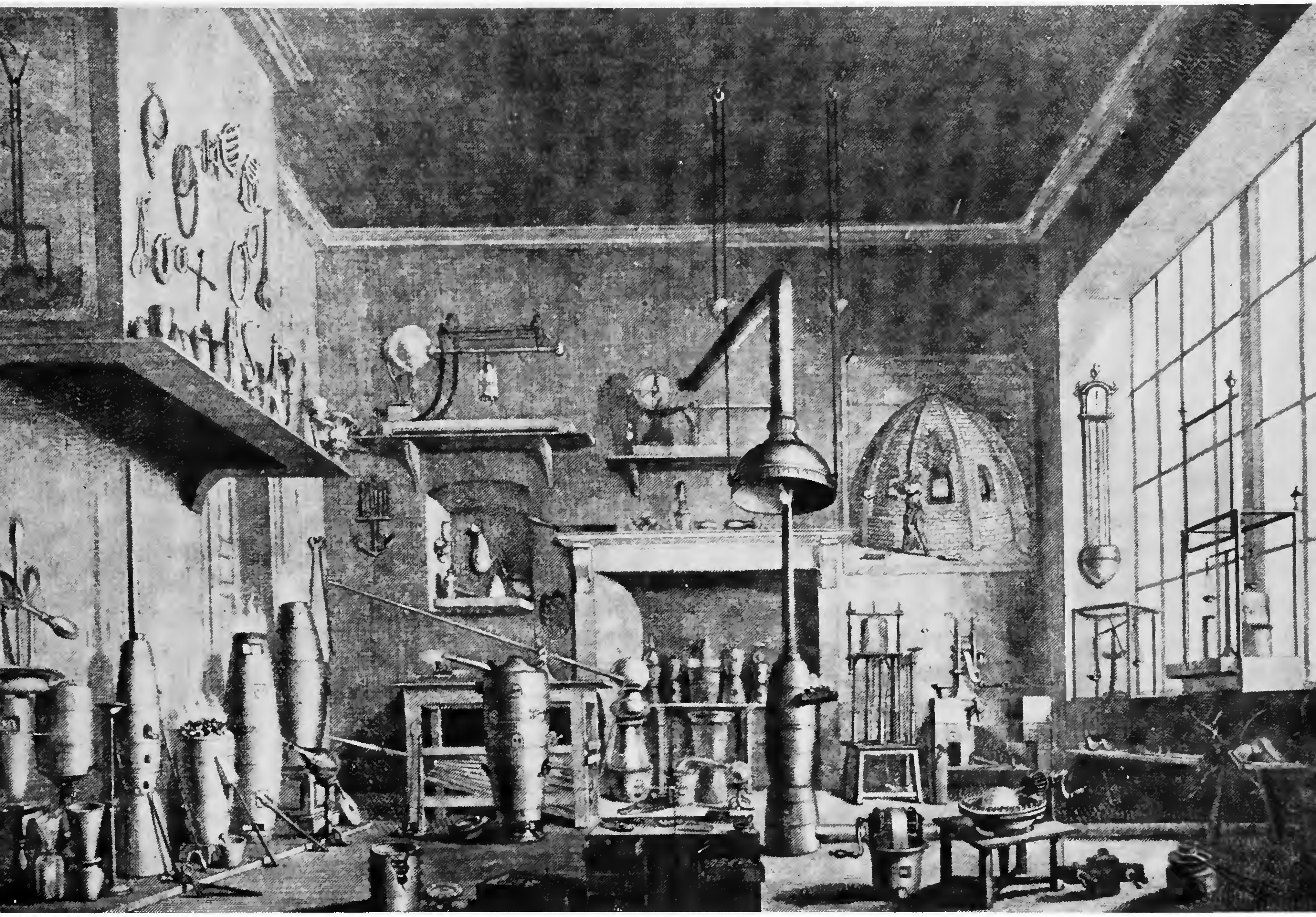


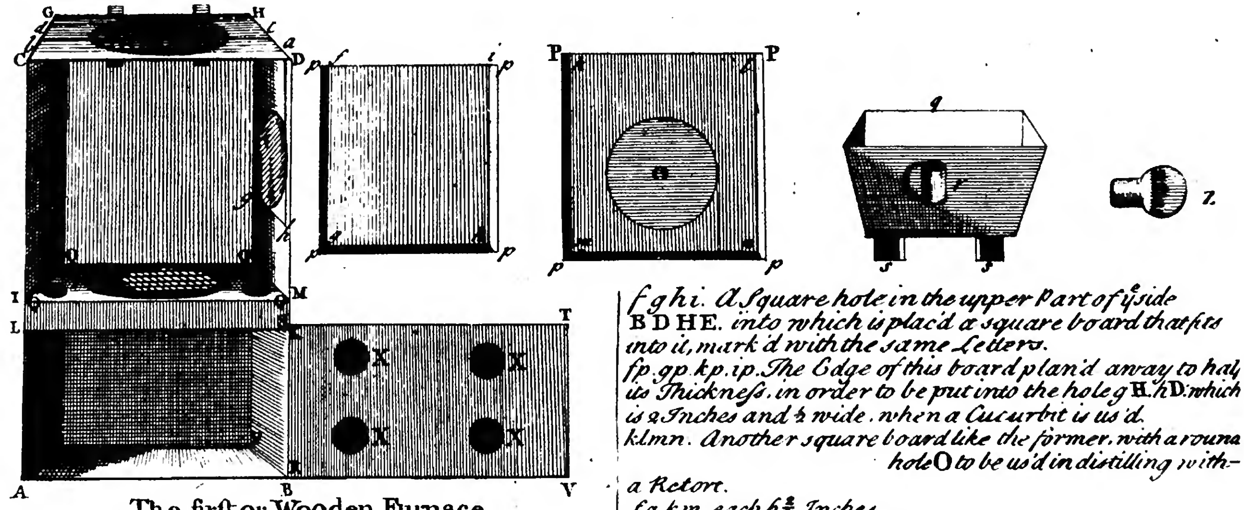
Figure 1. A chemical laboratory of the mid-eighteenth century. This particular facility was designed for assaying, with metallurgical or mineralogical work in mind, as it had an unusually wide variety of furnaces and weighing apparatuses yet relatively little glassware. It falls somewhat short of having the ideal amount of surface area for work or storage. [From William Lewis, *Commercium Philosophico-Technicum or the Philosophical Commerce of the Arts* (London, 1765), frontispiece.]

analytical results on the same material when other conditions were altered.[23] Macquer worried less about these difficulties. With the advantage of almost two generations of work by the German analytic school, he had a great advantage in interpretation of difficult results, though little in terms of advances in technique. Nevertheless, he maintained that "as all chemical operations may be reduced to decompositions and combinations, fire is therefore in chemistry, as in nature, a universal agent." [24]

If fire was the central instrument of the chemist, then the operational heart of the chemical laboratory was the furnace (or furnaces) and the chimney.[25] There were many types and sizes of furnaces. The design of a given furnace depended on a number of factors, including the range of temperature desired, the size of vessels to be accommodated, and the whim of the chemist, for these furnaces were built by hand. Many chemical treatises gave rather detailed instructions for their construction. Later in the eighteenth century there were more complicated devices of cast metal construction, and these had to be contrived by specialists.[26]

The most common type of furnace was the reverberatory furnace, which had a heating chamber with a hemispherical top in which the heat was supposedly reflected or "reverberated." Boerhaave recommended the simple "student's furnace" (shown in Figure 2) because of its simple construction and general applicability.[27] Lemery suggested that several reverberatory furnaces of different sizes be available to accommodate the various vessels.[28] Two or three furnaces were the minimum desirable number, but the number in any one laboratory was limited since they involved some expense and considerable work to construct and maintain.

The importance of the furnace reflected the seventeenth and early eighteenth century practice of performing reactions in the "dry way," where



The firſt or Wooden Furnace .

AB . *One Side of the Square base 9 Inches .*
ABEF . *The Square Base.*
ACBD *The Furnace 14 Inches high .*
AIBK *The Grate 5 Inches high .*
ILKM *The Partition 1 Inch thick.*
LCMD *The upper Part of the Furnace 8 Inches high .*
P P . *A round hole 5 Inches wide. for supporting a Retort &c.*
QQQQ . *Four round holes. each 1 Inch wide, for the Paſsage of the Heat to the upper Part of the Furnace.*

fghi. A Square hole in the upper Part of yͤ side **BDHE**. *into which is plac'd a square board that fits into it, mark'd with the same Letters.*
fp.gp.kp.ip. The Edge of this board plan'd away to half its Thickneſs. in order to be put into the hole g **H**.*h* **D**: *which is 2 Inches and ½ wide . when a Cucurbit is us'd.*
klmn. Another square board like the former. with a round hole **O** *to be us'd in distilling with a Retort.*
fg.km. each $6\frac{2}{3}$ *Inches.*
RSTV. *The Door of the Grate .*
XXXX. *Four round holes in it for admitting Air to the Fire place*
Z. *Registers of Wood to fix therein for governing the Fire*
Cb. **Da**. **Gd**. **Hc**. *Two folding Doors cut away in the Middle so as when shut to leave a hole a 5 Inches wide .*
q. An earthen Pan us'd in this Furnace.
r Its handle.
s s. Its feet.

FIGURE 2. A simple furnace design. The vessel to be heated was placed in the upper or draft chamber. The fire in the lower chamber was controlled through its own construction (banking) and by opening or closing the four draft holes (X) with stoppers (Z). [From *Elements of Chemistry,* Peter Shaw's translation of Herman Boerhaave's *Elementa Chemiae* of 1732 (London, 1741), volume 1, plate 13.]

the temperature requirements were higher. It also reflected the large role played by distillation in the chemistry of this period. While heat was (and is) a common requirement for most reactions, the temperature ranges were considerable. On the one hand, there were reactions involving minerals (especially dry distillation of minerals as in the preparation of spirit of sulphur from green vitriol or the extraction of some of the metals) that required a high degree of heat or even the hot blast provided by bellows. On the other hand, it had long been recognized that slower and more delicate organic processes called for carefully controlled heat where it was necessary to avoid direct contact of the reaction vessel with the flame. This was accomplished by several means. There was the water bath or *balneo mariae* in which the water kept the temperature constant because of its latent heat of vaporization; and some of the larger and more complicated furnaces had chambers heated by currents of hot air from the fire box. There was also the sand bath, which, though it required more alertness to maintain constant temperature, could work at a higher range than the water or steam baths.

For temperatures between these limits, furnaces were controlled by means of flues which regulated the draft on the fuel, the selection of the fuel itself, and the construction of the fire. Charcoal produced high heats, wood gave lower ones, and special mixed or dilute fuels could lower the temperatures still further. Some furnaces had a number of separate chambers at various distances from the fire to give several degrees of heat at one time.

It is clear that the control of temperature at this time was a major art which could be learned only through practice with an expert. Lemery listed four *degrez du feu* that were differentiated by such criteria as three versus four lighted coals; and these might even have given heats which were *tres-petite* or endurable by the hand for some time.[29] Boerhaave rejected this sort of "very obscure account." He could well afford to do so, for he had access to the excellent thermometers of Daniel Fahrenheit (1686–1736). Using these along with physical indicators for temperatures above 600°, Boerhaave defined six degrees of "chemical fire." [30] The importance of this development depended not on the number of these "degrees of heat" but on the use of the instrument itself, although few chemists followed Boerhaave in this practice.[31] Macquer himself was strongly influenced by Boerhaave's views on fire, but he did not use the latter's formal division of chemical fire into ranges or "degrees" of fire. Instead, he was content to note that chemists "have sought and found the means of procuring any degree of heat, from the weakest to the strongest, by using different intermediates and even more by the careful use and construction of furnaces." [32] Since the furnaces described by Macquer do not differ significantly from those of his predecessors, it is clear that there had been little technological advance in that area.[33] Nevertheless, it is equally clear that the chemists of this period had succeeded in solving their basic problems of supplying controlled heat for their reactions.

With the furnace ready, the eighteenth-century chemist might then look for a suitable vessel in which to perform the first reaction in the analytic procedure. I have used the general term "vessel" to emphasize the severe limitations of glass technology in the eighteenth century that forced the use of other types of materials. It was not mere whim or slavish habit that led chemists to use materials other than glass. Macquer, for example, was wistfully cognizant of what good glassware should be:

> Vessels intended for chemical operations should, to be perfect, be able to bear without breaking the sudden application of great heat and cold, be inpenetrable to every substance and inalterable to any solvent, be unvitrifiable and capable of enduring the most violent fire without fusing. But up to the present no vessels are known which combine all of these qualities.[34]

Under conditions of extreme heat or great changes in temperature, vessels of metal or earthenware were substituted for glass. The disadvantages of metal vessels lay in their reactions with common reagents such as acids. Earthenware vessels, on the other hand, tended to be porous, trapping reactants and products into the fabric of the vessel itself. Aside from the loss of material into the pores, the problem of contamination in later experiments could render the vessel unfit for further use. Some of these problems could be reduced by tinning the metal vessels and glazing the earthenware ones, but tin is still reactive to a number of acids and bases, and glazing renders a vessel more brittle.

Thus, glass vessels were used wherever possible "because they neither change, add or take away

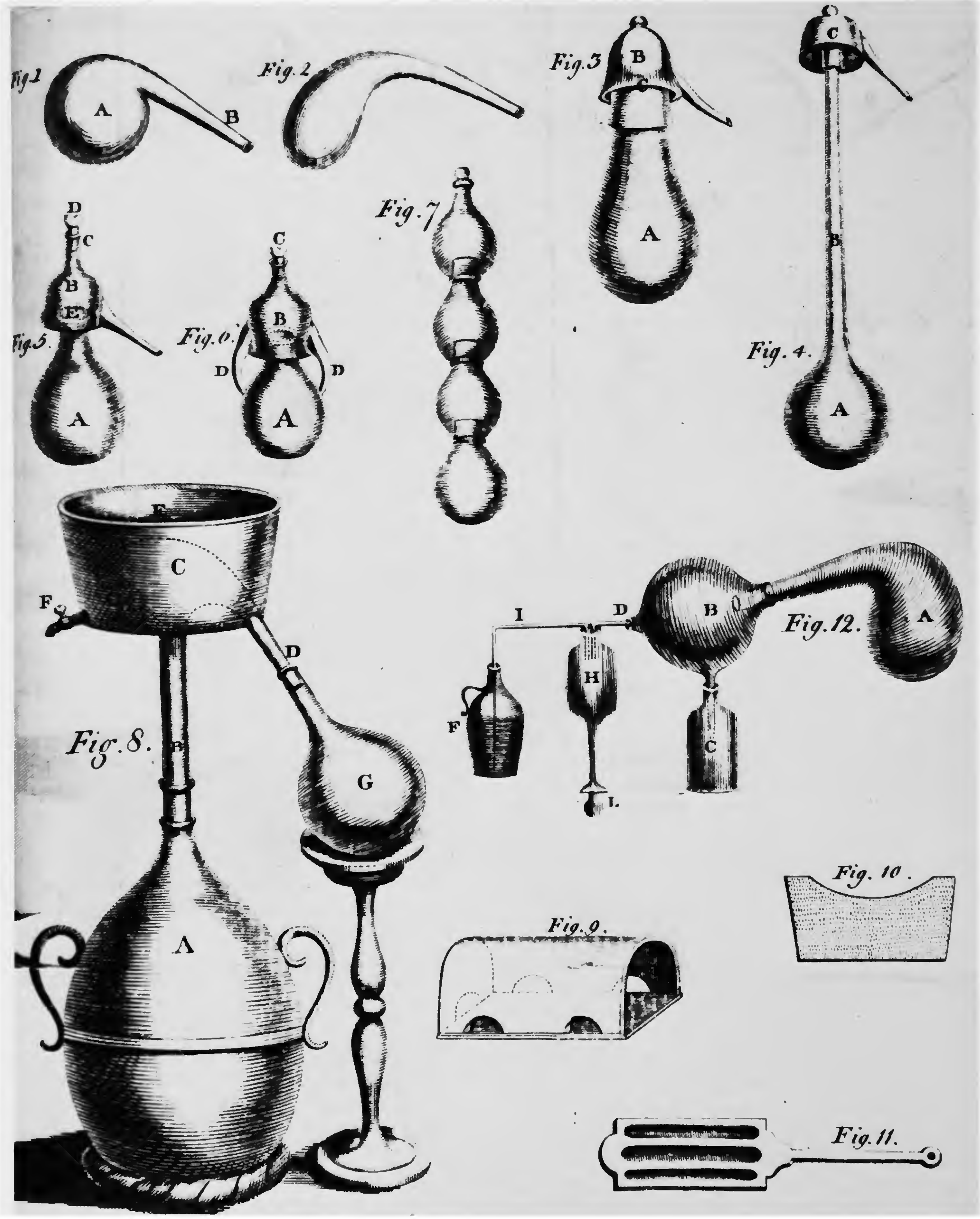


Fig.1
A
B
Fig.2
Fig.3
B
A
C
B
Fig.4.
A
D
C
B
E
Fig.5.
A
C
B
Fig.6.
D
D
A
Fig.7
E
C
F
D
Fig.8.
B
G
A
I
D
B
Fig.12.
A
F
H
C
L
Fig.10.
Fig.9.
Fig.11.

from the Bodies they contain; and whilst they are exposed to the action of the Fire, they suffer nothing to transude through them from within, nor admit any thing from without, except fire, and Magnetism." [35] In addition, as Macquer pointed out, "because they are transparent, [glass vessels] allow the chemist to freely observe what is happening in their interiors, which is always useful and interesting." [36] The best glass was the so-called "German green glass," which Boerhaave claimed could resist heat at least up to 600° and was therefore suitable for use at fairly high heat in distillations of corrosive materials.[37]

Several types of vessels were in common use in the eighteenth-century chemical laboratory, and many were modifications of the wide variety of vessels used by the alchemists.[38] With the passage of time these were standardized so that, as Macquer noted, "the vessels which are needed in a laboratory are now few and simple." [39] The most common of these, and of widest general use, was the "matrass," which closely resembled the modern florence flask. It could have a round or a flat bottom, and was adaptable to a wide variety of uses as a reaction vessel or as part of a distillation apparatus.

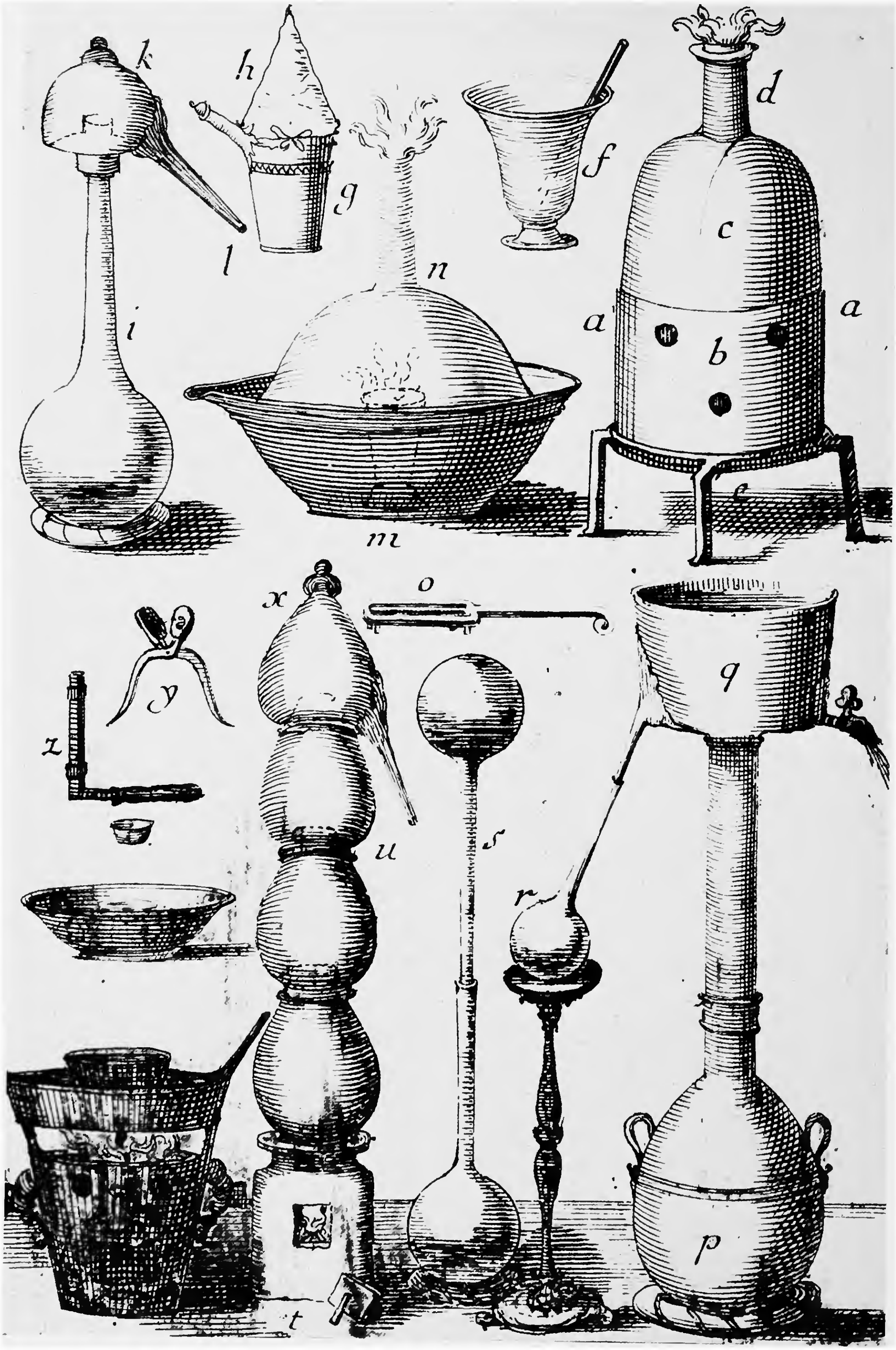
There were three basic types of apparatus for distillation (Figure 3). The "alembic," used in general-purpose distillation work, consisted of three parts: the body or cucurbit, which might be a matrass; the neck (if there were not already a neck on the cucurbit); and an upper condensation chamber called the head. The head might not be permanently attached to the neck, depending on whether the vapors were particularly subtle and thus liable to escape at joints. If they were, a one-piece glass alembic was usually employed. Alembics made of metal were used primarily for organic extractions, where there was less chance of corrosion.

The head itself was often equipped with a spout or beak to direct the condensed vapors to some other vessel. If it were not so endowed, it was known as a "blind head." A matrass could be equipped with a head for use in distillation. This gave the chemist some flexibility in separating volatile fractions since the length of the neck of the alembic was the determining factor in the "subtlety" of the vapors reaching the head. If the neck were rather long, only the most "subtle" vapors would be captured. With progressively shorter necks, more and more of the heavier fractions would be included in the distillate.[40]

The second basic type of distillation apparatus, the "pelican," has become familiar through recent studies of Lavoisier's experiment to test the transmutation of water into earth.[41] By the time it was employed by Lavoisier, however, the pelican had enjoyed a long history as a common piece of alchemical apparatus. It was a reflux device, which means that a portion of the reactants was kept in the vapor phase if it were thought that such a procedure would favor the reaction. In particular, the pelican was the natural choice where it was suspected that the reaction required a long time for completion.[42] The action of the device was simple: the vapors condensed in the head and returned to the liquid in the bottom of the vessel via the two curved beaks which connected the head to the cucurbit. As we know now, if the desired reaction took place primarily in the vapor phase the condensed vapors would be relatively rich in product. The process continued until someone decided that the liquid in the cucurbit contained a sufficient amount of product. After stopping the process, the chemist faced the problem of separating the newly formed product from whatever quantity of reactant remained. The task might be relatively easy, depending on the respective chemical and physical properties of reactant and product and to what extent the reaction went to completion. On the other hand, it might be impossible to get really meaningful data from distillation products of complicated animal and vegetable substances.[43]

The distillation of "heavy" or less volatile liquids was done in the third basic type of distillation apparatus, the "retort." Here the principal move-

FIGURE 3. Distillation apparatus. "Fig. 1" and "Fig. 2" are "retorts." The former has the shape most commonly associated with the term "retort," but the latter's tear-drop shape also was common. "Figs. 3–5, 8" are "alembics." The first three are of glass, and they vary only in the relative dimensions of their parts or in the number of separate pieces. "Fig. 8" is an alembic made of metal. Its principal parts are as follows: A, the "cucurbite" or "matrass"; C, the "capital" or "bolthead"; G, the "receiver." "Fig. 6" shows one version of the "pelican." "Figs 9–11" are parts and accessories for metallurgical furnace work. In "Fig. 12" the degree of sophistication of eighteenth-century apparatus is suggested. [From *Dictionary of Chemistry,* 2nd English edition of Andrew Kier's translation of Pierre-Joseph Macquer's *Dictionnaire de chymie* of 1766 (London, 1777), volume 3, plate 1.]


k
h
d
f
g
l
n
c
i
a
a
b
e
m
o
x
y
q
z
u
s
r
p
t

ment of vapor was lateral rather than vertical. In the one-piece retort the primary problem was to introduce the substance to be distilled. It had to be loaded by means of tubes or long ladles. Some retorts were made with a flange opening at the top that was sealed by means of a glass stopper. While these "tubulated retorts" were easier to load, it was necessary to seal the stopper in order to prevent the escape of the vapor. Thus, the tubulated retorts usually were employed only for processes in which it was absolutely necessary to add one or more reactants during the reaction. Clearly, unsealing and resealing a hot glass vessel required a great deal of skill.

The problems of handling expanding vapors and preventing them from escaping were partially solved by using an oversized vessel as a "receiver" at the end of the spout on the distilling head. These larger varieties of receiver, commonly known as "balloons" (French, *ballon*), resembled the modern short-necked, round-bottomed flask. For extra volume as well as greater condensation, small receivers, called "adopters" (French, *allonge*), with a neck at each end were so constructed that two or more could be connected in tandem between the spout of the distilling head and the receiver. While its primary function was to receive and collect the product of the distillation process, the receiver also served to correct the problem of heat control (see above). Distillation, especially when there were several fractions, was (and is) a delicate process. If the heat were too low, little or no vapor reached the head and the process was inexorably slow if it proceeded at all. On the other hand, if the heat were too high the distilling head might be unable to condense all the vapor which reached it, and some of the vapor might escape. To avoid such loss, eighteenth-century chemists (1) used oversized receivers to contain the vapors and (2) increased the distance between the receiver and the head by means of adopters which lowered the temperature of the receiver and increased the secondary condensation which occurred after the head.[44]

FIGURE 4. An apparatus sampler. From top, left to right: *i, k, l*, an alembic; *g, h*, a vessel with a paper cone suspended over it to collect sublimated "flowers of benzoin"; *m, n*, an apparatus for preparing "spirit of sulfur" (sulfuric acid anhydride) by burning sulfur under a bell in a humid atmosphere; *f*, mortar and pestle; *a–e*, a fusion furnace; *y*, a mold for "pierre infernale" (fused silver nitrate); *u, x*, a stack of "aludels" with a head on top; *o*, a general-purpose mold; *s*, an apparatus for refluxing; *p, q, r*, a copper alembic. The bucket-like item at lower left is a small furnace, and above it are two "coupels," metal vessels for testing precious metals. [From Nicolas Lemery, *Cours de chymie*, 6th edition (Paris, 1687), plate 2.]

If the product of a distillation were a finely divided solid (usually referred to as "flowers," e.g., "flowers of sulfur") a series of earthenware distilling heads without beaks was used. Such heads were called "aludels." Except for the top aludel, which was open only at the bottom, these vessels had a fitted opening at top and bottom so they could be stacked. This increased the flexibility of the device, for if the reaction had a high yield or if much product were wanted, a larger number of units could be put into the stack.

Besides specialized vessels such as those described above, there was a wide variety of dishes, bottles, basins, etc. An appreciation of the varieties of apparatus can be gained from Figure 4. A mortar and pestle were standard equipment, of course, as was the crucible. Macquer recommended that crucibles be made of the same kind of earth as the pots in which butter was brought from Brittany. In fact, "ces pots eux-memes sont de fort bons creusets." [45]

In addition, there were the odds and ends of everyday chemical use that one could easily imagine but that, as far as I know, have been listed together only by Macquer. These included glass stirring rods, spatulas of various materials (including ivory), thin pieces of board for collecting material that had been crushed and ground fine, white paper for keeping notes and for use in filtrations, and "a good supply of clean straw, cut to a length of eight to ten inches (*pouces*), which serve to stir mixtures in glass [vessels], and to support filter papers in glass funnels." [46]

A major problem for the chemists of the time was the jointure of two or more vessels, especially those made of glass. Since the glassware of this period was hand blown, there was no possibility of producing standard fittings like those in use today. The problem was not due to an inability to produce individual, ground-glass joints but because such construction was both fragile and expensive and each joint was unique.[47] One of the most striking aspects of contemporary illustrations of eighteenth-century apparatus is the rarity of glass tubing in connecting individual pieces. But in the absence of rubber tubing there was little to be gained by such connections. Instead, most pieces of apparatus that were designed to be connected with others were provided with tapered flanges, spouts, beaks, etc. In this way, the closest mechanical fit possible was obtained (considering that both the male and the female fittings were usually out of round). Once the mechanical fit was obtained, the joint was sealed with various substances having the generic name "lutes."

The ideal lute was a substance soft enough to be worked into and around the joint to form a vapor-tight (later, a gas-tight) seal and, at the same time, of sufficient mechanical strength to endure the rigors of the experiment. Apparently there were no permanently pliable substances which met all of these requirements. Those that had mechanical strength tended to dry into a brittle mass, while the most pliable of lutes—the "fat lute"—required separate mechanical support. Some lutes had clay as a base since it was the right consistency when wet to work into the joint. To offset the brittleness of the clay when it dried, other substances were added to the clay to endow it with the right consistency.[48]

The preparation of lutes was something of an art. The recipes varied from such a simple expedient as wet paper strips to the more exotic arcanum of "soft cheese, Lime and Rye flower." [49] Simple seals for noncorrosive or nonpenetrating vapors were made with strips of paper or cloth soaked in flour paste. Stronger seals were obtained from strips of bladder soaked for a long time in water. The soaking process apparently elicited some sort of sticky gelatinous matter similar to the active ingredient of animal hide glues.

In extremes, the chemist of the period could call upon the "fat lute," the term given to a mixture of fine clay and boiled linseed oil. The advantage of the fat lute was that it did not harden and thus would not shrink or become brittle. Unfortunately, all surfaces had to be almost perfectly dry or the fat lute would not adhere. Because it did not harden, fat lute was totally lacking in mechanical strength and had to be covered with a second lute of linen strips soaked in a mixture of quicklime and egg white. This latter concoction also was used as a lute by itself.[50]

For joints that were not reached by heat, various mixtures of beeswax and resins were employed as lutes.

The problem of joining pieces of glass apparatus remained with chemists over a long period. A comparison of Macquer's recommendations for preparing lutes in 1766 with those of Le Fevre in 1670 or Lavoisier in 1789 shows far more similarities than differences.[51] Because of the technical problem involved, individual pieces of apparatus had to be closely coupled, with one piece joined to another by means of short, strong connections and, therefore, heavy joints. As a result, the apparatus of this period has an awkward appearance to anyone familiar with its modern counterparts. As Lavoisier's elegant and expensive later apparatus [52] shows, this was not due to a lack of design ingenuity. But until the development of extrusion processes for glass and rubber in the mid-nineteenth century made standardized rubber and glass tubing possible, the construction of more complicated apparatus remained a special problem.

Along with glassware and hardware, the chemist of this period usually had at his disposal a number of chemical reagents. In the ordinary laboratory one might expect to find all of the common mineral acids: vitriolic (sulfuric), nitrous (nitric), and marine (hydrochloric).[53] Similarly, the common alkalis were useful to have on hand, including solutions of alkalis rendered caustic by treatment with quicklime (which changed the carbonates to hydroxides). Such solutions would include vegetable alkali (potassium carbonate), mineral alkali or soda (sodium carbonate), fixed alkali of tartar (also potassium carbonate), and vegetable alkali (ammonia).

Limewater (calcium hydroxide) and quicklime (calcium oxide), although not classed as alkalis at the time, were common reagents. Of substances which now would be classed as organic reagents, there were distilled vinegar (which contained acetic acid), vitriolic ether (diethyl ether), oils of various substances including turpentine and olives, soap, and, of course, the purest and most highly rectified (i.e., having undergone several distillations) spirit of wine (ethanol).

Common sulfur and as many metals and semimetals as possible also were required.

This selection of materials was sufficient to prepare a large number of common compounds, particularly neutral salts. Some of these compounds, particularly those that were commonly available from the apothecary shop, probably would have been on hand in most laboratories. These would include common salt, alum, borax, blue and green vitriol (copper and iron sulfates), sedative salt (boric acid), sal ammoniac (ammonium chloride), chalk (calcium carbonate), marble (also calcium carbonate), sand, and such common industrial chemicals as ceruse (lead carbonate), minium (red lead oxide, Pb_3O_4), litharge (yellow lead oxide, PbO) and corrosive sublimate (mercuric chloride).

In addition to these reagents, several substances had come into standard use for definitive tests for the presence of important compounds or classes of compounds. Many of these tests for acids and alkalis had been invented or compiled by Robert Boyle. The substances most commonly used in these tests were oak galls, turnsole, and syrup of violets.[54]

Besides physical appointments and reagents, a number of recognized procedures were a standard part of the laboratory repertoire of the eighteenth-century chemist. For convenience we classify these as preparative, reactive, separative, and purificative and will treat them in that order.[55]

Solids usually were first prepared by "division": a separation of the parts of the substances by purely mechanical means. Then, as now, the purpose was to facilitate solution or to speed up a reaction being carried out "in the dry way" by increasing the surface area. Another term for this separation was "trituration" although more often it was used to signify grinding or pulverizing several substances simultaneously to prepare mixtures for reaction in the dry way. Metals were divided by pouring the molten metal slowly into water that was continuously agitated. This resulted in small particles or shot. Filing also was possible, but it was not recommended because of the possibility of introducing iron impurities.

Soluble substances often were put into solution directly by "extraction": the separation of a substance from a mixture by means of a solvent or "menstruum." If no heat were involved, the product of this process was called an infusion; if the solids and solvent were heated, the result was a "decoction." Other processes related to these included "maceration," which was essentially the same as infusion, and "digestion," which, though sometimes used in a way similar to decoction, usually implied a spontaneous reaction that needed the aid of prolonged moderate heat.[56] Digestion, often carried out in the matrass, was felt to be "useful to favor the action of certain substances upon each other." [57] It also was used as a preparative procedure "to soften and open certain bodies," especially in the animal and vegetable realms.

Organic liquids also were prepared by the purely mechanical method of "expression" or squeezing in a press.

A solution that might be too dilute when first prepared would have to be concentrated by evaporation in large open earthen dishes or, in some cases, by distillation. The term "dephlemation" was used synonymously with "concentration" for removing excess watery parts of a solution, but it often had the specific meaning of making an acid more concentrated.

Although there were no adequate criteria for purity, there was a sense of freeing a substance or separating it from unwanted foreign bodies. Thus, when a chemist separated a solid substance from acids by washing it with cold water, the process was known as "edulcoration." It was preferable to have an insoluble solid for this operation, but with care even a somewhat soluble substance could be made milder in this way.

Some reactions proceeded spontaneously to a satisfactory product, but for those that did not the chemist had recourse to several reactive processes. Perhaps the best known was "calcination," a general term for exposing a solid reactant to the action of fire to produce some change in it. Less well known is the fact that the term calcination also was applied somewhat loosely to a variety of operations in which volatile principles were carried off but not collected as they were in distillation. Such a process was regarded as intermediate between the physical and chemical. In this sense, calcination could be carried out in the absence of air, although the presence of air was recommended since it had the ability to mix with and help carry off volatile matters.[58]

In the sense that calcination involved a destruction of the properties of a substance through the loss of an essential component, "reduction" (or "revivification") was its opposite. Reduction was the restoration of the substance to its natural state. As in calcination, reduction usually referred to metals. The calx was believed to have lost phlogiston, so the obvious cure was to restore the phlogiston by action with a substance that was rich in this principle. Carbon was the common choice for restoring phlogiston to metals, but other substances such as liver of sulphur could be employed in reactions involving relatively small quantities of calx. As with calcination, there was a second sense of the term "reduction." That term also meant the restoration of a substance to its natural state through a removal of heterogenous matters which had combined with the original substance to alter or mask its natural state.[59]

Another important process was "dulcification" in which caustic and corrosive substances were rendered "milder" by being combined with another substance. Instead of thinking of this process as producing an entirely new substance—a product per se—most chemists viewed it as a method for varying the properties of the original substance which, though still present after the process was complete, was to their intents and purposes harmless.[60]

Aside from simple heating and distillation, further reactions in the liquid state were performed by "cohobation," which is analogous to the modern method of refluxing. We have noted this process before in the discussion of the apparatus known as the pelican. It was not recognized at this time that the reaction really occurred in the vapor phase as the vapors went through the evaporation and condensation cycle. For early chemists the primary virtue of the process appears to have been the length of time it took. By the eighteenth century, however, the mystical advantages which surrounded any long-term process seem to have lost their charms somewhat, for Macquer commented that cohobation "is one of those operations which the ancient chemists practised with great patience and zeal, and which are now neglected." [61] Sad to say, this may have been because "the modern chemists have not so much patience as the ancient chemists had for making long experiments."[62] A second use for cohobation, and one which was not so neglected, was for dissolving a substance which normally went into solution with difficulty.

The process known as "detonation" was used not only to describe reactions of explosive force but also to apply to the often spectacular and violent inflammation of nitre with various combustible substances.[63]

The increasing importance of solution chemistry is reflected in the fact that "precipitation" was regarded as a true reaction (i.e., a process in which a new substance was formed). Indeed, Macquer saw precipitation as "one of the most general and most important operations of chemistry." [64] It was seen as a chemical decomposition caused by an intermediate substance.

Once a reaction was complete, it usually was necessary to separate the products from the reaction solution, if any, or from each other. In the case of liquid products, or a solid-liquid mixture, the usual choice was distillation, still attractive albeit venerable.

If there were only one liquid product, or if the supernatant liquid which remained after the completion of a reaction were required for further work, "decantation" was used. Although distillation has acquired a considerable sophistication over the years, decantation has not; thus, decantation provides a methodological link with eighteenth-century chemistry.

A more bothersome but more complete method than decantation for separating liquids from solids was (as now) "filtration." [65] Standard commercial paper (classified then by color—brown, white, or gray), free from paste or sizing, was used. If a large quantity was to be filtered, various kinds of cloth stretched over a wooden frame were preferred. Caustic substances represented a greater problem. Sand could be used for these if one were willing to put up with great difficulty in recovering the desired solid substances after filtration. If a noncorrosive substance was difficult to filter, it was heated to make the liquid less thick.

In a mixture (or sometimes even a substance assumed to be a compound) in which the soluble portion was desired, the process of "lixiviation" was used. This process consisted of treating the substance with a menstruum for a rather long period of time and then separating the solution from any remaining solids. It is not clear what criteria differentiate lixiviation from infusion, although in the latter the mixture often was prepared for use in another reaction rather than just to prepare a liquid product.[66]

If the liquid part of the solution was of little interest, the solid might be collected by "evaporation to dryness" in large open dishes. This process differed from crystallization in that the latter usually was used for purification.

The problem of "purification" loomed large in eighteenth-century chemistry. Purification was defined as "any chemical operation by which substances required to be obtained pure and single are separated from other heterogeneous matters with which they happen to be mixed." But the operational criteria by which a body could be judged pure were ill-defined at best. The process of purification used almost all of the other processes of chemistry, but particularly "rectification," "sublimation," and "crystallization."

Rectification simply was repeated distillation. Chemists had long recognized that liquids such as spirit of wine (ethanol) came over free from obvious foreign particles in the first phases of distillation.[67] Thus, Baumé, for example, could recommend that the first fifteen or so pints of the distillate from 300 pints of aqua vitae (crude alcohol from fermentation) could be regarded as spirit of wine in the purest form possible.[68] The only criteria mentioned to test the effectiveness of the rectification of spirit of wine involved sight, smell, and taste. There was no chemical test felt to be reliable at that time.[69]

Although technically one could have used the boiling point to test the quality of liquid substances such as spirit of wine, the thermometer was not commonly found in chemical laboratories of the eighteenth century. While processes that required control of heat were difficult in conjunction with furnaces, as we have noted, they were hardly impossible. Yet in spite of several suggestions for its use, the thermometer was not employed even in distillation.[70] In fact, the thermometer, like the ordinary analytical balance, was not even given an entry in the first edition of Macquer's *Dictionnaire,* although by that rather late date (1766) adequate thermometers had long been available.

In spite of the lack of adequate criteria for determining purity, to obtain pure substances in many cases was possible because a number of the inherent physical properties of the processes could produce nearly pure substances if reasonable care were taken. Distillation, as mentioned above, was one such process; another was "sublimation." Although that term now refers to the production of the vapor phase directly from a solid, in the eighteenth century it had a wider meaning. Sublimation included, for example, reactive processes in which all volatile matter driven off from solids was chemically combined in the vapor phase and collected separately as it condensed. The term sometimes even described the production of volatile substances which condensed as liquids, but the terminology was not entirely consistent here and such processes usually were simply called distillation. The primary technical problem in sublimation was removing the product after it had condensed as a solid. If the solid product were soluble, there was little difficulty; if it were not soluble, however, the condensing apparatus sometimes had to be broken to remove the product.[71]

Certainly the most important purificative process was "crystallization." As we know now, most substances crystallize out of solution in an almost pure form. In many cases this is true even in a mixture of salts, although the problems become much more complicated. In general, however, if the crystallization is stopped well before the solution is evaporated to dryness, the principal component in the crystallized solid mass will be the substance which is least soluble. In rare cases where two or more of the substances in the solution are isomorphic, a mixed species such as alum can be formed, but if other processes are available for purification such mixed crystals can be detected. Excluding this problem, repeated crystallization was, then, perhaps the best method of obtaining pure solids, and particularly salts.

There is, of course, more to crystallization than evaporation. There is a strong temperature dependence in the solubility of many salts, so that one salt may crystallize out of a given solution at one temperature but another will do so later at a lower temperature. Concentration is a factor as well.

Eighteenth-century chemists were well aware of these factors in crystallization. Macquer recommended repeated crystallizations as the primary method for obtaining pure salts.[72] To separate mixtures of two salts, Antoine Baumé used various properties which offset crystallization. The paradigm case was a mixture of nitre (potassium nitrate) and sea-salt (sodium chloride). Depending on the relative concentrations of these two salts, Baumé's method of alternately evaporating and cooling the solution to encourage the crystallization of first sea-salt and then nitre produced not only a separation but nearly pure salts as well. The difficult properties of the solution aptly illustrate Baume's ingenuity in separating the desired products.[73]

The process of alternately cooling and evaporating to separate out fractions of $NaCl$ and KNO_3 must, of course, be repeated a number of times before either fraction can be regarded as pure.

Thus properly armed with a vocabulary and a picture of the eighteenth-century chemist's tools and surroundings, we may consider examples of chemical research in that period. The first is a short work by the masterful German chemist A.-S. Marggraf (1709–1782). In 1746 Marggraf reported the success of some attempts to dissolve silver and mercury in such weak vegetable acids as vinegar, Rhine wine, and citron.[74]

Early investigations on the nature of phosphorous had led Marggraf to the discovery of various ammoniacal salts from urine. These salts would react with silver and gold to produce precipitates which in turn could be dissolved in some of the salts of strong acids. It was reasonable, then, for Marggraf to see if these and other alkaline precipitates, which were thought to be related to these salts from urine, could be dissolved in the weaker vegetable acids.

Although this was a logical, if minor, step in Margraf's investigations, his style and organization make the paper appear to be a self-motivated unit. This standard practice often makes it difficult, of course, to determine the motivation for a given piece of work. Marggraf tied it to the claims of such earlier chemists as Borrichius, Becher, and Henckel that the precious metals, properly treated, could be dissolved in vinegar.[75] Of these, only a chemist named Kessler gave definite instructions on the procedure, and Marggraf's careful repetition of Kessler's manipulations gave a product which, when tested by the usual methods, showed no sign of silver.

But our goal here must be to understand Marggraf's procedure in detail, looking over his shoulder as it were.[76] Marggraf began by preparing a solution of silver in the conventional way, dissolving it in nitric acid solution. But Marggraf's elaborate efforts to insure that the silver be "the purest and very free of copper" were definitely *not* conventional. Similarly, he demanded that the spirit of nitre be of the "best purity," the water distilled, and the vinegar used in a later operation not only to be distilled but concentrated by the glacial method.

To the silver solution, Marggraf added a specially prepared solution of the salt of urine (primarily ammonia) drop by drop until no more precipitate was formed. The precipitate was yellow, and Marggraf edulcorated it "perfectly" with boiling distilled water and separated it out (perhaps by filtering). He then let it go to dryness.

One dram of the precipitate was divided into a fine powder in mortar and pestle and transferred to a narrow-mouth bottle. Four ounces of distilled vinegar, "perfectly" concentrated,[77] was poured in and the mixture of solids and solvent was digested in a sand bath until "coction." The mixture was allowed to cool and then was filtered. The procedure was repeated on the solids, this time with six ounces of the vinegar.

Marggraf then concentrated the solution in a glass retort down to 1½ ounces. It was now the characteristic gray-brown of a finely divided silver suspension, which was Marggraf's interpretation of the result. Filtering the mixture to remove the suspended silver once again, he found the liquor to be yellowish.

The remaining yellow solids, which had not dissolved in the vinegar, were edulcorated in boiling water, dried, and weighed. They had decreased in weight "by one scruple and several grains."

But weighing was, for Marggraf, only an indirect test for dissolution. For a direct test for the presence of silver, he added common salt. The precipitate proved to be good horn silver (silver chloride). In addition, two other tests—reducing the silver with a blowpipe and precipitating it through displacement with solid copper—provided further confirming evidence in case anyone doubted the first results.[78]

The strategy of this investigation is quite straightforward. Marggraf had produced the precipitate of silver before. He had dissolved it with various dissolving agents before. Clearly the compound had reactive properties which the metal, a notably inert substance, did not have. "Everything lies," he said, "in the exact preparation of the silver precipitate; it is this [process] which prepares this metal to allow entry to the vegetable acids." [79]

To maximize the likelihood of dissolution, Marggraf divided the precipitate into a fine powder. To further aid the hoped-for dissolution, he digested it thoroughly. In case the precipitate were only slightly soluble, Marggraf would repeat the process. In either case, he then concentrated the resulting solution. Great care was taken throughout to use pure substances in order to minimize the possibility for unknown side reactions which might inhibit or mask any dissolution. Finally, out of elegance as much as caution, Marggraf used not one but three tests to demonstrate beyond any doubt the presence of the silver.

In his insistence on purity and his care in developing evidence, Marggraf must be seen as rather an exception. His attention to details and the care in which he wrapped even such a relatively simple investigation as this suggest that we should view his work as the upper boundary in elegant chemical analysis. Moreover, although more complicated examples of Marggraf's work could be analyzed, this particular piece of work is not as pedestrian as it might at first seem. Dissolution was becoming more and more important as chemistry moved away from simple distillation analysis and the limited method of performing reactions in the dry way. To do reactions in solution one must, obviously enough, get the reactants into solution. Moreover, the solubility properties of a substance were an important defining characteristic. Many chemists, notably those who admired Stahlian chemistry, saw dissolution (quite properly) as a reaction, i.e., as a chemical rather than a physical process. At any rate, solubility was used at least implicitly as a defining characteristic for a chemical species.

Although it is not really fair to compare English chemists of that time with Marggraf or with any of a dozen or so skillful French scientists, one ought to look at one example of English chemistry for the sake of completeness if nothing else. To soften the blow to English pride a bit, for our second example of eighteenth-century chemical research we consider an excellent piece of work by William Lewis (1708–1781).[80] Lewis was widely read in chemistry, including pharmacy. He translated and rearranged the lectures of Stahl's pupil and follower, Caspar Neumann, into English and thus was instrumental in carrying phlogiston chemistry to England.[81]

Sometime in the early 1750s, Lewis obtained a sample of the substance usually called platina, a heterogeneous mixture of ore residues from certain gold ores in the Spanish West Indies. The analysis of ore samples was one of the most common and important tasks of the eighteenth-century chemist. Orderly and controlled, Lewis' approach to the analysis can be viewed as reflecting organization and training rather than genius. This particular investigation also has intrinsic interest as one of the first studies on platinum in English.[82]

The so-called platina (Spanish, "little silver") was identified physically as "white shining grains" of definite crystalline figure. By physical means the investigators separated the grains from the heterogeneous mixture of granular mineral matter. To clean the separated grains chemically, Lewis chose the (German) industrial technique for cleaning metals by treating them first with *aqua fortis* (nitric acid) and then with sal ammoniac (ammonium chloride) rather than with *aqua regia* directly. The intent was the same: to cleanse the metal of foreign chemical matter by a reaction in solution.

Lewis determined the most important physical parameter—specific gravity—for both the cleaned grains and the heterogeneous mixture. Other physical characteristics such as malleability and friability also were tested. Also, there was some evidence of magnetic properties.

Fire was the chemist's most basic tool, and it usually was the first treatment for any metal or ore. Lewis' approach was no exception. Gradually increasing the quantity and duration of the fire, Lewis attempted without success to fuse (melt) the metallic substance.[83] After using the hottest fire he could obtain, he subjected the platina grains to various reducing mixtures, then in increasing order of effectiveness, to all the fluxes commonly used. Such techniques came from a long history of metallurgy, of melting and reducing hard metals and refractory ores. When they failed, as they did, it was clear to Lewis that he was seeking a metal unlike any which had been seen before.

Having exhausted the efficiency of fire, Lewis "proposed to examine the effect of acid spirits, simple and compound, applied after various manners." Clearly these substances served him as chemical instruments to define the nature of the new metal, "to determine not only its relation or *habitus* to them, but likewise its less obvious agreement or disagreement with the metallic bodies, whose history is more known." Although Lewis does not specify the specific gravity of his acids or the amount of dilution, it is highly probable that he was using well-defined solutions, "both concentrated, and diluted with different proportions of water.[84] Usually even the most refractory substances, save gold, yielded to one of the three mineral acids or to such related compounds as nitre or corrosive sublimate (mercuric chloride). But no mode of application of these substances, dilute or concentrated, cool or boiling, could affect the platina.

As with many contemporary chemists testing the effects of both fire and acids, Lewis used change in weight of reactants when seeking positive indication that a chemical process had occurred.

Lewis' conclusion after applying these techniques for fusing or dissolving gold was that the platina was "nearly as ponderous as gold [and] equally fixed and permanent in the fire" [85] and that "equally with gold [it] resists the force of the vitriolic, marine and nitrous acids, tho' apply'd in such a manner as to be capable of perfectly dissolving all other known metallic bodies." [86]

The array of techniques used by Lewis gave further indications that the new metal was similar to gold. It was not affected by sulphur and nitre, but it dissolved in liver of sulphur.[87]

The next logical step for anyone who suspected that this strange metal had properties analogous to those of gold would be to subject it to the gentle persuasion of *aqua regia*.[88] It worked! It worked for every variety and dilution of that great solvent. But more important than the new knowledge that platina had yet another of gold's properties was the actual existence of a solution of the new metal.

The reason for Lewis' perseverance and energetic pursuit of a solvent soon becomes apparent. Since gold clearly seemed an appropriate substance against which the new metal could be compared, what more could a chemist ask than to continue the comparative process by utilizing the extensive solution chemistry of gold? For economic reasons, few substances had been subjected to such intensive study as gold, but for chemical reasons these labors had produced little of interest to the philosophical chemist. Now at last a new substance had arrived which cried out for comparison to and contrast with the long-known reactions of gold. Certainly a situation which would send any chemist—save those whose operations were limited to the "salon"—to his bottles and bench.

Thus Lewis ran quickly through the standard gold reactions but used dissolved platinum instead of gold solution. Hot marble, skin, feathers, and ivory did not stain as they did in the gold solution. These hoary and honorable indicator tests for gold would not serve for platina. There *was* a reaction with tin plates, however, though nothing like the distinctive purple tint which characterized solution of gold. The solution turned a rather disappointing olive brown, letting down a reddish brown precipitate and then losing its color again. Altogether, it was not a satisfactory result; that is, it was not a result on which he could establish a definitive test for use by later investigators.

But on balance, the similarities and differences between the solution chemistry of gold and platina were enough to provide the all-important operational definition of the new substance. Aside from the properties discussed above, Lewis wrote that

> it differs from gold . . . in not being revived from its solutions by inflammable spirits, not being totally precipitible by alcaline sales: that in certain circumstances [platina] throws out gold from its solutions . that platine is precipitated from its solutions by the vitriolic acid, and by the metallic substances, which precipitated gold, though scarcely totally by any; And that its precipitates resist vitrification and this perhaps in a more perfect manner than precipitates of gold itself.[89]

Specifically, these observations from experiment were able to afford "means of distinguishing a small proportion of gold mixed with a large one of platina, or a small proportion of platina mixed with a large one of gold." Since the latter condition was common in nature, the result was most useful. One thing was certain from these investigations: "the common methods of assaying or purifying gold by *aqua fortis, aqua regis,* or the *regal cement* can no longer be depended on." [90]

Continuing in a metallurgical vein, Lewis explored the relationship between platina and each of the other known metals and nonmetals. The most startling general result was that, in spite of its refractory nature, the platina melted into each of the metals, "occasioning remarkable alterations in their colour, texture and hardness." [91] The many and varied metallurgical properties of platina, though interesting, added little to what has already been said. They did, however, serve to define the new metal better.

Our third example of chemical research of the period is an investigation carried out by a French chemist. Compared to the work of Marggraf and Lewis, it is somewhat more complex in its techniques, both in terms of apparatus and operations. The author was Francois de Tellier, Marquis de Courtanvaux (1718–1781), and the subject was the synthesis of "marine ether" (ethyl chloride).

The reactions of vitriolic acid and nitrous acid on spirit of wine to produce vitriolic ether (diethyl ether) and nitrous ether (ethyl nitrate) led naturally to attempts to produce a marine either with marine acid and spirit of wine. But a number of chemists, including Baumé, had only slightly encouraging results with the simple and direct approach of mixing the two substances and then distilling.[92] De Courtanvaux applied the reasonable next step—the use of a preparation that included the marine acid, the "fuming liquor of Libavius." His explanation for this choice was plausible. Because they were extremely volatile, spirit of wine and spirit of salt could not take on the degree of heat necessary to let the combination be made simply and directly. The tin in the fuming liquor gave it a greater density and weight, causing it "to take on a greater degree [amount] of heat during the distillation than spirit of salt alone. This brings a greater activity to the decomposition of the spirit of wine, and consequently to the formation of the ether." [93] Whether that reasoning was *a priori* or *ad hoc* is difficult to say. Certainly it is possible that de Courtanvaux hit upon the fuming liquor of Libavius after trying a number of substances containing spirit of salt. Moreover, this substance was known at the time as a good source of marine acid.[94]

De Courtanvaux revealed his theoretical sympathies by preparing the fuming liquor according to the method of Stahl.[95] Adding small portions of a *known weight* of the fuming liquor to a *known volume* of spirit of wine and mixing carefully after each hissing, boiling, smoking bit of the reaction subsided, de Courtanvaux found himself with a retort partially full of hot, amber liquid. As receivers, he fitted two balloons, apparently in tandem, to the neck of the retort.[96] The second balloon had a tubulature for pressure relief. The jointure was made by using the fat lute, strengthened with linen strips soaked in quicklime and egg white. For the best condensation possible, each balloon was fitted into a shallow earthenware vessel by sitting it on the handy ubiquitous straw *ronds* or woven rings and fastening the neck with cord across the open top. Crushed ice cooled the lower part of each balloon while ice-cold towels (changed every few minutes) performed the same service for the exposed areas.

To distill the ether, de Courtanvaux heated the retort in a sand bath. The air in the apparatus was allowed to escape until there was a distinct odor of spirit of wine, then the tubulature of the second balloon was sealed. In the actual experiment, the ice was added after this last step. Using these procedures, de Courtanvaux could do most of his distillation without having to open the system. The technical reason for this was that the liquid condensing in the balloon kept the pressure at low level. When the chemist judged that it was time to relieve the pressure in the balloon, de Courtanvaux recommended that he put a bottle over the mouth of the tubulature in the second flask "to evaluate the loss approximately." [97]

The mixture in the retort had the nasty habit of boiling up suddenly if the heat were allowed to rise too high. To control this, de Courtanvaux would open some of the flues in the furnace and drop the fire, or rearrange or remove some of the sand around the flask.

When no more vapor seemed to be coming over, the vessels were cooled, unluted, and their contents combined. The "éther non-purifié" weighed one pound, two ounces, six gros. Also, there were one ounce of an oily liquid and two pounds fourteen ounces of residue. But this product was highly acidic, and to obtain a pure ether it had to be neutralized by adding base until blue indicator paper no longer turned red. The neutral solution then was rectified in the usual way by distilling it several times. From two pounds of the "impure" ether (the additional amount was from another preparation), only one pound two ounces of the purified marine ether was finally obtained.

The procedure described above was the one which gave the maximum yield. Departures from the quantities of reactants, from the procedures, or even from the apparatus gave poorer yields of ether.

On analysis, de Courtanvaux found that the residue was a butter of tin (primarily stannic chloride) with excess acid ("surabondance d'acide").[98]

By any reasonable standards, the Marquis de Courtanvaux had done in admirable piece of work; and the same must be said of Lewis and the incomparable Marggraf. But there is more to these investigations than demonstrations of the impressive skill of some eighteenth-century chemists. Not only chemical theory but chemical epistomology was being changed and refined at the hands—literally—of such men. In choosing to work with solutions, in accepting precipitations and liquid color changes as reliable indications of the presence of a chemical species, in developing operations whose purpose was to define substances in terms of their relationship with other substances rather than the unitary operations so common to classical distillation analysis—in all these things, such men were effecting a change in the old order.

Moreover, many of the features seen here—such as measuring and weighing, giving some attention to purity, performing a *series* of operations on a given substance, and a fairly sophisticated approach to handling "vapours" or other subtile, elastic fluids—were, if not the rule, at least not the exception. Since these characteristics are usually associated with the chemistry of Lavoisier, they are particularly worthy of note.

A Dictionary of British Eighteenth-Century Chemical Terms

Just as Samuel Johnson pointed out that no dictionary of a living language can be perfect, so it must be argued that no dictionary for a living historical discipline will initially be complete or free from errors. The purpose of our dictionary is to make it easier for students to become acquainted with an esoteric and often confused nomenclature in order to more clearly interpret the technical activities of eighteenth-century chemists. This first effort is not truly multilingual, though it includes Latin and French phrases that were common in British journals and treatises. Those who wish to determine French and German equivalents usually can do so by finding parallel sections in the French, English, and German editions of Macquer's original *Dictionnaire de Chymie,*[99] though it is hoped that an expanded, multilingual edition may be prepared for publication sometime in the future. In any event, readers are encouraged to communicate additions and corrections to the present dictionary.

For a full discussion of the significance of chemical nomenclature in the history of chemistry, the reader is urged to consult Maurice Crosland's classic *Historical Studies in the Language of Chemistry.*[100]

Absorbent Earths: Chalk, marble, and clays. No specific formulas. Generally carbonates, silicates, and sulfates.

Acesunt: Any substance which is slightly acid, or turning sour.

Acetated Earths, Metals, etc.: Acetates $(-C_2H_3O_2^-)$.

Acetous Acid: Impure acetic acid from vinegar.

Acetum: Referring to vinegar, or to a compound made from vinegar, as in "acetum radicatum."

Acid Air (Priestley): Hydrogen chloride (HCl).

Acid from Ants: Formic acid (HCOOH).

Acid, Nitri Phlogistic: See Nitrous Air.

Acid of Amber: Succinic acid $(C_4H_6O_4)$.

Acid of Apples: Malic acid $(C_4H_6O_5)$.

Acid of Arsenic: Arsenic acid (H_3AsO_4).

Acid of Barberry: Malic acid.

Acid of Benzoin: Benzoic acid (C_6H_5COOH).

Acid of Borax: Boric acid (H_3BO_3).

Acid of Burning Sulphur: Sulfurous acid (H_2SO_3).

Acid of Flour Spar: Hydrofluoric acid (mixed usually with silicon fluoride) (HF; SiF_4).

Acid of Lemons: Citric acid $(C_6H_8O_7)$.

Acid of Milk: Lactic acid $(C_3H_6O_3)$

Acid of Milk-Sugar: Mucic acid $(COOH\ (CHOH)_4COOH)$.

Acid of Molybdaena: Molybdic acid (H_2MoO_4).

Acid of Nitre: Nitric acid (HNO_3).

Acid of Phosphorus: Phosphoric acid (H_3NO_4).

Acid of Salt: Hydrochloric acid (HCl).

Acid of Sea-Salt: Hydrochloric acid, alone, or in a compound (i.e., the Cl^- radical).

Acid of Sorrel: Oxalic acid (COOH COOH).

Acid of Sugar: Oxalic acid (COOH COOH).

Acid of Tamarinds: Tartaric acid $(C_4H_6O_6)$.

Acid of Tartar: Tartaric acid.

Acid of Urine: Phosphoric acid (H_3PO_4).

Acid of Vinegar: Acetic acid (CH_3COOH).

Acid of Vitriol: Sulfuric acid (H_2SO_4).

Acidum Aereum: Carbon dioxide (CO_2).

Acidum Mephiticum: Carbon dioxide (CO_2).

Acidum Pingue: J. F. Meyer's hypothesized "fatty acid."

Acidum Sacchari: Oxalic acid (COOH COOH).

Acid Vitriolated Tartar: Potassium hydrogen sulphate $(KHSO_4)$.

Adopters: Small, circular vessels with a necked opening and a spout opposite. They were connected between the distilling head and the receiver. See text, page 11.

Aduration: A union or combination into one.

Aerated Alkali: Any alkali carbonate (e.g., K_2CO_3).

"Aerated" Compounds (Bergman): Carbonates ($-CO_3^{-2}$).

Aerated Lime: Calcium carbonate ($CaCO_3$).

Aerated Water: Water containing dissolved carbon dioxide.

Aer Hepaticus: Hydrogen sulfide (H_2S).

Aerial Acid: Carbon dioxide (CO_2).

Aerugo (Aeruca) (Rust of Copper): See Verdigris.

Aer Urinosum: Ammonia (NH_3).

Aethiops Mercuriales: See Aethiops Mineralis.

Aethiops Mineralis (Aethiops Mercuriales): Black mercuric sulphide (H_2S).

Air: Generally, any substance in gaseous state.

Air (Priestley): A gaseous substance which could *not* be liquified by cold.

Air, Dephlogisticated: Oxygen (O_2).

Air, Fixed: Carbon dioxide (CO_2).

Air, Hepatic: Hydrogen sulphide (H_2S).

Air, Inflammable: Hydrogen (H_2).

Air, Marine Acid: Hydrogen chloride (HCl).

Air, Mephitic: Carbon dioxide (CO_2).

Air, Phlogisticated: Nitrogen (N_2).

Air, Vital: Oxygen (O_2).

Air of Flour Spar: Hydrofluoric acid gas (usually with silicon fluoride) (HF).

Air of Vitriol: Sulphur dioxide (SO_2).

Alaunerde: Alumina (Al_2O_3).

Alcohol: Usually spirit of wine (CH_3CH_2OH) (sometimes *any* very fine powder).

Alembic: A type of distillation apparatus. See text, page 9.

Alexipharmic: A remedy or preservative against poison.

Alicant Kelp: Crude sodium carbonate (Na_2CO_3).

Alk. Min. Vitriol: Sodium sulphate (Na_2SO_4).

Alkahest: Originally, the universal solvent (alchemical term).

Alkahest Glauberi: See Fixed vegetable alkali (K_2CO_3).

Alkahest of Reapour: See Fixed vegetable alkali (K_2CO_3).

Alkahest of van Helmont (Glauber's Alkahest): Concentrated potassium carbonate (K_2CO_3).

Alkalescent: Any substance which is slightly alkaline or turning alkaline.

Alkali, Caustic: Hydroxides ($-OH-$).

Alkali, Common Mineral: Sodium carbonate ($Na_2CO_3 \cdot 10H_2O$).

Alkali, Concrete Volatile: Ammonium carbonate ($(NH_4)_2CO_3$).

Alkali, Fossil: Sodium carbonate (Na_2CO_3).

Alkali, Marine: Sodium carbonate (Na_2CO_3).

Alkali, Mild: Carbonates ($-CO_3$).

Alkali, Vegetable, Fixed: Potassium carbonate (K_2CO_3).

Alkali, Vegetable, Mild: Potassium carbonate (K_2CO_3).

Alkali, Volatile: Ammonia (NH_3).

Alkali of Soda: Sodium carbonate (Na_2CO_3).

Alkali of Tartar: Potassium carbonate (K_2CO_3).

Alkali of Wine Lees: Potassium carbonate (K_2CO_3).

Alkali Veg. Salitum: Potassium chloride (KCl).

Alkali Veg. Vitriolat.: Potassium sulphate (K_2SO_4).

Alkaline Air (Priestley): Ammonia gas (NH_3).

Alkalized Nitre: See Fixed Nitre.

Allay: Alloy.

Allonge: See Adopters.

Alterant: Anything which alters or changes the state of another.

Aludels: A unit of a multiple-head, earthenware distilling apparatus. Usually used for sublimations. See text, page 11.

Alum: Mixed double salts of aluminum sulphate with potassium sodium or ammonium sulfate. (The potassium salt, when pure, was most commonly called "alum."). ($Al_2(SO_4)_3 \cdot K_2SO_4 \cdot 24H_2O$); ($Al_2(SO_4)_3 \cdot (NH_4)_2SO_4 \cdot 24H_2O$); ($Al_2(SO_4)_3 \cdot Na_2SO_4 \cdot 24H_2O$).

Alumen: Aluminum sulfate ($Al_2(SO_4)_3$.

Alumen Ustum (Burnt Alum): Alum dehydrated by heating.

Amalgam: Any mercury alloy.

Ammoniacal Nitre: Ammonium nitrate (NH_4NO_3).

Ammonium Fixatum (Fixed Ammoniac): The residue on heating sal ammoniac with lime, i.e., calcium chloride ($CuCl_2$).

Ammonium Nitrosum: Ammonium nitrate (NH_4NO_3).

Animal Alkali: Ammonium carbonate ($(NH_4)_2CO_3$).

Anodyne: A medicine or drug which alleviates pain.

Antichlor: Hydrated sodium thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$).

Antimonial Caustic: Antimony trichloride ($SbCl_3$).

Antimonium Diaphoreticum: Mixture of antimony oxide and potassium antimoniate (Sb_2O_3; $KSbO_3$).

Antimony: Antimony sulfide (Sb_2S_3) (pre-eighteenth century). Pure antimony was called "regulus of antimony."

Antizeumic: Opposed to fermentation.

Aqua Fortis: Concentrated nitric acid (HNO_3).

Aqua Phagadena or Phagadenica: A mixture of corrosive sublimate and limewater.

Aqua Regia: Mixture of HCl and HNO_3. Various proportions were used, depending on the material to be dissolved. Commonly, more nitric acid than hydrochloric was employed.

Aqua Secunda: Dilute nitric acid, often used for cleaning metals and minerals.

Ardent Spirit: Ethyl alcohol obtained after repeated distillations (CH_3CH_2OH).

Argillaceous Earth: Clay.

Aromatic Oil: Any "oil" with a sweet or exotic odor. Often an "essential" oil.

Arsenic: Arsenic trioxide (As_2O_3).

Arsenical Sal Ammoniac: Ammonium arsenate $(NH_4)HAsO_4$.

Ash, Black: Impure sodium carbonate (Na_2CO_3).

Ash, Pearl: See Pearl Ash.

Ash, Pot: See Potash.

Ashes of Tin: Stannic oxide (SnO_2).

Assay: A quantitative determination of the metal in an ore or alloy.

Atramentum: Ferrous sulfate ($FeSO_4$).

Attrition: The action of rubbing one body against another; mutual friction.

Auripigmentum: Arsenic trisulfide (AS_2S_3).

Aurum Fulminans: An explosive gold compound prepared from gold dissolved in "Aqua Regia" and a solution of ammonium carbonate. The exact formula is still in doubt.

Avolation: Evaporation, escape, act of "flying away."

Azote: Nitrogen (N_2).

Azure: A blue pigment from cobalt.

Azurite: Basic copper (cupric) carbonate ($2CuCO_3 \cdot Cu(OH)_2$.

Baking Soda: Sodium bicarbonate ($NaHCO_3$).

Balloons: Vessels used to receive condensation products in distillation. See text, page 11.

Balneum Mariae: The water bath used for heating more delicate materials such as animal and vegetable matter. See text, page 7.

Balsam: Light oily aromatic extracts from trees which cure into resins.

Barilla: Impure soda extracted from soap-wort (impure Na_2CO_3).

Barite, Baryte(s): Barium sulfate ($BaSO_4$).

Baryta: Barium oxide (BaO).

Basis or Base: Any substance "A" which (1) is dissolved by a substance "B"; (2) receives "B" and "fixes" it; (3) forms a compound of "B."

Bath Metal: A 4:1 alloy of copper and zinc, respectively.

Bay Salt: Sodium chloride (NaCl).

Beak: A tube, usually tapered, attached to a vessel to allow the exit of its contents. See text, page 9.

Berlin Blue: Ferric ferrocyanide ($Fe_4[Fe(CN)_6]_3$.

Berlin Green: Ferric ferricyanide ($Fe[Fe(CN)_6]$.

Berthollet's Salt: Potassium chlorate ($KClO_3$).

Bezoardicum Minerale: See Bezoar Mineral.

Bezoar Mineral: Antimonic acid (H_3SbO_4).

Bismuth Corne: Bismuth oxychloride (BiOCl).

Bitter Cathartic Salt: Magnesium sulfate ($MgSO_4$).

Bitter Earth: Magnesium oxide or carbonate (MgO; $MgCO_3$).

Bittern: Liquor remaining after salt-boiling; a solution containing magnesium salts.

Bitter Salt: Magnesium sulphate ($MgSO_4 \cdot 7H_2O$).

Bitter Spar: "Dolomite"—Calcium and magnesium carbonate ($CaCO_3 \cdot MgCO_3$).

Bitumens: An amorphous grouping of resinous and petroleum products: crude oil, amber, asphaltum, coal.

Black Ash: Impure sodium carbonate (impure Na_2CO_3).

Black Copper: Copper sulfide (CuS).

Black Flux: A mixed product from the deflagration of charcoal, metal filings, nitre, and excess tartar.

Black Jack: See Blend.

Black Lead: Natural graphite of the sort used in pencils.

Black Wad: Manganese dioxide.

Blend: A mineral which looks very much like galena (PbS) and thus sometimes called "false galena." Now known as sphalerite. Primarily zinc sulfide (ZnS).

Blind Head: The top portion of a distilling apparatus which is not equipped with a beak or spout. See text, page 9.

Blue Vitriol: Copper sulfate ($CuSO_4$).

Bole (or Bolar Earth): Clays which adhere to the tongue when applied dry and which are colored yellow and red by a ferruginous (iron oxide) earth.

Borax: Sodium tetraborate ($Na_2B_4O_7 \cdot 10H_2O$).

Brass: An alloy of copper and zinc.

Braustein: Manganese dioxide (MnO_2).

Brimstone: Sulphur (S).

Bronze: An alloy of copper and tin.

Buddling Dish: A flat pan or vat used in washing ores.

Burning Spirit of Saturn: Impure acetone (CH_3COCH_3).

Burnt Alum: Exsiccated alum ($AlK(SO_4)_2$. Product of heating potassium alum.

Burnt Lime: See Quicklime.

Butter of Antimony: Deliquescent antimony trichloride ($SbCl_3$).

Butter of Arsenic: Arsenic trichloride ($AsCl_3$).

Butter of Tin: Stannic chloride ($SnCl_4$).

Butter of Zinc: Zinc chloride ($ZnCl_2$).

Butyrum Antimonii: See Butter of Antimony.

Cadmia: A term used for various forms of several substances, including cobalt. Minerals containing carbonates of zinc and various compounds of iron, among other things, were often called cadmia or "calamine."

Calamine: In its purest form, zinc carbonate ($ZnCO_3$).

Calamy (Calamine): Zinc carbonate ($ZnCO_3$), sometimes ($Zn_2SiO_4 \cdot H_2O$).

Calcareous Earth: Usually chalk ($CaCO_3$). Also possible: magnesia and/or alumina and/or barytes. Also lime.

Calcarium Potentiale: Potassium carbonate (K_2CO_3).

Calcic Liver of Sulfur: Calcium sulfide (CaS).

Calcination: The action of fire on mineral substances in which the reactants (a) often lose a noticeable amount of weight, (b) acquire a white color, (c) become friable (easily crumbled or pulverized). Almost always, a very high heat is employed. See text, page 13.

Calcined Metals: Oxides.

Calcite: Calcium carbonate ($CaCO_3$).

Callus: Any hard formation on the surface of a liquid or another solid.

Calomel: Mercurous chloride (Hg_2Cl_2).

Calx: Any powder obtained by strongly heating a substance in air. Almost always an oxide.

Calx Acetosell: Calcium oxalate (CaC_2O_4).

Calx Aerata: Calcium carbonate ($CaCO_3$).

Calx Citrata: Calcium citrate ($Ca_3(C_6H_5C_7)_2 \cdot 4H_2O$).

Calx Molybdaenata: Calcium molybdate ($CaMoO_4$).

Calx of Antimony: Antimony trioxide (Sb_2O_3).

Calx of Gold: Not a true compound, but small discolored pieces of gold formed after exposure to relatively high heat.

Calx of Stone: Calcium oxide (CaO).

Calx Plumbi Aerata: See White Lead.

Calx Saccharata: Calcium oxalate (CaC_2O_4).

Calx Tartarisata: Calcium tartrate ($CaC_4H_4O_6 \cdot 4H_2O$).

Calx Viva: Quicklime (CaO).

Camphire (Camphora, Canfora, etc.): See Camphor.

Camphor: An aromatic extract from the sap of certain trees found in Brazil and the Far East.

Caput Mortum: Most commonly signifies any solid residue remaining after dry distillation. Sometimes used for ferric oxide (Fe_2O_3).

Carbonate of Lime: Calcium carbonate ($CaCO_3$).

Carbonic Acid: Carbon dioxide (CO_2).

Carbonic Oxide: Carbon monoxide (CO).

Carburetted Hydrogen Gas: Methane (CH_4).

Cathartic Salt of Glauber: Sodium sulphate (Na_2SO_4).

Caustic Alkalis: Hydroxides ($-OH^-$).

Caustic Baryta: Barium hydroxide ($Ba(OH)_2 \cdot 8H_2O$).

Caustic Calcareous Earth: Calcium hydroxide ($Ca(OH)_2$).

Caustic Ley (Caustic Lees, etc.): See Caustic Lye.

Caustic Lye: Since "lye" had several meanings, this phrase was often used to refer specifically to the three strong mineral (NaOH, KOH, and NH_4OH) bases and usually meant potassium hydroxide (KOH).

Caustic Ponderous Earth: Hydrated barium hydroxide ($Ba(OH)_2 \cdot 8H_2O$).

Causticum Antimoniale: Probably antimony trichloride ($SbCl_3$).

Cawk: Barium sulphate ($BaSO_4$).

Cementation: Any process by which a solid is caused to penetrate and combine with another substance.

Cendres Gravellees: Potassium carbonate (K_2CO_3).

Ceruse (Cerussa) (Cerusse): See White Lead.

Cerusse Antimony: White antimony trioxide (Sb_2O_3).

Chalk: Calcium carbonate ($CaCO_3$).

Chalybeate (Water): Any water which is impregnated or flavored with iron.

Chalybs cum Sulphure Preparatus: Ferrous sulfide (FeS).

Chalybs Tartar (Tartarified Iron): A substance produced by the action of cream of tartar on iron filling. Probably ($FeC_4H_4O_6$).

Chymist's Spirit: Any solution of ammonia (NH_4OH).

Cineres Clavellati: Potassium carbonate (K_2CO_3).

Cinnabar: Mercuric sulfide (HgS).

Cinnabar of Antimony: Mercuric sulphide (HgS), when produced by heating together mercuric chloride and crude antimony (antimony trisulfide).

Circulation: Cyclic distillation or refluxing.

Citrated Alkalies: Citrates.

Clays: Any stiff but malleable and sticky mineral solid.

Clyssus: Any vapors from the detonation of nitre with other substances which have been condensed and collected, as in "clyssus of sulphur."

Coagulation: Reducing fluids to solid form.

Coagulum: A precipitate.

Cobalt: Cobalt ore. Pure cobalt was "regulus of cobalt" (CoAsS).

Cochineal: A scarlet dye made from the insect *Coccus cacti*, native to Mexico and Central America.

Coction: Any process in which heat was applied over a long period. This term usually implied less strenuous applications of heat than calcination, but it was used more broadly than "decoction."

Cohobation: Repeated distillations, or any cyclic process in which a liquid is vaporized and condensed as, for example, in refluxing. See text, page 14.

Colcothars: Any colorless sulfates (vitriols) in which the water of hydration was removed ($-SO_4$).

Colcothar: Ferric oxide (Fe_2O_3).

Colcothar Vitrioli: Red oxide of iron ($Fe_2O_3 \cdot FeO$) produced by heating green vitriol.

Collature: Filtration through a relatively coarse filter, e.g., a hair sieve, woolen cloth, etc.

Colophony: A resinous substance from distillation of light oil from turpentine.

Common Ammoniac: Ammonium chloride (NH_4Cl).

Common Caustic: Potassium hydroxide or, less often, sodium hydroxide.

Common Magnesia: Magnesium carbonate ($MgCO_3$).

Common Mineral Alkali: Sodium carbonate (Na_2CO_3).

Common Nitre (Saltpeter): Potassium nitrate (KNO_3).

Common Salt: Sodium chloride (NaCl).

Concentration: Any process in which the solute/solvent ratio is increased. Less often, this term was used to describe the separation of a substance "A" from a substance "B" by joining it to a third substance, "C." See text, page 13.

Concreted: Solidified, congealed, coagulated, or (as verb) to unite, combine physically, as in solidity. Very rarely used for chemical combinations.

Concrete Volatile Alkali: Ammonium carbonate ($(NH_4)_2CO_3$).

Copperas: Originally blue vitriol. Later sometimes used for the entire class of vitriols (sulfates). Also sometimes ferrous sulfate ($FeSO_4 \cdot 7H_2O$).

Corneous (Horn) Lead: Lead chloride ($PbCl_2$).

Corning: Any process in which a whole or coarsely ground substance is granulated.

Cornu Cervi: Impure ammonium carbonate ($(NH_4)_2CO_3$).

Corrosive Sublimate: Mercuric chloride ($HgCl_2$).

Coruscate: To give off intermittent flashes of light, to sparkle.

Cream of Lime: Fine precipitate of calcium hydroxide ($Ca(OH)_2$) from water.

Cream of Tartar (Tartar): Potassium hydrogen tartrate (KHC_4H_4O).

Creech: Calcium sulfate ($CaSO_4$).

Cremor: Any scum gathering at or near top of a liquid. Also, a thickening or change in color or consistency on top or within a liquid.

Creta Alba: Gypsum (calcium sulfate dihydrate) ($CaSO_4 \cdot 2H_2O$).

Crocus: Any solid of a saffron or reddish color, as in "Crocus of Mars."

Crocus Martis: Ferric oxide (Fe_2O_3).

Crocus of Iron: Ferric oxide.

Crocus of Mars: Ferric oxide.

Crocus Saturni: Red lead (minium) (Pb_3O_4).

Crude Antimony: Natural antimony sulfide (Sb_2S_3).

Crude Flux: Nitre and tartar mixed in any proportion without detonation.

Crystalline Earths: Any solid which is (1) not attached in acids, (2) friable, (3) hard enough to strike fire with steel.

Crystallised Alkali: Sodium carbonate (Na_2CO_3).

Crystallised Alkali of Tartar: Potassium hydrogen carbonate ($KHCO_3$).

Crystallised Fixed Alkali: Sodium carbonate (Na_2CO_3).

Crystallised Verdigris: Cupric acetate ($Cu(C_2H_3O_2)_2 \cdot H_2O$).

Crystallised Volatile Alkali: Ammonium carbonate $(NH_4)_2CO_3$.

Crystallization: Any process in which crystals are formed from a liquid. Usually accomplished through concentrating and/or cooling a solution.

Crystals of Copper: Mostly copper acetate ($Cu(C_2H_3O_2)_2$).

Crystals of Silver (Lunar Crystals): Silver nitrate, usually as a powder ($AgNO_3$).

Crystals of Venus: Copper acetate ($Cu(C_2H_3O_2)_2$).

Cubic Nitre: Crystallized sodium nitrate ($NaNO_3$).

Cucurbit: The lower part of an alembic. Shorter, more squat and ovoid than a matrass.

Cyprian Vitriol: Copper sulfate ($CuSO_4$).

Damps: Any dangerous "vapors" in caves, mines, etc.

Decantation: To separate the supernatant liquid from a solid precipitate by pouring the liquid off, being careful that all of the solid remains in the vessel.

Decoction: Continuous application of boiling heat to a reaction mixture.

Decompounded: Doubly compounded, or composed of three or more substances.

Decrepitation: Rapid physical decomposition of some crystals when heated. Characterized by a crackling noise.

Deflagration: To cause a substance to burn rapidly, with flame.

Deliquescence: The property some crystalline substances have of dissolving spontaneously in liquid absorbed from the air.

Deliquium: Change of a salt from a solid to a fluid state by contact with air only.

Demi-Metal: See Semi-Metals.

Dephlegmation: To remove water from a solution, usually one of an acid or alcohol. There is a sense of refining or purifying about the term, as opposed to simple concentration.

Dephlogisticated Acid of Salt: Chlorine (Cl_2).

Dephlogisticated Air: Oxygen (O_2).

Dephlogisticated Calx of Iron: Ferrous oxide (hydroxide) (FeO or $Fe(OH)_2$).

Dephlogisticated Marine Acid: Chlorine (Cl_2).

Depuration: To free from impurities, purify.

Desquamation: The process of removing scaly crusts which form on a surface.

Detonation: Any rapid chemical reaction accompanied by noise and often by heat and light, e.g., explosions.

Diaphoretic: Any substance which induces perspiration when administered to a patient.

Diaphoretic Antimony (Diaphoretic Mineral): Mixture of antimony oxide and potassium antimonate (Sb_2O_3; KS_bO_3).

Digestion: The process in which heat is continuously applied to a substance without boiling it (usually in open vessels).

Digestive Salt: Potassium chloride (KCl).

Digestive Salt of Sylvius: Potassium chloride (KCl).

Diminished Nitrous Air (Priestley): Nitrous oxide (N_2O).

Distillation: A process in which all or some portion of a substance is vaporized and then condensed and collected.

Distillation per Ascensum: Distillation with the collecting vessel above the heated vessel.

Distillation per Decensum: Any distillation where the collecting vessel is below the heated vessel.

Distillation per Obliquium: Distillation in a retort used for substances of (a) relatively low vapor pressure and (b) other properties that make the distillation difficult, e.g., honey.

Distillation with Addition: Adding some substance prior to distillation that will aid the process by (1) loosening the desired volatile product chemically from its compound; (2) "fixing" the product not desired, thus retaining it in the vessel; (3) by adding a volatile substance to a fixed substance desired, thus making the fixed substance volatile (addition of properties).

Diuretic Salt: Potassium acetate ($KC_2H_3O_2$).

Division: Any process in which mixtures are separated into their homogeneous components by mechanical means.

Docimacy: Assaying.

Dry Way: Term used for all operations that are conducted without adding a liquid medium. Reactions done through fusion, however, are still regarded as in "the dry way."

Dulcification: Any process in which a caustic substance is rendered less corrosive.

[An] Earth: Usually a carbonate, oxide or hydroxide. "Earths" were originally classified by physical properties as "absorbent," "crystalline," and "talky." They also were described variously as "dry," "insipid," "not inflammable," "fusible" solids which often recovered their original texture after fusion.

Earth, Calcareous, Caustic: Calcium hydroxide ($Ca(OH)_2$).

Earth, Calcareous, Mild: Calcium carbonate ($CaCO_3$).

Earth, Magnesian, Mild: Magnesium carbonate ($MgCO_3$).

Earth, Silicious: Silica (SiO_2).

Earth of Rhubarb: Calcium oxalate (CaC_2O_4).

Earthy Salts: Compound of acids and "earths."

Eau Forte (Strong Water): Usually concentrated nitric acid (HNO_3), sometimes (1) spirit of wine (ethanol), (2) caustic soda solution.

Ebullition (Ebulition): The agitating, bubbling action of a liquid that is undergoing rapid, active boiling.

Edulcorated Quicksilver: Mercurous chloride (Hg_2Cl_2).

Edulcoration: The washing of a solid (often a precipitate) with water to free it from soluble impurities such as salts and acids. Because of the latter, there are overtones of "sweetening," "purification," and "softening" with this term. See text, page 13.

Elaeosaccharum: A mixture of an oil and sugar. Used to make "oils" soluble in water, wines, spirits, etc.

Electuaries: Medicinals in the form of a paste or conserve.

Elixation: The action of boiling or stewing.

Elutriation (Eleutriation): Separation and purification of a mixture of granular solids with water by (a) decanting, (b) straining, or (c) washing.

Emetic: Any substance that induces vomiting.

Emetic Powder: Potassium antimonyl tartrate ($KSbC_4H_4O_7 \cdot 1/2H_2O$).

Emplastrum Simplex: Impure lead oleate ($Pb(C_{18}H_{33}O_2)_2$).

Empyreumatic: Tasting or smelling of burnt organic matter.

Empyreumatic Oils: Liquid oils that (a) are acid, (b) are soluble in ardent spirits, (c) do not retain the taste and odor of the substance from which they are obtained, (d) have a taste and/or odor of burnt organic matter.

Enfiladed Balloon: A spherical vessel with opposed, necked openings.

English Laxative Salt: Magnesium sulphate ($MgSO_4$).

English Salt: See Bitter Salt.

Ens Martis: A mixture probably consisting of iron chlorides and ammonium chloride. Used as a medicine.

Ens Veneris: A mixture probably consisting of copper chlorides and ammonium chloride. Used as a medicine.

Epsom Salts: Magnesium sulfate ($MgSO_4$).

Essay: See Assay.

Essence: Any essential oil.

Essential Oil: Any "oil" that smells the same as the vegetable from which it was obtained and has a low boiling point (below that of water).

Essential Oil of Turpentine: The most volatile portion of turpentine.

Etain de Glace: Bismuth (Bi).

Ether: In the 18th century, alkyl chlorides and nitrates often were confused with true ethers, such as ethyl ether ($CH_3CH_2-O-CH_2CH_3$).

Ether of Benzoin: Ethyl benzoate ($C_9H_{10}O_2$).

Ether of Nitre: Mainly ethyl nitrite ($C_2H_5NO_2$).

Ether of Vinegar: Ethyl acetate ($C_4H_8O_2$).

Ether of Vitriol: Ethyl ether ($C_4H_{10}O$).

Ethiops Mineral: Mostly black mercury sulfide (Hg_2S).

Evaporation: Any process in which the liquid portion of a solution or mixture is vaporized, often with the help of heat.

[To] Exalt: To make more spiritous, volatile, or generally more active; to activate.

Exsiccate: To dry; remove moisture.

Exhalation: When parts of substances are separated by heat from the solid and fly off into the air. Used as a tool to obtain "fixed parts" as well as "volatile parts." This includes calcination, distillation, etc.

Expression: To separate a component from organic matter or any other solids or semisolids by squeezing the material in a press. A mechanical rather than a chemical means of separation.

Extemporaneous Alkali: See white flux.

Extraction: To separate one substance from others by using solvents.

Extract of Lead: Impure lead actetate ($Pb(C_2H_3O_2)_2$).

Extract of Mars: Solid ferrous tartrate ($FeC_4H_4O_6$).

Extravasation: The escape of an organic fluid (e.g., blood, sap) from its proper vessels into surrounding tissues.

Faints: The second identifiable, thin, and light liquid fraction from distillation.

Fearce: To pulverize or mascerate.

Febrifugal Salt: Potassium sulphate (K_2SO_4).

Febrifugal Salt of Sylvius: Potassium chloride (KCl).

[A] Ferment: A substance actually fermenting, inclined to ferment, or used to cause fermentation, e.g., yeast.

Fetid Oil: Any oil substance that was "empyreumatic," i.e., had the odor of burned animal matter.

Filtration: To separate a liquid from a particulate solid by passing the liquid through a porous material, e.g., cloth or paper.

Finery Cinder: Iron oxide (Fe_3O_4).

Fire Air: (Scheele): Oxygen (O_2).

Fixed Air: Carbon dioxide (CO_2).

Fixed Alkali (Soda): Sodium carbonate (Na_2CO_3).

Fixed Alkali Salt: Solid potassium carbonate (K_2CO_3).

Fixed Ammoniac (Fixed Sal Ammoniac): Calcium chloride ($CaCl_2$).

Fixed Nitre: Usually potassium carbonate; sometime potassium sulfate (K_2CO_3; K_2SO_4).

Fixed Sulphur of Antimony: Oxides of antimony, probably primarily the trioxide (Sb_2O_3) which forms when antimony ore (Sb_2S_3) is heated in air. Antimony calx.

Fixed Vegetable Alkali: Potassium carbonate (K_2CO_3).

Fixity: The degree of solidity of a substance as measured by the ability of that substance to resist the action of fire. The opposite of volatility.

Flores: See Flowers.

Flores ac Vitrum Antimony: Probably antimony trioxide (Sb_2O_3) with small amounts of antimony trisulfide (Sb_2S_3).

Flores Antim.: See Flowers of Antimony.

Flores Benzoini: Benzoic acid (C_6H_5COOH).

Flores Martiales (Ens Veneris): Impure ammonium chloride (NH_4Cl). Also includes iron filing used in the reaction, with possibly some chlorides of iron.

Flores Sulphuris: See Flowers of Sulfur.

Flores Viridis Aeris: Crystallized cupric acetate ($Cu(C_2H_3O_2)_2$).

Flores Zinc: See Flowers of Zinc.

Flowers (Flores): Any solid product of sublimation. Usually a powder.

Flowers of Antimony: Antimony trioxide (Sb_2O_3).

Flowers of Arsenic (White Arsenic): Arsenious oxide (As_2O_3).

Flowers of Benjamin: See Flowers of Benzoin.

Flowers of Benzoin: Benzoic acid (C_6H_5COOH).

Flowers of Phosphorus: Volatile oxides of phosphorous (P_2O_3; P_2O_5).

Flowers of Sulfur: Sublimed and condensed sulfur vapors (S).

Flowers of Zinc: Volatile zinc oxide (ZnO).

Fluor: (as adjective): "Flowing," an adjective indicating that the substance cannot be made solid, e.g., "fluor volatile alkali"; or, in referring to a mineral, a solid that is easily fusible.

Fluor Acid Air: Silicon fluoride (SiF_4).

Fluorspar: Calcium fluoride (CaF_2).

Focus of a Furnace: That part of a furnace where the fuel is actually burned.

Foliated Earth of Tartar: Potassium acetate ($KC_2H_2O_2$).

Fossil: Any mineral substance.

Fossil Alkali: Sodium carbonate (Na_2CO_3).

Fossil Cadmia: A cobalt mineral, probably cobaltite ($CoAsS$).

Fossil Oil: Clear, distilled crude oil.

Frigorific: Having property of producing cold.

Fucus: A substance which can act as a (usually opaque) surface coloring agent.

Fulginosity: Soot or any black deposit from flames of oily substances.

Fulmination: Any very rapid reaction which produces heat, light, and noise; e.g., explosions.

Fuming Liquor of Boyle: Ammonium polysulfide ($(NH_4)_2S_y$).

Fuming Liquor of Libavious: Stannic chloride solution ($SnCl_4$).

Fusion: Changing a solid body to a liquid by the action of fire.

Galena: Lead sulfide (PbS).
Galley: A type of furnace in which several vessels are heated side by side simultaneously.
Galls: Parasitic growths, commonly found on oaks, which, when dried, ground, and dissolved were useful as chemical indicators for iron.
Gentle Calx of Lead: Lead nitrate ($Pb(NO_3)_2$.
German Ash: Potassium carbonate (K_2CO_3).
German Potash: Probably a mixture of potassium carbonate and oxide.
German Vitriol: An ore with both copper and ferrous sulfates ($CuSO_4$; $FeSO_4$).
Glacial Oil of Antimony (Butter of Antimony): Antimony trichloride ($SbCl_3$).
Glass of (a Substance): The fused form of the substance, especially if semitransparent.
Glass of Antimony: Probably antimony oxysulfate ($Sb_2O_2SO_4$). Prepared by fusion of antimony sulfide, antimony, and an oxide of antimony.
Glass of Borax: Fused borax.
Glass of Lead: Any fused lead compound (especially ceruse, minium, or litharge).
Glauber's Alkahest (Alkahest of van Helmont): Concentrated potassium carbonate solution (K_2CO_3 (aq)).
Glauber's Sal Ammoniac: Ammonium sulphate ($(NH_4)_2SO_4$).
Glauber's Salt (Sal Mirabile): Sodium sulphate (Na_2SO_4).
Glauber's Spirit of Nitre: Fuming nitric acid (HNO_3).
Globuli Martiales: Iron powder boiled in cream of tartar solution. Presumably contains some ferrous tartrate ($FeC_4H_4O_6$). A pharmaceutical preparation of iron.
Glucinum: Beryllium (Be).
Golden Spirit of Sulphur: Ammonium sulphide ($(NH_4)_2S$).
Graves: The residue left after extracting oils from animal fat by means of heat and moderate pressure.
Gravid: Heavy or dense.
Green Vitriol (Vitriol of Mars): Ferrous sulfate ($FeSO_4$).
Grume (s) (Grumous): (1) Viscous, clotty; (2) heap (s), clusters.
Guaic (Guyac, Guaicum): A tropical wood, sometimes used for the resinous extract of that wood.
Gum: Resinous or musiloginous extracts from plants, shrubs, or trees.
Gum Acacia: Like gum arabic, but thought to be distinguishable from it; the dried resinous exudation of certain varieties of the acacia tree.
Gum Arabic: The dried exudation of certain varieties of the acacia tree.
Gum Benzoin: The dried resin of the tree *Styrax benzoin.*
Gum Dragon: See Gum Tragacanth.
Gum Lac: Dark-red resinous incrustation produced in certain trees by the insect *Carteria lacca.* When refined by certain processes it becomes "shell-lac" or "shellac."
Gum Tragacanth (Gum Dragon): Dried, gummy exhudation of the tree *Astragalus gummifer* and related species.
Gypseous Earths: Used for both gypsum or the "earth" contained in it, i.e., calcium oxide. Sometimes the oxide was confused with carbonate as the "earth" of gypsum.
Gypseous Substances: Solid substances which (a) are not soluble in acids, (b) are not hard enough to strike fire from steel, (c) when mixed with water may form a paste which hardens into a solid, and (d) becomes powdery when exposed to fire.
Gypsum: Calcium sulfate dihydrate ($CaSO_4 \cdot 2H_2O$).

Halitus: Matter in a very subtile form, as a "vapor" or "exhalation." Like these, a "halitus" was often hypothesized if a phenomenon was ascribed to material causes, but no material could be detected by known means.
Hartshorn (Hart's Horn): Ideally, the horn of the male European red deer, but the horns of other deer species were acceptable substitutes.
Hartshorn Calcined to Whiteness: Hartshorn subjected to heat over a long period and developing into a white substance.
Hartshorn Prepared Philosophically: Much like hart's horn calcined to whiteness, but usually with less heat and for a longer period.
Head: The upper part of a distillation apparatus. Also, the bulb or other enlargement at the end of a tube.
Heavy Carburetted Hydrogen: Ethylene (C_2H_4).
Heavy Earth: Barium oxide (BaO). Also barium hydroxide and barium carbonate.
Heavy Inflammable Air: Used at various times

for (a) carbon monoxide (CO), (b) water gas (a mixture of H_2 and CO), or (c) methane (CH_4).

Heavy Spar: Barium sulfate ($BaSO_4$).

Hellebore: A plant of the genus *Helleborus*. Usually *Helleborus niger,* the so-called "Christmas rose." The poisonous extract was used in dilute preparations as a medicinal in the 17th and 18th centuries.

Hemlock: The vulgar name for the poisonous plant *Conium maculatum* and/or its extract.

Henna: The plant *Lawsonia inermis*. The dried and powdered shoots and leaves were used as a dye or, with suitable medium, a cosmetic.

Hepar Antimonii: Antimony trisulfide (Sb_2S_3).

Hepar Calcis: Calcium sulfide (CaS).

Hepars: Sulfides ($-S^{-2}$).

Hepar Sulphuris (Liver of Sulphur): Produced by heating potassium carbonate with sulphur. Not a true compound, it was a metastable mixture of potassium polysulfides and sulfate (K_2S, K_2S_2, K_2S_3, K_2S_4, K_2S_5, K_2SO_4).

Hepatic Air: Hydrogen sulfide gas (H_2S).

Hessian Crucible: A type of crucible made in Hesse, Germany, of a mixture of native clay and fine sand. Such crucibles were noted for being able to withstand sudden changes in temperature.

Homberg's (Sedative) Salt: Boric acid (H_3BO_3 (ortho); $H_2B_4O_7$ (tetra)).

Horn (Corneous) Lead: Lead chloride ($PbCl_2$).

Horn Mercury: Chloride of mercury ($HgCl_2$; Hg_2Cl_2).

Horn Silver (Luna Cornea): Fused silver chloride (AgCl).

Horn Tin: Stannous chloride ($SnCl_2$).

Hungarian Vitriol: Usually ferrous sulfate ($FeSO_4$) but also used for copper sulfate ($CuSO_4$).

Hydromel: Mixture of honey and water, usually in equal proportions. Ferments into "mead."

Iceland Spar (Calcite): A particular crystal form of calcium carbonate ($CaCO_3$).

Icy Butter: Antimony chloride ($SbCl_3$).

Imbibition: To soak or saturate with a liquid.

Infernal Stone: An alkali hydroxide (NaOH, KOH). [Not to be confused with the French term *pierre infernale.*]

Inflammable Air: Usually hydrogen (H_2), though the usage is not constant among Priestley, Watt, Lavoisier, or Berthollet. Sometimes carbon monoxide (CO).

Inflammable Air from Metals: Hydrogen (H_2).

Inflammable Air of Sulphur: Hydrogen sulphide (H_2S).

Infusion: The extraction of chemical substances by soaking them in a solvent, usually water. Sometimes boiling water was poured on a mixture of substances and then allowed to cool in order to aid the extraction; but if the heat were used, the temperature could not exceed that of boiling water.

Insolation: Digestion in which the heat was supplied by the sun rather than a furnace.

Inspissate: To thicken or condense.

Intermediate Salt of the Ley of Blood: Potassium ferrocyanide ($K_4Fe\,(CH)_6$).

Intermediate Salts: Usually normal salts; occasionally acid salts.

Intermedium: Any reagent or reactant believed to be necessary for a reaction but which does not always appear on the product.

Intumescence: The process of swelling up.

Ipecacuanha: A preparation from the root of the South American plant *Cephaëlis Ipecacuanha.*

Iron Ochre: A mixture of silica, clay, and various oxides of iron. In red ochre the oxide is simple Fe_2O_3; in yellow ochre it is $Fe_2O_3 \cdot H_2O$.

Iron Vitriol: Ferrous sulphate ($FeSO_4$).

Isinglass: In the first half of the eighteen century a gelatinous substance extracted from the air-bladders of certain fish. Later, a synonym for sheet mica.

Ivory-Black: A black pigment prepared by the calcination of ivory in a closed vessel.

Jalap: A powder from the dried roots of the Mexican plant *Exogonium purga*. Used as a purgative.

James' Powder: A powder prepared by Dr. Robert James (1703–1776) that was used to reduce fevers.

Japanning: The coating of an object with a very dark varnish. The original varnish came from Japan, but substitutes were later found.

Jove (of Jove): Tin, or some compound or alloy of tin.

Kali: The plant *Salsola kali* or glasswort from which, oddly enough, "mineral" alkali (sodium carbonate) was extracted by calcination. Also sometimes used for crude sodium carbonate.

Kaolin: A fine, white clay used in the manufacture of porcelain.

Kelp: Impure soda (Na_2CO_3) from seaweed. In

Britain, the term was sometimes used for crude sodium carbonate from any source.

Kermes Mineral: A natural mixture of antimony sulphide and antimony oxide or a mixture obtained in the laboratory by the action of potassium carbonate on antimony sulphide.

Lac (Laque): A relatively thick solution of a colorant or coating.

Lac Sulphuris: See Milk of Sulfur.

Lapis Calaminaris (Calamine): Mineral form of zinc carbonate ($ZnCO_3$).

Lapis Haematites: Hematite (Fe_2O_3).

Lapis Infernalis: Fixed vegetable alkali, i.e., potassium carbonate (K_2CO_3).

Lapis Philosophorum: A mixture of fused alum, vitriol, bolus, cerussa, camphor, vinegar.

Lapis Ponderosus: Calcium tungstate ($CaWO_4$).

Lapis Septicus: Potassium hydroxide (KOH).

Lapis Serpentin: A mineral chiefly characterized by the presence of hydrous magnesium silicate ($Mg_3Si_2O_5(OH)_4$).

Laque: See Lac.

Laudanum: Any medicinal preparation with opium as a primary ingredient.

Lead-Glance: Lead sulphide (PbS).

Ley of (Ox-)blood: The lixiviate from the residue produced by igniting blood with potashes.

Ley of Soapboilers: Potassium hydroxide (KOH).

Light Carburetted Hydrogen: Marsh gas or methane (CH_4).

Light Inflammable Air: Hydrogen (H_2).

Lignum Nephriticum: Two distinct woods were known as lignum nephriticum: (1) the small Mexican tree or shrub *Eysenhardtia polystachya* and the large Philippine tree *Pterocarpus indica.* In the sixteenth, seventeenth, and early eighteenth centuries, cups, powders, and dried extracts of this wood were thought to have great medicinal powers. The infusion was fluorescent.

Lignum Vitae: "Tree of life." The wood, and sometimes the resin, of several semitropical trees, but most often referring to *Guaiacum.*

Limation: Filing on a metal piece to reduce it to filings. Sometimes used for simply polishing an object.

Lime: Calcium oxide (CaO).

Lime, Carbonate of: Calcium carbonate ($CaCO_3$).

Lime, Quick: Calcium oxide (CaO).

Lime, Slaked: Calcium hydroxide ($Ca(OH)_2$).

Limestone: Calcium carbonate ($CaCO_3$).

Lime Water: A solution of calcium carbonate ($CaCO_3$).

Liquescent (Salts): See Deliquescence.

Liquor Fumans Boyle (Spiritus Fumans Boyle): Ammonium polysulphide ($(NH_4)S_2$; $(NH_4)_2S_5$).

Liquor Fumans Libavii (Fuming Liquor of Libavius): Stannic chloride ($SnCl_4$).

Liquor of Flints: See Liquor Silicum.

Liquor of Hoffman: A mixture of ethanol and ether.

Liquor of Liravius: See Smoking Spirit of Libavius.

Liquor Silicum (Liquor of Flints): A solution of potassium silicate (K_2SiO_3). Sometimes used for other soluble silicates.

Litharge: Yellow lead oxide (PbO).

Lithomarge: Soft, claylike substances, such as kaolin.

Litmus: A blue pigment extracted from certain lichens. It is acid sensitive, turning red in the presence of an acid. The red form turns blue again when a base is added.

Liver of Antimony: Fused antimony sulfide (Sb_2S_3). Usually produced from the detonation of equal parts of crude antimony and potassium nitrate.

Liver of Arsenic: Fused mixture of potassium carbonate and (white) arsenic. May have contained some potassium arsenate.

Liver of Sulphur (Hepar Sulphuris): Produced by heating potassium carbonate with sulphur. Not a true compound, it is a metastable mixture of potassium polysulfides and sulfate. (K_2S, K_2S_2, K_2S_3, K_2S_4, K_2S_5, K_2SO_4).

Lixivial Salts: Salts prepared by lixiviation.

Lixiviate of Mars (Iron): Possibly a tincture of iron, of which there were many different preparations. Typically, these were solutions of salts of iron to which rectified spirit of wine (ethanol, CH_3CH_2OH) was added.

Lixiviation: Separation of soluble from unsoluble solid substances by soaking the mixture of solids and removing the resulting solution which contained the soluble material. See text, p. 14.

Lixivium: A solution produced by lixiviation. Sometimes used as a general synonym for "solution."

Lixivium of Tartar: A solution of potassium carbonate (K_2CO_3).

Load (Lode): Any ore.

Logwood: The American tree *Haematoxylon Cam-*

pechionum, used in dying. It produces dark shades: blacks, blues, and dark grays.

Lucillite: A variety of limestones.

Luna Cornea (Horn Silver): Fused silver chloride ($AgCl$).

Lunar Caustic: Fused silver nitrate ($AgNO_3$).

Lunar Crystals: Finely divided parts of silver nitrate ($AgNO_3$). In preparing these crystals great care was taken to use only the purest silver and nitric acid possible.

Lunar Nitre: Silver nitrate ($AgNO_3$).

Maceration: The softening and weakening of a solid sample, even to the point of partial decomposition, by soaking it in a liquid. See text, p 13.

Magisterium Tartari Vitriolati: Probably potassium sulfate (K_2SO_4).

Magistery of (any Substance): A precipitate of any substance, i.e., a pure form of the substance which has been separated by precipitation.

Magistery of Bismuth: Basic bismuth nitrate ($BiONO_3 \cdot H_2O$); sometimes the oxide (BiO) or even the oxychloride ($BiOCl$).

Magistery of Coral: Calcium carbonate ($CaCO_3$).

Magistery of Sulfur: Precipitated milk of sulphur (S).

Magistry: Any substance prepared from the basic elements of that substance without impurities. A magistry was supposed to be closer to the ideal for a substance than was usual for real chemical preparations.

Magnesia: Magnesium carbonate ($MgCO_3$). [Modern magnesia = magnesium oxide (MgO)]. Some chemists called magnesium (Mg) by the name "magnesia."

Magnesia Aerata: Magnesium carbonate ($MgCO_3$).

Magnesia Alba: Magnesium carbonate ($MgCO_3$).

Magnesia Nigra: Manganese dioxide (MnO_2).

Magnesia Salita: Magnesium chloride ($MgCl_2$).

Malachite: Basic copper carbonate ($CuCO_3 \cdot Cu(OH)_2$).

Malic Acid: An acid extracted from apples and various other fruits. Pure malic acid is $C_4H_6O_5$.

Malt: Barley or other suitable grains after a preparation for brewing or distilling that usually included soaking, germination, and drying.

Manganese: Manganese dioxide (MnO_2). Manganese as we know it was called "regulus of manganese."

Manna Mercurii: Mercurous chloride (Hg_2Cl_2).

Marble: A hard, crystalline, mineral form of calcium carbonate ($CaCO_3$).

Marcasita Plumbea: Antimony (Sb).

Marcasites: Minerals similar in appearance or properties to iron pyrites (FeS_2). Later, a general term for pyrites. Sometimes the term was used for sulfides of arsenic (As_2S_2, As_2S_3, As_2S_5).

Marchpane: See Marzipan.

Marine Acid: Hydrochloric acid (HCl).

Marine Acid Air: Hydrogen chloride (HCl).

Marine Alkali: Sodium carbonate (Na_2CO_3).

Marl (Marle): A loose soil of clays and calcium carbonate ($CuCO_3$).

Mars (of Mars): A substance related in some way to iron.

Marsh Gas: Methane (CH_4).

Martial Balls: A mixture of iron filings (Fe) and cream of tartar ($KHC_4H_4O_6$).

Martial Ethiops: Hydrated ferrosoferric oxide ($Fe_3O_4 \cdot XH_2O$). Usually made by the action of water on finely divided iron.

Martial Extract: Concentrated tincture of mars. A concentrated solution, the chief component of which may have been ferrous hydroxide ($Fe(OH)_2$).

Marzipan: A confection of pounded almonds, sugar, and other ingredients.

Matrass: A vessel with a round bottom and long, slender neck. Used as part of several common types of distillation apparatus. See text p. 9.

Menstruum: A solvent. See text p. 13.

Mephitic (as adjective): Noxious; poisonous or pestilential.

Mephitic Acid: Carbonic acid (H_2CO_3).

Mephitic Air: Carbon dioxide (CO_2).

Mercurius Calcinatus: Mercuric oxide (HgO).

Merc. Calcin. Nitrat.: Mercuric nitrate ($Hg(NO_3)_2$).

Mercurius Corrosivus: Mercuric chloride $HgCl_2$.

Mercurius Corrisivus Ruber: Mercuric oxide (HgO).

Mercurius Dulcis (Calomel, Mercurious Sublimatus Dulcis, Mild Mercury): Mercurous chloride (Hg_2Cl_2).

Mercurius Praecipitatus per se: Mercuric oxide (HgO).

Mercurius Praecipitatus Ruber: Mercuric oxide (HgO).

Mercurius Solubilis Hahnemanni: Mercurous oxide (Hg_2O).

Mercurius Sublimatus Dulcis (Calomel, Mercurius Dulcis, Mild Mercury): Mercurous chloride (Hg_2Cl_2).

Mercurius Sublimatus Rubeus non Corrosivas: Mercuric oxide (HgO).

Mercurius Vitae: Mixture of antimony oxychloride and antimony oxides (Sb_2O_3; Sb_2O_4, Sb_2O_5, $SbOCl$). In some contexts the term may mean just antimony oxychloride ($SbOCl$).

Mercurius Vitae Antimonii: Mixture of antimony oxychloride and antimony oxide (Sb_2O_3; Sb_2O_4; Sb_2O_5, $SbOCl$).

Mercury of Life: See Mercurious Vitae.

Metallic Salt: Compound of a metal and an acid.

Miasma (Miasmata): A noxious or infectious subtle material (e.g., a vapor or exhalation) thought to be from decaying organic matter. Sometimes used for any unseen poisonous or infectious substance.

Mica: A mixed mineral form composed mostly of aluminum silicate but with silicates of other metals. Several complicated minerals are variously, and in combination, referred to as mica; e.g., biotite $K(Mg,Fe)_3AlFeSi_3O_{10}(OH,F)_2$.

Microcosmic Salt: Sodium ammonium phosphate ($NaNH_4HPO_4 \cdot 4H_2O$).

Mild Alkali: Alkalies which produce effervescence with acids; i.e., carbonates ($-CO_3{}^{-2}$).

Mild Calcareous Earth: Calcium carbonate ($CaCO_3$).

Mild Magnesian Earth: Magnesium carbonate ($MgCO_3$).

Mild Mercury: Mercurous chloride (Hg_2Cl_2).

Mild Vegetable Alkali: Potassium carbonate (K_2CO_3).

Milk of Lime: Calcium hydroxide (suspension) ($Ca(OH)_2$).

Milk of Sulfur: Finely divided sulfur (S) in solution. Usually the product of the reaction between a soluble sulfide and an oxidizing acid.

Minderer's Spirit: A solution of ammonium acetate ($NH_4C_2H_3O_2$).

Mineral Alkali: Sodium carbonate (Na_2CO_3).

Mineral Anodyne of Hoffman (Liquor of Hoffman): A mixture of ethanol and ether (C_2H_5OH), ($CH_3CH_2OCH_2CH_3$).

Mineral Crystal: Sal prunella = potassium nitrate with a small admixture of potassium sulfate (HNO_3; K_2SO_4).

Minium (Red Lead): Lead tetroxide (Pb_3O_4).

Mixt: A chemical union of two or more true "elements" or "principles." Later, any substance which could be resolved into constituent parts only by chemical means. Although the term had greater philosophical complexities, it was roughly equivalent to our term "compound," but the latter is not to be considered a synonym.

Mixtura Salina: Saline mixture prepared by saturating potassium carbonate with lemon juice and adding syrup of black currants, julep.

Mofette: An exhalation or vapor of a mephitic (noxious or poisonous) gas.

Mohr's Salt: Ferrous ammonium sulfate ($FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$).

Molybdaena: Native molybdenum sulfide (MoS_2).

Mordant: Any substance which fixes or holds a colorant in the material to be dyed.

Mortify: To change or destroy the normal, external form or appearance of a substance.

Mosaic Gold: Stannic sulfide (SnS_2).

Mucilagenous Matter: Any semisolid material that was soft, moist, and viscous.

Mundic (Mundick): Iron pyrites (FeS_2). Sometimes used for other pyrites or as a general term for pyrites.

Muriates: Chlorides ($-Cl^-$).

Muriatic Acid: Hydrochloric acid (HCl).

Muriatic Ether: Probably impure ethyl chloride (CH_3CH_2Cl).

Naples Yellow: Lead antimoniate ($Pb_3(SbO_4)_2$).

Naptha: Any highly inflammable, volatile, naturally occuring mixture of hydrocarbons. Also could be obtained as the "lightest" fraction in the distillation of asphalts, bitumens, and petroleum.

Natrium: Sodium.

Natron (Natrum): Sodium sesquicarbonate, a naturally occurring combination of sodium carbonate (Na_2CO_3) and sodium bicarbonate $NaHCO_3$) in the ratio 1:1 ($Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$).

Neutral Arsenical Salt of Macquer: Potassium dihydrogen arsenate ($KH_2A_3O_4$).

Neutral Salts: Salts resulting from the reaction of an acid and a base (hydroxide) but having no characteristics of either acid or base.

Nihil Album (sometimes just Nihil): Flowers of zinc: zinc oxide (ZnO).

Nitrated Earths, Metals, etc.: Nitrates ($-NO_3$).

Nitre (Common Nitre): Potassium nitrate (KNO_3).

Nitre Fixed by Tartar: A mixture of nitre and tartar left after reaction between the two.

NITRE WITH AN EARTHY BASIS: Usually calcium nitrate ($Ca(NO_3)_2$).

NITREUM (Bergman): Nitrous acid (HNO_2).

NITRO-AERIAL SPIRIT: The hypothetical subtle substance which was thought by some to be responsible for the ability of nitre to support combustion and to be a key component of detonations.

NITROUS ACID: Nitric acid (HNO_3).

NITROUS ACID VAPOR (Priestley): Nitrogen dioxide (NO_2).

NITROUS AIR (Priestley): Nitric oxide (NO).

NITROUS ETHER: Ethyl nitrite ($CH_3CH_2NO_2$).

NITROUS GAS (Lavoisier): Nitric oxide (NO).

NITRUM AEGYPTICUM: Sodium carbonate (Na_2CO_3).

NITRUM ANTIMONIATUM: Product containing potassium nitrate, nitrite, and antimonate.

NITRUM COMMUN: See Common Nitre.

NITRUM CUBIC: See Cubic Nitre.

NITRUM FIXATUM (NITRUM FIXUM, FIXED NITRE): An often impure preparation of potassium carbonate (K_2CO_3). Usually prepared by deflagrating charcoal and saltpeter (KNO_3).

NITRUM FLAMMANS: Ammonium nitrate (NH_4NO_3).

NITRUM REGENERATUM: Potassium nitrate (KNO_3).

NITRUM SATURNI: Lead nitrate ($Pb(NO_3)_2$).

NITRUM STIBNATUM: Probably antimony nitrate $2Sb_2O_3 \cdot N_2O_5$).

NITRUM SULPHURE PURGATUM: Mixture of potassium nitrate and potassium sulfate (KNO_3; K_2SO_4).

NITRUM VITRIOLATUM: Mixture of potassium sulphate and potassium bisulfate (K_2SO_4; $KHSO_4$).

NON METALS: A term used by William Cullen and his students for the following group of substances: zinc (Zn), antimony (Sb), bismuth (Bi), arsenic (As), platinum (Pt), cobalt (Co), nickel (Ni).

OCHRE: A class of mineral solids which, in powdered form, were commonly used as pigments. Their colors varied from yellow to brown, including reddish hues. Chemically, the ochres are iron oxides, or mixtures of iron ovides, in varying states of hydration. For example, red ochre is primarily Fe_2O_3. Silicates, carbonates, sulfates, etc., also were commonly present with these oxides.

OCHROITE: Cerium oxide (CeO_2).

OFFA HELMONTII: Potassium carbonate (K_2CO_3).

OIL: Any relatively insoluble, inflammable, somewhat viscous liquid.

OIL GAS: Mixture of methane, carbon monoxide, and butylene (CH_4; CO; C_4H_8).

OIL OF ANTIMONY (BUTTER OF ANTIMONY): Antimony trichloride ($SbCl_3$).

OIL OF ARSENIC: Arsenic trichloride ($AsCl_3$).

OIL OF CALAMINE: Concentrated zinc chloride solution ($ZnCl_2$).

OIL OF CHALK: Calcium chloride solution ($CaCl_2$).

OIL OF CLOVES: An oily substance extracted from the buds and flower stalks of the clove tree *Caryophyllus aromaticus*. Used as a medicinal.

OIL OF DIPPEL: The insoluble, viscous fraction from decomposed animal matter that has gone through repeated distillations.

OIL OF HARTSHORN: A crude animal oil obtained from the destructive distillation of bones.

OIL OF LIME: A solution of calcium chloride ($CaCl_2$).

OIL OF RUE: The oil extracted from evergreens of the genus *Ruta*. Used as a medicinal.

OIL OF SULPHUR: Concentrated sulfuric acid. Sometimes the term was used for alkaline sulphide of ammonia ($(NH_4)_2S$).

OIL OF TARTAR: Concentrated potassium carbonate solution (K_2CO_3).

OIL OF TARTAR PER DELIQUIUM: Potassium carbonate, which is hydroscopic, dissolved in the water which it extracts from the air.

OIL OF VENUS: Concentrated solution of copper nitrate ($Cu(NO_3)_2$).

OIL OF VITRIOL: Sulfuric acid (H_2SO_4).

OIL OF WINE: A hypothetical component of alcohol thought to give it its odor and inflammability.

OLEA TEREBINTHINE: Terpentine.

OLEFIANT GAS: Ethylene (C_2H_4).

OLEUM ANIMALE: Any of the liquid oils (triglycerides) that could be extracted from animal matter.

OLEUM DULCE: See Oil of Wine.

OLEUM SULPHURIS PER CAMPANUM: Sulfuric acid (H_2SO_4) prepared by burning sulfur under a bell jar and later concentrating and purifying the product by heating to drive off water and sulfur dioxide.

OLEUM SUCCINI: Concentrated succinic acid ($HOOCCH_2CH_2COOH$).

OLEUM TARTAR PER DELIQUIUM: See Oil of Tartar per Deliquium.

OLEUM VITRIOLI: Oil of vitriol.

ORPIMENT: Arsenic trisulfide (As_2S_3).

OXYCARBURETTED HYDROGEN: Water gas, mixture of hydrogen (H_2), carbon monoxide (CO), and carbon dioxide (CO_2).

Oxymuriatic Acid: Chlorine (Cl_2).

Panacea: Potassium sulfate (K_2SO_4).

Pan-Stone: Calcium sulfate ($CuSO_4$).

Parting: The operation by which gold and silver are separated from each other.

Pearl Ash: The *whitest* potassium carbonate (K_2CO_3) extracted from calcined plants. In a sense, then, pearl ash is purified potash.

Pearl White: Bismuth oxychloride [$BiOCl$].

Pelican: A special distillation apparatus. The condensing head had two curved tubes emerging on opposite sides. These tubes led down and entered the lower section or body of the vessel; thus, the condensed liquid ran back to the heated section where it was revaporized, giving a cyclic action. The pelican was especially effective for reactions that took place in the vapor phase. See text, p. 9.

Pellicle: Any thin saline crust that forms on a solution.

Per Campanum: Any process carried out under a glass bell jar.

Per Deliquium: A hygroscopic salt was said to "run *per deliquium*" when it changed from solid to liquid by extracting water from the air.

Perlate Salt: Sodium phosphate (Na_3PO_4).

Perspiration: Spontaneous evaporation or (less often) vaporization through heating. Also used to indicate condensation of moisture on a relatively cool body.

Perspirative: A medicinal which promoted perspiration.

Petrolia: Liquid bitumens.

Petuntse: A white mineral solid used in the manufacture of porcelain.

Pewter: An alloy of tin. Originally with up to one-fifth lead, but later bismuth and copper were substituted for lead.

Philosopher's Wool: Zinc oxide (ZnO).

Philosophical Flowers of Vitriol: Boric acid (H_3BO_3).

Philosophical Foliated Earth: Potassium acetate ($KC_2H_3O_2$).

Philosophical Mercury: An alchemical term signifying the property-bearing principle of chemical activity.

Philosophical Sal Ammoniac: Ammonium sulfate ($(NH_4)_2SO_4$).

Philosophical Spirit of Nitre: Nitric acid prepared by distilling saltpeter with oil of vitriol (HNO_3).

Philosophical Spirit of Tartar: Potassium hydrogen tartrate ($KHC_4H_4O_6$) distilled with wine.

Philosophical Spirit of Vitriol: Hydrochloric acid (HCl).

Philosophical Spirit of Wine: Spirit of wine (alcohol) concentrated by freezing (CH_2CH_3OH).

Philosophical Water: Aqua regia. A solution of hydrochloric and nitric acids, usually in ratios from 2:1 to 4:1 (HCl to HNO_3).

Phlegm: A general term for any aqueous fraction of a distillation.

Phlogisticated Acid of Nitre: Nitrous acid (HNO_2).

Phlogisticated Acid of Vitriol: Sulphurous acid (H_2SO_3).

Phlogisticated Air: Nitrogen (N_2).

Phlogisticated Alkali: Potassium ferrocyanide ($K_4Fe(CN)_6 \cdot 3H_2O$).

Phlogisticated Calx of Iron: Ferrous oxide (hydroxide) (FeO).

Phlogisticated Earth of Molybdaena: The solid reduction product of molybdic acid.

Phlogisticated Manganese: Manganous carbonate ($MnCO_3$).

Phlogisticated Nitre: Impure potassium nitrite (KNO_2).

Phlogisticated Nitrous Acid: Nitrous acid (HNO_2).

Phlogisticated Vitriolic Acid: Sulfurous acid (H_2SO_3).

Phlogiston: A hypothetical substance originally used to account for the property of inflammability. It later was made to carry many more properties and formed a central point for the theoretical beliefs of a number of eighteenth-century chemists.

Phlogiston Elasticum: Hydrogen (H_2).

Phosphorated Iron: Ferric phosphate ($FePO_4$).

Phosphorated Mercury: Mercuric phosphate ($Hg_3(PO_4)_2$).

Phosphorated Vegetable Alkali: Potassium phosphate (K_3PO_4).

Phosphorous: Sometimes used for any phosphorescent substance.

Phosphorous of Baldwin: Calcium nitrate ($Ca(NO_3)_2$).

Phosphorous of Homberg: Calcium chloride ($CaCl_2$).

Phosphorous of Urine: As the name implies, a form of phosphorous (P) extracted from urine.

Pierre Infernale: Fused silver nitrate ($Ag(NO_3)$). [Not to be confused with "Infernal Stone."]

Pinchbeck: A gold-colored alloy of about five parts copper (Cu) to one part zinc (Zn).

Pinguious (Pinguinous): Fatty, oily.

Plaster: Any semisolid plastic mixture that could be applied to a surface and then spontaneously cured or hardened. One of the oldest plasters is a mixture of slaked lime ($Ca(OH)_2$), sand, and hair. The term also was used to refer to impure lead oleate ($Pb(C_{18}H_{33}O_2)_2$).

Plaster of Paris: Calcium sulfate monohydrate ($((CaSO_4)_2 \cdot H_2O)$).

Platina: Platinum (Pt.), or sometimes the usually impure form of platinum found in nature that is alloyed with other exotic metals.

Plumbago: Carbon (C) in the form of graphite.

Plumbum Album: Basic lead carbonate ($2PbCO_3 \cdot Pb(OH)_2$). Sometimes the term was applied to basic lead acetate ($Pb(C_2H_3O_2) \cdot Pb(OH)_2 \cdot H_2O$).

Plumbum Cinereum: Bismuth (Bi).

Plumbum Corneum (Horn Lead): Lead chloride ($PbCl_2$).

Plumbum Stridens: Tin (Sn).

Pneumatic: Pertaining to subtle, rarified, or vaporous substances such as air. In modern terms, gaseous.

Pneumatic Trough: An apparatus developed over the eighteenth-century from John Mayow (1641–1679) through Stephen Hales (1677–1761) to Antoine Lavoisier (1743–1794). The trough was any large pan or vat in which inverted bottles full of water could be supported. Glass tubes conducted the gases from the vessels in which they were generated outside the trough to the inverted bottle in the trough, where the gases were trapped and held.

Point of Saturation: The instant when the exact proportions of the two "saline principles" (one from an acid, the other from a base) unite to form a perfectly neutral salt.

Pompholix: Flowers of zinc (ZnO).

Ponderous Spar: Barium sulfate ($BaSO_4$).

Pot Ash: Potassium carbonate (K_2CO_3).

Powder of Algaroth: Antimony oxychloride (SbOCl).

Precipitant: A substance serving as intermediary to separate two other substances from each other.

Praecipitate Per Se: Mercuric oxide (HgO).

Praecipitatus Albus: Mercurous chloride (Hg_2Cl_2).

Praecipitatus Vigonis: Mercuric oxide (HgO).

Precipitate of Sulfur: Precipitated milk of sulfur (S).

Precipitation: The phenomenon in which a solid is formed within a solution and falls to the bottom of the vessel in which the solution was contained. See text, p. 14.

Primus Metal: See Prince Rupert's Metal.

Prince Rupert's Metal (Bath Metal, Primus Metal, Princes Metal): A brass alloy in which the ratios of copper (Cu) to Zinc (Zn) are approximately 4 to 1.

Prince's Metal: See Prince Rupert's Metal.

Principle: One of the simplest forms of matter, from which other substances are formed through combinations with other principles or other combinations of principles. Although there are similarities to the modern term "element," the two are not truly synonymous.

Proximate Principles: Components obtained through chemical analysis which themselves are compounds but presumed to be simpler than the original substance.

Prussian Blue: Ferric ferrocyanide ($Fe_4[Fe(CN)_6]_3$).

Prussic Acid: Hydrocyanic acid (HCN).

Pulvis Algarothi: Antimonious oxychloride (SbOCl).

Pulvis Fulminans: An explosive mixture made from potassium nitrate, potassium carbonate, and sulfur.

Pumice: A light, porous stone of mixed silicates.

Pure Clay: Alumina. Aluminum oxide (Al_2O_3).

Pure Ponderous Earth: Baryta. Barium oxide (BaO).

Purification: Any process in which one substance is rendered free, or relatively free, of any other substance. Common methods included distillation, crystallization, and precipitation. See text, p. 14.

Pyrites: Originally, any mineral which could strike sparks from steel. The term was often used to refer to iron pyrites (FeS_2).

Pyroligneous Acid: Crude acetic acid from wood ($HC_2H_3O_2$).

Pyroligneous Spirit: Methyl alcohol (CH_3OH).

Quadrangular Nitre: Sodium nitrate ($NaNO_3$).

Quartation: The process of combining gold (Au) and silver (Ag) in the ratio 1:3. When the combination is dissolved in nitric acid, the silver is dissolved and the gold is separated, free from impurities.

Quartz: A mineral whose primary component is silicon dioxide (SiO_2). Its color and other aspects of its appearance depended on the impurities present.

Quicklime: Calcium oxide (CaO).

Quicksilver: Mercury (Hg).

Quicksilver Calcined Per Se: Mercuric oxide (HgO).

Quintessence: A mixture of an essential oil and alcohol.

Quintessence of Lead: Acetone (CH_3COCH_3).

Rabel's Water: The liquid obtained by macerating poppy flowers in a mixture of sulphuric acid and alcohol for some days and then filtering.

Ramous: (1) Individual (fundamental) particles of viscous or rigid bodies; (2) branching or filiment-like parts of a liquid mixture.

Realgar: Arsenic disulfide (As_2S_2).

Receiver: The vessel attached to the condensing part of a distillation apparatus in order to receive the condensed products from the distillation. See text, p. 11.

Recrement: Solid waste or refuse from a chemical operation, e.g., scoria.

Rectification: The purifying or refining of a substance by one or (usually) more distillations. See text, p. 15.

Red Arsenic (Realgar): Native arsenic disulphide (As_2S_2).

Red Bole: A red clay that contained silicates of iron and aluminum. Used as a red pigment and as a base for gilding.

Red Flowers of Antimony: Probably antimony sulfide (Sb_2S_5).

Red Lead (Minium): Lead tetroxide (Pb_3O_4).

Red Ochre: A mineral solid approximately 95 percent red iron oxide (Fe_2O_3). An old and important pigment.

Red Precipitate: See Red Precipitate of Mercury.

Red Precipitate of Mercury: Impure mercuric oxide (HgO).

Red Saunders (Red Sanders): The wood from the tree *Pterocarpus santalinus,* commonly called red sandlewood. Used in dyeing.

Reduction: The returning of a substance to a previous or original condition; e.g., the restoring of a metal to the metallic state from its oxide. See text, p. 13.

Refractory Earths: Mineral substances that do not fuse under the action of fire.

Refrigoratory: A vessel at the top or head of some stills that is surrounded by or filled with cold water to condense any vapors in tubes or vessels within it.

Regenerated Marine Salt: Potassium chloride (KCl).

Regenerated Sea Salt: Potassium chloride (KCl).

Regenerated Tartar: Potassium acetate ($KC_2H_3O_2$). In this form, the compound was made from distilled vinegar and salt of tartar.

Reguline Caustic: Potassium carbonate (K_2CO_3).

Regulus: The pure form of a metal, e.g., regulus of antimony.

Resins: A vegetable product, almost always viscous and sticky, formed within a plant or tree. Resins usually are obtained as natural exudations, by incisions into the tree, or by treating the wood chemically.

Retort: A vessel with a long neck bent down at the point where it joins the body of the vessel. Especially suited for the distillation of substances under low heat. See text, p. 9.

Revivification: The restoration of a metal to the metallic state from one of its compounds. Similar to, but broader in scope, than "reduction." See text, p. 13.

Risigallum: See Realgar.

Rob: A sort of conserve in which the juice of a fruit is extracted, condensed, and preserved with sugar.

Roche Alum: See Rock Alum.

Rochelle Salt (Seignette Salt): Potassium sodium tartrate ($KNaC_4H_4O_6 \cdot 4H_2O$).

Rock Alum: Usually larger crystals or formations of potassium aluminum sulfate ($KAl(SO_4)_2 \cdot 12H_2O$). Alum of this quality often was imported from Italy.

Rock-Crystal: Pure, colorless, transparent, crystalline quartz occurring naturally in large prismatic crystals. Silicon dioxide (SiO_2).

Rog: Concentrated native vegetable acid. From the usual preparations, it would be primarily citric acid ($C_6H_8O_7$).

Roman Vitriol: Copper sulfate ($CuSO_4$). In Britain this term was sometimes used for ferrous sulfate ($FeSO_4$).

Russian Pot Ash: Potassium carbonate (K_2CO_3).

Rust of Copper: See Verdigris.

Saccharated Lime: Calcium oxalate (CaC_2O_4).

Saccharum Saturni: Lead acetate ($Pb(C_2H_3O_2)_2$).

Saffron: A range of orange-yellow colors. The color called saffron comes from the dye of the same name, which is an extract of the plant *Crocus sativus*.

Saffron of Gold: See Aurum Fulminans.

Saffron of Iron: See Saffron of Mars.

Saffron of Mars: Any yellowish iron compound, e.g., hydrated ferroso ferric oxide ($Fe_3O_4 \cdot XH_2O$) or ferric sulfide (Fe_2S_3).

Saffron of Metal: A mixture of antimony sulfide (Sb_2S_3), nitre (KNO_3), and antimony sulfate ($Sb_2(SO_4)_3$).

Sal Absinthi (Salt of Wormwood): Mostly potassium carbonate (K_2CO_3).

Sal Albus: Borax (sodium tetraborate) ($Na_2B_4O_7 \cdot 10H_2O$).

Sal Alkali Vitriolatum: Potassium sulfate (K_2SO_4).

Sal Alkalinus Vegetablis: Potassium carbonate (K_2CO_3).

Sal Amarum: Magnesium sulfate ($MgSO_4$).

Sal Ammoniac (Sal Armoniac): Ammonium chloride (NH_4Cl). Sometimes used for other ammonium salts.

Sal Ammoniacum Fixum: Calcium chloride ($CaCl_2$).

Sal Ammoniacum Volatilis: A term variously used for any salt solution that gave off the odor of ammonia. When referring to solid salts the term meant ammonium carbonate ($(NH_4)_2CO_3$).

Sal Anglicum (Epsom Salt): Magnesium sulfate ($MgSO_4$).

Sal Catharticum: Magnesium sulfate ($MgSO_4$).

Sal Catharticum Amarum: Magnesium sulfate ($MgSO_4$).

Sal Catholicum: Potassium sulfate (K_2SO_4).

Sal de Duobus: Potassium sulfate (K_2SO_4).

Sal de Seignette (Sal de Soinette): See Seignette's Salt.

Sal Digestiv: Potassium chloride (KCl).

Sal di Modena: Magnesium sulfate ($MgSO_4$).

Sal Diureticus: Potassium acetate ($KC_2H_3O_2$).

Sal Duplicatum: Potassium sulphate (K_2SO_4).

Sal Enixum: Potassium sulfate (K_2SO_4).

Sal Epsom: (Epsom Salt): Magnesium sulfate $MgSO_4$).

Sales Medii: See Sal Medium.

Sales Salsi: See Sal Salsam.

Sal Gemme (Sal Gem): Sodium chloride ($NaCl$).

Sal Gentianae: Mostly potassium carbonate (K_2CO_3).

Sal Glauber (Glauber's Salt): Sodium sulfate (Na_2SO_4).

Sal Guaiaci ex Ligno: Mostly potassium carbonate (K_2CO_3).

Saline Bodies (Cullen): Substances which are (a) sapid, (b) miscible with water, and (c) noninflammable.

Salited Earths, Metals, etc.: Chlorides (Cl^-).

Sal Juniperi: Mostly potassium carbonate (K_2CO_3).

Sal Kali (Sodium Carbonate): Soda (Na_2CO_3).

Sal Marinus: Sea salt; mostly sodium chloride ($NaCl$).

Sal Marinus Fontan: Sodium chloride ($NaCl$) as found in or near landlocked bodies of water.

Sal Marinus Regeneratus: Potassium chloride (KCl).

Sal Martis: Ferrous sulfate ($FeSO_4$).

Sal Medium (Sal Salsum) (Sales Medii): Any neutral salt that would not precipitate solutions made with acid or alkaline salts and would not change the color of syrup of violets.

Salmiac: See Sal Ammoniac.

Sal Mirabile (Glauber's Salt): Sodium sulphate (Na_2SO_4).

Sal Nitriforme Inflammable: Probably ammonium nitrate ($(NH_4)NO_3$).

Sal Nitrii: Potassium nitrate (KNO_3).

Sal Perlatum: Sodium phosphate (Na_3PO_4).

Sal Polychrestum: Potassium sulphate (K_2SO_4).

Sal Polychrestum Anglorum (Sal Polychrestum Glaseri): Potassium sulfate (K_2SO_4).

Sal Polychrestum de Rochelle: See Sal Polychrestum de Seignette.

Sal Polychrestum de Seignette: Potassium sodium tartrate ($NaKC_4H_4O_6$).

Sal Polychrestum e Nitro et Sulphure: Potassium sulfate (K_2SO_4).

Sal Polychrestum Glaseri: Potassium sulfate (K_2SO_4).

Sal Prunellae: A mixture of potassium nitrate and potassium sulfate ($KNO_3;K_2SO_4$).

Sal Rupellensis (Rochelle Salt): Hydrated potassium sodium tartrate ($KNaC_4H_4O_6 \cdot 4H_2O$).

Sal Salsam: (1) Any neutral combination of an acid with an absorbent earth; (2) any neutral combination of acid with alkali. (See also Neutral Salts, Sal Medium, or Salts.)

Sal Sapientiae: Potassium sulfate (K_2SO_4).

Sal Saturni: Lead acetate ($PbC_2H_3O_2$).

Sal Sedivatus (Sedative Salt): Boracic or boric acid, (H_3BO_3) or ($H_2B_4O_7$).

Sal Sennerti: Potassium acetate ($KC_2H_3O_2$).

Sal Soda (Salt Soda, Soda): Sodium carbonate (Na_2CO_3).

Sal Succini (Salt of Amber): Succinic acid ($HO_2CCH_2CH_2CO_2H$).

Salt: In the 16th and 17th centuries this term denoted a group of solid, soluble, noninflammable substances with characteristic tastes. In the 18th century salts gradually became to be thought of in terms of *process,* as, for example, the product of the reaction between acids and bases, acids and other salts, or between two salts, etc. Some chemists regarded acids and bases themselves as salts or at least saline substances. In general, salts were increasingly recognized as the largest and most important class of substances as the eighteenth century progressed.

Salt Alembroth: A mixture of equal parts of corrosive sublimate (mercuric chloride, $HgCl_2$) and sal ammoniac (NH_4Cl). Used as a flux for metals.

Sal Tartari: Potassium carbonate (K_2CO_3). It usually was produced by strongly heating tartar.

Salt Ash: Magnesium chloride ($MgCl_2$).

Salt of Amber: Succinic acid ($C_4H_6O_4$).

Salt of Art: See Salt Alembroth.

Salt of Benzoin: Benzoic acid (C_6H_5COOH).

Salt of Centaury: Solid residues obtained from the calcination of any of the plant species of the genus *Centaurea.*

Salt of Chalk: Calcium acetate ($Ca(C_2H_3O_2)_2$).

Salt of Colcothar: Probably impure ferric hydroxide ($Fe(OH)_3$).

Salt of Coral: Calcium acetate ($Ca(C_2H_3O_2)_2$).

Salt of Crab's Eyes: Calcium acetate ($Ca(C_2H_3O_2)_2$).

Salt of England: Ammonium carbonate ($(NH_4)_2CO_3$).

Salt of Epsom: See Epsom Salt.

Salt of Gall-Nuts: Tannic acid ($C_{76}H_{52}O_{46}$).

Salt of Glass: A mixture of the various salts found in raw materials used in glassmaking. These included fixed alkali (potassium carbonate), common salt (sodium chloride), Glauber's salt (sodium sulfate), vitriolated tartar (potassium sulfate), etc.

Salt of Hartshorn: Ammonium carbonate ($(NH_4)_2CO_3$).

Salt of Human Blood: A mixture of ammonium salts, including ammonium hydroxide (NH_4OH), and various organic solids.

Salt of Lead (Sugar of Lead) (Sal Saturni): Lead acetate ($Pb(C_2H_3O_2)_2$).

Salt of Lime: Calcium carbonate ($CaCO_3$) precipitated from limewater (calcium hydroxide solution, $Ca(OH)_2$) by a carbonate compound.

Salt of Mars: Most often used for ferrous sulfate ($FeSO_4$). Occasionally used as a general term for any iron salt and as a specific name for ferrous acetate ($Fe(C_2H_3O_2)_2$).

Salt of Milk: Probably calcium lactate ($Ca(C_3H_5O_3)_2$).

Salt of Oxbone: Impure ammonium salts from bone extracts of cattle (NH_4OH).

Salt of Science: See Salt Alembroth.

Salt of Sedlitz: See Sedlitz Salt. (Sometimes sedlitz salt was confused with Glauber's salt.)

Salt of Soda: See Soda.

Salt of Sorrel: Acid potassium oxylate (KHC_2O_4).

Salt of Steel: Loosely applied to various iron salts. Most commonly applied to martial vitriol. (Ferrous sulfate; $FeSO_4$).

Salt of Sulphur: Impure potassium sulfate (K_2SO_4).

Salt of Sylvius (Febrifugal Salt of Sylvius): Potassium chloride (KCl).

Salts of Tachenius: Impure potassium and sodium carbonates (K_2CO_3,Na_2CO_3) obtained from the incomplete combustion of plant products. These salts contained organic impurities.

Salt of Tartar: Potassium carbonate (K_2CO_3).

Salt of Urine: Impure ammonium salts extracted from urine.

Salt of Vinegar: Impure potassium sulfate. Probably mixed with acetates and citrates.

Salt of Wisdom: See Salt Alembroth.

Salt of Wormwood: Mostly potassium carbonate (K_2CO_3).

Sal Vitrioli: Ferrous sulfate ($FeSO_4$).

Sal Volatile Fixatum: Ammonium sulfate ($(NH_4)_2SO_4$).

Sal Volatile Oleosi: Any solid extracted from animal or vegetable matter containing ammonium salts, e.g., salt of hartshorn, etc.

Sandarach: (1) See Realgar; (2) a resin from the tree *Callitris quadrivalvis.*

Sandiver (Glass Gall): A solution containing a mixture of salts found on the surface of glass after vitrification.

Saphire: See Sapphire.

Sapid: To have a decided, yet pleasant taste.

Saponaceous: To be soapy, slippery, sometimes foaming.

Sapphire (Saphire): A clear blue gem material which is like ruby, a crystalline form of alumina (Al_2O_3).

Sarcocolla: A gum resin imported from the Middle East.

Sarsparilla: The roots of plants of the family Smilaceae from which gummy and resinous extracts are obtained.

Sassafras: A term applied both to the tree *Sassafras officinale* and to its bark when dried and prepared.

Saturation: The action by which a "perfect" union between an acid and an alkali is accomplished. Its product is a neutral salt.

Saturn (of Saturn): Used in referring to lead or to compounds containing lead.

Saunders: See Red Saunders.

Scammony: A gummy, resinous juice from the root of the plant *Convolvulus scammonia.*

Scheele's Green: Cupric hydrogen arsenite ($CuHAsO_3$).

Schorl: A black mineral. Now known as a variety of tourmaline.

Schwartz Blei Weiss (Black White-Lead): Plumago (graphite) (C_N).

Scordium: The plant *Teucrium scordium* from which gummy and resinous extracts are obtained. It has an odor of garlic.

Scoria: The undesirable solid residues or slag which remain after a metal has been separated from an ore.

Scorification: Any process which produces scoria or slag. Sometimes used for processes which yield metal or semimetals. Scorification usually involved the addition of other substances to the ore, then heating.

Secret Fixed Sulphur of the Philosophers: Calcined residue when sulfur is distilled with linseed oil.

Secret Sal Ammoniac (Glauber's Secret Sal Ammoniac): Ammonium sulfate ($(NH_4)_2SO_4$).

Sedative Salt: Usually boric acid, but sometimes sodium tetraborate ($Na_2B_4O_7$).

Sedative Spar: Calcium borate (CaB_4O_7).

Sedlitz Salt (Epsom Salt): Magnesium sulphate ($MgSO_4$).

Seignette's Salt: Sodium potassium tartrate (Rochelle salt) ($NaKC_4H_4O_6$).

Selenite: The various mineral forms of Calcium sulphate ($CaSO_4$).

Selenitic Spar: Any mineral assigned to the family of "spars" that could be calcined like gypsum ($CaSO_4 \cdot 2H_2O$).

Semi-Metals: Substances which have the properties characteristic of metals except for ductility and which sublime. Different chemists had different lists, but most included antimony (Sb), arsenic (As); bismuth (Bi), cobalt (Co), and Zinc (Zn). Some included mercury (Hg) and, later in the century, nickel (Ni).

Sena (Senna): Several similar plants of the genus *Cassia* from the leaves of which gummy and resinous extracts were obtained.

Senegal: A gum extract from the root of the North American species *Polygala senega.*

Senna: See Sena.

Separating-Glass: A vessel narrow at the top, then bellying out in the center, and narrowing again to a hollow tube or stem. Shaped somewhat like the modern separatory funnel and often used for similar purposes.

Serpentine: A steatite, usually green.

Shoot: When crystals appeared, especially suddenly in a saturated solution, they were said to "shoot."

Siderum: Iron phosphide (Fe_3P).

Silex: Silicon dioxide (SiO_2).

Silicious Earth (Silica): Silicon dioxide (SiO_2).

Similor: A copper zinc alloy with a color approximating that of real gold.

Slaked Lime: Calcium hydroxide ($Ca(OH)_2$).

Smalt: A blue, glassy substance used as a pigment. The blue comes from cobaltous oxide (CuO). Smalt also contains silica (SiO_2).

Smelting: The process of extracting a metal from its ore.

Smo(a)king Spirit of Libavius: Primarily stannous chloride ($SnCl_2$) but with chlorides of mercury mixed in.

Smo(a)king Spirit of Nitre: Concentrated nitric acid (HNO_3).

Snow of Antimony: See Flowers of Antimony.

Soap: In general, any chemical combination of acids, bases, or salts with oils that exhibit detergent action. Common soap was the product of sodium hydroxide with an oil or fat.

Soap of Glass: Manganese dioxide (MnO_2) in its role of agent to remove color bodies from glass while the glass was molten.

Soap-Rock: See Steatites.

Soapstone: See Steatite.

Soda: Sodium carbonate (Na_2CO_3).

Soda Baryllia (Spanish): Sodium carbonate (Na_2CO_3).

Soda Hispanica (Washing Soda): Sodium carbonate (Na_2CO_3).

Solder: Any fusible metal alloy used for joining two pieces of metal. Most types were alloys of tin and lead.

Soluble Tartar: Normal potassium tartrate. Probably ($K_2C_4H_4O_6$).

Solution: Any liquid in which one component called the "solute" is dispersed in a second component called the "solvent."

Solvend (Cullen): Solute.

Soot: Carbon and hydrocarbon deposits from incomplete combustion of fuels.

Sorrel: Various plants of the genus *Rumex* from which an acid salt (acid potassium acetate) was extracted.

Spanish Earth: Vitriols (mixture) ($CuSO_4;FeSO_4$).

Spanish Green: Basic copper carbonate ($2CuCO_3 \cdot Cu(OH)_2$).

Spanish White: Bismuth oxychloride (or oxynitrate) ($BiOCl;BiONO_3$).

Spar: A class of compounds characterized by a crystalline form that features shiny reflective plate surfaces.

Spath (Spat) Stone: A naturally occurring mineral solid containing mostly calcium sulfate ($CaSO_4$).

Spathic Iron Ore: Ferrous carbonate ($FeCO_3$).

Specificum Purgans Paracelsi: Potassium sulfate (K_2SO_4).

Spermaceti: The white fatty substance obtained from the head of the sperm whale. Used in pharmaceuticals and candles.

Sphacelated: Gangrenous.

Spikenard: The aromatic extract from the Indian plant *Nardostachys jalamansi.* The term was also used for the plant itself.

Spirit: (1) Any liquor obtained from another substance by distillation; (2) later, any subtle substance dissolved in another substance. The concept gradually veered toward what we now call the gaseous state.

Sp. Ammon. cum Calce Viva: Ammonium carbonate ($(NH_4)_2CO_3$).

Spirit. Ammon. Sal. Vol.: Mostly ammonium carbonate ($(NH_4)_2CO_3$).

Spirit of Alum: Sulfuric acid (H_2SO_4) obtained from the destructive distillation of alum ($KAl(SO_4)_2 \cdot 12H_2O$).

Spirit of Hartshorn: Strong solution of ammonia produced by the distillation of hartshorn (NH_4O_4).

Spirit of Libavius: Stannic chloride ($SnCl_4$).

Spirit of Mindererus: Ammonium acetate solution ($NH_4(C_2H_3O_2)$.

Spirit of Wine: Ethanol (ethyl alcohol) (C_2H_5OH).

Spiritus Aceti: The acetic acid ($HC_2H_3O_2$) obtained from distilling any fermented material which produces this acid, e.g., vinegar.

Spiritus Beguini: Ammonium polysulfide (fuming liquor of Boyle) ($(NH_4)_2S$).

Spiritus CC: Ammonium carbonate ($(NH_4)_2CO_3$).

Spiritus Nitri Coagulatus: Potassium nitrate (KNO_3).

Spiritus Nitri Dulcis (Sweet Spirit of Nitre): Ethyl nitrite ($C_2H_5NO_2$).

Spiritus Sal Ammoniacum: See Spirit of Sal Ammoniac.

Spiritus Salis Ammoniaci cum Sale Alkali Parata: Ammonium carbonate ($(NH_4)_2CO_3$).

Spiritus Salis Coagulatus: Potassium chloride (KCl).

Spiritus Sulphuris: See Spirit of Vitriol or Spirit of Sulphur.

Spiritus Sulphuris Volatilus Beguinii: Ammonium polysulphide ($(NH_4)_2S$).

Spirit Veneris: Sulfuric acid (H_2SO_4).

Spiritus Vitrioli: See Spirit of Vitriol.

Spiritus Vitrioli Coagulatus: Potassium sulfate (K_2SO_4).

Sp. Mind.: See Spirit of Mindererus.

Spout: Any hollow projection from a vessel that is used to direct the liquid flow while pouring. This term was most commonly applied to the spout on an alembic.

Spuma Lupi: The mineral from which tungsten was extracted.

Stagnant Gas (Marsh Gas): Methane (CH_4).

Stamping: Crushing of ores.

Stannum Anglici: Tin (Sn) from England.

Stannum Glaciale: Bismuth (Bi).

Starkey's Soap: Saponaceous substance from the reaction between potassium carbonate and essential oil of turpentine.

Steatite: A mineral substance composed mostly of various forms of magnesium silicate, e.g., ($Mg_3Si_4O_{11} \cdot H_2O$).

Steel: Regarded as a form of iron which (a) contained a larger portion of the inflammable principle and (b) had fewer chemical impurities.

Stibiated Tartar: Potassium antimonyl tartrate ($KSbC_4H_4O_7$).

Stibium: Antimony sulfide (Sb_2S_3).

Stick Laque: See Lac.

Stinking Sulphurecus Air: Hydrogen sulphide (H_2S).

Stone of Bologna: A variety of barium sulfate ($BaSO_4$) that became phosphorescent when calcined.

Spirit of Niter "Besoardique": Nitric acid added to "Butter of Antimony" and the mixture distilled to get a liquor which holds the "Regulus of Antimony" in solution.

Spirit of Nitre: Dilute nitric acid (HNO_3).

Spirit of Sal Ammoniac: Ammonia (NH_3), or ammonium hydroxide solution (NH_4OH).

Spirit of Salt: Hydrochloric acid (HCl).

Spirit of Saturn: Impure acetone made from lead acetate (CH_3COCH_3).

Spirit of Sea-Salt: Hydrochloric acid (HCl).

Spirit of Sulphur: Mixture of sulfuric and sulfurous acids (H_2SO_4; H_2SO_3).

Spirit of Tartar: Potassium hydrogen tartrate ($KHC_4H_4O_6$). Product of the dry distillation of crude tartar.

Spirit of Urine: Ammonium carbonate ($(NH_4)_2CO_3$). Derived from an impure solution of ammonia obtained by the distillation of urine.

Spirit of Venus: Concentrated and relatively pure acetic acid ($HC_2H_3O_2$).

Spirit of Verdigris: Acetic acid ($HC_2H_3O_2$).

Spirit of Vinegar: Impure acetic acid obtained by distilling vinegar ($HC_2H_3O_2$).

Spirit of Vitriol: Dilute sulfuric acid (H_2SO_4) and/or sulfurous acid (H_2SO_3).

Strontia: Strontium oxide (SrO).

Sublimate: Solid or concrete products of sublimation. Not powder.

Sublimation: A property possessed by some substances enabling their going directly from the solid to the gaseous state without passing through the liquid phase. (See text, p. 15).

Substantia Ferrea Vitrioli: Ferric oxide (Fe_2O_3).

Succinum: Amber.

Sudorific: Any medicinal substance which promoted, or was believed to promote, sweating.

Sugar of (a Substance): Usually signifying an acetate ($-C_2H_3O_2-$).

Sugar of Lead: Lead acetate ($Pb(C_2H_3O_2)_2$).

Sulphur: (a) As a "principle," in the seventeenth and early eighteenth centuries the substantive causes of the properties of inflammability, color, and odor; (b) in the doctrine of phlogiston, a compound composed of vitriolic (sulfuric) acid and the inflammable principle, "phlogiston."

Sulphur Album Fixum: Potassium nitrate (KNO_3).

Sulphurated Iron: Ferrous sulphide (FeS).

Sulphur Minerale: Solid mineral sulphur (S).

Sulphur of Antimony (Golden Sulphur of Antimony): The orange sulfide of antimony, usually a mixture of the trisulfide (Sb_2S_3) with some of the pentasulfide (Sb_2S_5).

Sulphureous Salt of Stahl: Impure potassium sulfite (K_2SO_3).

Sulphureous Acid: Sulfuric acid (H_2SO_4).

Sulphurets: Sulfides ($-S$).

Sulphureum (Bergman): Sulfurous acid (H_2SO_3).

Sulphurous Acid (Pre-Lavoisier): Sulfuric acid (H_2SO_4).

Sulphur Vivum: Naturally occurring sulphur (S).

Superolefiant Gas (Dalton): Butylene (C_4H_8).

Swedish Acid: Hydrofluoric acid (HF).

Sweetened Spirit of Salt: Ethyl chloride (C_2H_5Cl).

Sweet Mercury (Mercureous Dulcis): Mercurous chloride (Hg_2Cl_2).

Sweet Principle from Oils and Fats: Glycerol ($HOCH_2CHOHCH_2OH$).

Sweet Sublimate: Mercurous chloride (Hg_2Cl_2).

Sympathetic Ink: Any solution that is colorless but becomes dark (and thus visible) by heating, by addition of other chemicals, etc.

Syrup of Violets: A water extract of the petals of violets.

Syrupus Violarum: See Syrup of Violets.

Tabasheer (Tabachir): A white powder formed at the joints of bamboo shoots. Imported from the Orient and used as a medicinal.

Talc: A mixture of magnesium metasilicilate ($Mg_3H_2(SiO_4)_3$) with magnesium silicate ($Mg_3Si_4O_{11} \cdot H_2O$).

Talky Earths: (a) fibrous earths; (b) earths that suffer no change from the action of acids or fire; (c) earths that do not become viscid or hard when made into aqueous paste, e.g., asbestos.

Tannin: Any astringent vegetable substance that can react with animal hyde and convert it to leather. The most common tannin was tannic acid extracted from oak-galls.

Tar: The dense, black, inflammable liquid or semisolid obtained from the distillation of various woods or coal. A complex mixture of hydrocarbons and other organic compounds.

Tartar: Potassium hydrogen tartrate ($KHC_4H_4O_6$).

Tartarated Alkali of Tartar: Potassium tartrate ($K_2C_4H_4O_6$).

Tartar Emetic (Stibiated Tartar): Potassium antimonyl tartrate ($KSbC_4H_4O_7$).

Tartarified Iron: See Chalybs Tartar.

Tartarified Tartar: See Soluble Tartar.

Tartarified Tincture of Iron: Ferrous tartrate solution ($FeC_4H_4O_6$).

Tartarin: A term occasionally used for potassium carbonate (K_2CO_3).

Tartarized Tartar: Potassium tartrate ($K_2C_4H_4O_6$).

Tartarized Tincture of Mars: Not a true alcohol solution, this medicinal was dubbed a tincture largely because of its deep color. Probably iron tartrate ($FeC_4H_4O_6$) with various impurities.

Tartarum Regeneratum (Regenerated Tartar): Potassium acetate ($KC_2H_3O_3$) for the most part, but also used for assorted potassium salts. Not very well defined.

Tartarum Solubus (Soluble Salt of Tartar): Potassium tartrate ($K_2C_4H_4O_6$).

Tartarum Tartarisatum: Potassium tartrate ($K_2C_4H_4O_6$).

Tartarum Vitriolatum (Vitriolated Tartar). Potassium sulphate (K_2SO_4).

Tartarus Citratus: Potassium citrate ($K_3C_6H_5O_7 \cdot H_2O$).

Tartarus Nitratus: Potassium nitrate (KNO_3).

Tartarus Tartarisatus: Potassium tartrate ($K_2C_4H_4O_6$).

Tartarus Vitriolatus: Potassium sulfate (K_2SO_4).

Tartre Stybie (Tartar Emetic): Potassium antimonyl tartrate ($KSbC_4H_4O_7$).

Tar Water: A solution of the water-soluble components of tar. Mostly alcohols and polar organic materials.

Tectum Argenti: Bismuth (Bi).

Terebinth: The resin from the terebinth tree *Pistacia terebinthus*.

Terebinthaceous: Impregnated with turpentine, having turpentine as a component, or just similar to turpentine.

Terebinthine: The refined portion or the "spirit" of the resin from the terebinth and other trees having similar resins. Very similar to what we now call turpentine.

Terra Anglica Rubra: Ferric oxide (Fe_2O_3).

Terra Foliata Nitri: Potassium acetate ($KC_2H_3O_2$).

Terra Foliata Tartari: See Regenerated Tartar.

Terra Foliata Tartari Crystallisabilis: Sodium acetate ($NaC_2H_3O_2$).

Terra Foliata Secretissima: Solid potassium acetate ($KC_2H_3O_2$).

Terra Francisca: Assorted sulfates (e.g., $FeSO_4$, $CuSO_4$).

Terra Molybdaenae: Molybdic acid ($H_2MoO_4 \cdot H_2O$).

Terra Ponderosa: Barium sulfate ($BaSO_4$).

Terra Ponderosa Acetate: Barium acetate ($Ba(C_2H_3O_2)_2$).

Terra Ponderosa Aerata: Barium carbonate ($BaCO_3$).

Terra Ponderosa Molybdaenata: Barium molybdate ($BaMoO_4$).

Terre Foliee Animale: Ammonium acetate ($NH_4C_2H_3O_2$).

Terre Foliee Crystallisee: Sodium acetate ($NaC_2H_3O_2$).

Test: A large cupel used for refining substantial quantities of gold and silver by means of lead.

Testaceous Earths: Mineral solids that came from or were chemically similar to shells. Thus, "testaceous powders" were prepared from shells.

Testing: The operation of refining gold and silver by means of lead.

Theriac: A general term for an antidote for the poison of a venomous snake.

Tincal (Tinkal): Crude borax imported from India.

Tinct. Tartari: Solution of potassium hydroxide (KOH) in alcohol.

Tinctura Antimonii: See Tincture of Antimony.

Tincture: A solution in which ethanol is the primary solvent. The term was applied most often to colored solutions.

Tincture of Antimony: A medicinal prepared from antimony metal and liver of sulphur (potassium polysulfides).

Tincture of Coral: Crude acetone (CH_3COCH_3).

Tincture of Mars: A general term for various medicinal preparations involving iron salts. Common components included ferrous hydroxide and mixed tartrates and oxides.

Tincture of Mars of Mynsicht: An alcohol solution in which the solute is primarily ferric chloride ($FeCl_3$).

TIN-GLASS: Bismuth (Bi).

TINGING: When one substance tinges or slightly colors another.

TORREFACTION: Roasting of ores in the hope of removing impurities.

TOURMALINE (TOURMALIN, ASH-STONE): A mineral solid consisting of various forms of silicoborate, including the black mineral "Schorl."

TOURNESOLE: See Turnsol.

TRIPLE SALTS: Salts which seemed to have three components rather than the usual two; e.g., alum ($KAl(SO_4)_2 \cdot 12H_2O$).

TRIPOLI (INFUSORIAL EARTH, ROTTEN-STONE): A finely divided mineral solid used for polishing. Obtained from the shells of diatoms.

TRITORIUM: A vessel used for the separation of immiscible liquids. It was often shaped somewhat like two modern separatory funnels cut near their tops and fused together. Basically the same as a separating glass.

TRITURATION: Mechanical breakdown or division of solid substances through grinding; e.g., with mortar and pestle, in a mill, etc. (See text, p. 13).

TRITURE: See Trituration.

TRONA: Naturally occurring sodium carbonate (Na_2CO_3). It usually had some bicarbonate ($NaHCO_3$) in it as well.

TUBULATED RETORT: A retort which had a sealable opening in the top to allow addition or removal of material without changing the position of the retort. See text, p. 11.

TUNG SPAT: See Heavy Spar.

TUNGSTEN (SCHEELITE): Native calcium tungstate ($CaWO_4$).

TURMARIC: A powder made from the root of the imported East Indian plant *Curcuna longa.*

TURNER'S YELLOW: Yellow lead oxychloride ($PbCl_2 \cdot 3PbO$).

TURNSOL(E): The bluish purple substance from the plant lichen *Crozophora tinctoria.* Used as an indicator. Synonymous with litmus.

TURPENTINE: A resinous liquid extracted from various trees. Originally the extract of the terebinth tree *Distacia terebinthus.*

TURPETH MINERAL (TURBETH MINERAL): Basic mercuric sulphate ($HgSO_4 \cdot 2HgO$).

TUTENAG (CHINESE COPPER): A term occasionally applied to zinc (Zn). Also used for a white metal alloy (Chinese copper) which consisted primarily of copper (Cu), zinc (Zn), and nickel (Ni). Used to alloy silver in coins and jewelry items.

TUTIA: See Tutty.

TUTTY: Zinc oxide (ZnO).

ULIGINOUS: Any watery, oozing matter like that in a swamp.

ULMIN: A mucilagenous substance from the inner bark of the elm.

ULTRAMARINE: A blue pigment made from the gem mineral lapis lazuli. The relative composition of ultramarine is not fixed, but the largest component is a sodium aluminum silicate combined with sulphur.

UMBER: A mineral solid which exists in a range of brown hues. Chemically, umber is mostly a mixture of hydrous ferric oxide ($Fe_2O_3 \cdot XH_2O$) and manganese dioxide (MnO_2). It was believed by many in the eighteenth century to be a fossil wood originally found in Umbria near Spoleto in Italy.

UNCTUOUS: Oily; i.e., viscous, adherent and lubricating.

UNCTUOUS OILS: Oils that have little or no taste or odor but are relatively "oily"; i.e., are viscous, adherent, and lubricating.

URINOUS SALTS: Usually any ammonium salt. Sometimes any of the alkali carbonates.

USTULATION: The loss of volatile components of a substance without loss of texture or body. Cf. Calcination.

VAGUE ACID OF MINES: An aeriform fluid which was probably largely sulphur dioxide (SO_2).

VAPOUR: Rather loosely applied to any aeriform substance or phase. Perhaps the best eighteenth-century definition was any aeriform substance that could be liquefied by cold.

VAPOUR OF ARSENIC: Arsenious oxide (As_2O_3).

VARNISH: A resin in solution. "Spirit" varnishes were resins dissolved in turpentine or alcohol. "Oil" varnishes were resins dissolved in linseed and/or other oils.

VEGETABLE ACID: Any acidic substance extracted from whole or fermented vegetable matter. Thus, the term was applied to acetic (CH_3COOH), citric ($C_6H_8O_7$), and tartaric ($C_4H_6O_6$) acids, etc.

VEGETABLE ACID, FERMENTATIVE: Primarily acetic acid from vinegar ($HC_2H_3O_2$).

VEGETATIVE ACID, NATIVE: Citric acid ($C_6H_8O_7$).

VEGETABLE ALKALI (POTASH): Potassium carbonate (K_2CO_3).

Vegetable Ammoniacal Salt: Solid ammonium acetate ($NH_4C_2H_3O_2$).

Vegetable Salt: See Tartarified Tartar or Soluble Tartar.

Venus (of Venus): Usually suggested either copper or a compound of copper. Sometimes it simply indicated an acetate ($-C_2H_3O_2^-$).

Verdigris (Verdegrise): A basic copper acetate ($Cu(C_2H_3O_2)_2 \cdot 2Cu(OH)_2$). Long used as a green pigment.

Verditer (Blue Verditer; Blue Bice): A blue pigment made from a basic copper carbonate ($2CUCO_3 \cdot Cu(OH)_2$) which is chemically the same as azurite.

Vermillion: The red pigment made from cinnabar (mercuri sulfide, HgS). See Cinnabar.

Vine Black: A preparation of carbon from the twigs and wood of vines. Used as a black pigment.

Vinegar of Lead: Primarily lead acetate ($Pb(C_2H_3O_2)_2$).

Vital Air: Oxygen (O_2).

Vitiated Air: Air from which oxygen has been removed, thus mainly nitrogen.

Vitresant (Vitrifiable): Any solid that could be made into "glass."

Vitrifiable Earths (Vitreous Earths): Mineral substances which fuse under the action of fire.

Vitrification: The chemical part of the process of making glass or of any high-temperature process which produced a glass-like substance.

Vitriol: Used mainly for ferrous sulphate ($FeSO_4$), but a generic term for sulfates. As with many old terms, the usage varied; e.g., some used the term for nitrates of silver and copper.

Vitriol, Blue: Copper sulphate ($CuSO_4$).

Vitriol, Green: Ferrous (or iron) sulphate ($FeSO_4$).

Vitriol, White: Zinc sulphate ($ZnSO_4$).

Vitriol (or Vitriolic) Acid: Sulphuric acid (H_2SO_4).

Vitriolated Earths, Metals, etc.: Sulphates.

Vitriolated Ether: Diethyl ether ($C_4H_{10}O$).

Vitriolated Tartar: Potassium sulfate (K_2SO_4).

Vitriolic Ether: Diethyl ether ($C_4H_{10}O$).

Vitriol of Goslar (White Vitriol): Zinc sulfate ($ZnSO_4$).

Vitriol of Jove: Stannous sulphate ($SnSO_4$).

Vitriol of Jupiter: Stannous acetate ($Sn(C_2H_3O_2)_2$).

Vitriol of Mars (Green Vitriol): Ferrous sulfate ($FeSO_4$).

Vitriol of Quick Silver: Mercuric nitrate ($Hg(NO_3)_2$).

Vitriol of Saturn: Lead acetate ($Pb(C_2H_3O_2)$).

Vitriol of Silver: Occasionally, early in the century, silver nitrate ($AgNO_3$). As the century progressed, the term was more reasonably applied to silver sulfate (Ag_2SO_4).

Vitriol of Venus: Cupric sulfate ($CuSO_4$).

Vitriolum Album: See White Vitriol.

Vitriolum Ammonium: Ammonium sulfate ($(NH_4)_2SO_4$).

Vitriolum Anglicum: Ferrous sulphate ($FeSO_4$).

Vitriolum Veneris cum Alkali Fixo Praecipitatum: Basic copper acetate ($Cu(C_2H_3O_2)_2 \cdot CuO \cdot 6H_2O$).

Vitrium Antimonii (Glass of Antimony): Fused antimony oxide (Sb_2O_3).

Vivifying Spirit: A hypothetical principle in the air which, according to some early eighteenth-century chemists, was the active agent in combustion and respiration.

Volatile: An adjective usually used to indicate not only that a substance naturally gave off some aeriform component (as indicated by an odor) but also that it decomposed easily and gave off one or more aeriform components to the air on heating.

Volatile Acid of Nitre: Nitrous acid (HNO_2).

Volatile Acid of Sulfur (Phlogisticated Vitriolic Acid): Sulfurous acid (H_2SO_3).

Volatile Alkali: A term most commonly used for solutions of ammonia; e.g., ammonium hydroxide.

Volatile Alkali in Its Concrete Form: Ammonium carbonate (NH_4CO_3).

Volatile Liver of Sulphur: Volatile product from heating sulphur with quicklime and ammonium chloride.

Volatile Sal Ammoniac: Ammonium hydroxide solution.

Volatile Salt: Ammonium carbonate ($(NH_4)_2CO_3$).

Volatile Salt of Amber: See Salt of Amber.

Volatile Salt of Hartshorn: Ammonium carbonate (NH_4CO_3).

Volatile Spirit of Sal Ammoniac: Ammonium hydroxide (NH_4OH) obtained from quicklime (calcium oxide) and sal ammoniac (ammonium chloride).

Volatile Spirit of Sulphur: The aeriform product from burning sulphur; mostly sulphur dioxide

(SO_2) with some sulphur trioxide (SO_3). The term was also applied to sulphurous acid.

Volatile Vitriol of Venus: Copper acetate $Cu(C_2H_3O_2)_2$.

Wash: Any fermented mixture which, after distillation, would produce distilled spirits (ethanol, CH_3CH_2OH, with impurities).

Water Gas: Mixture of hydrogen (H_2) and carbon monoxide (CO).

Water of Minderus: A solution of ammonium acetate ($NH_4C_2H_3O_2$).

Water of Rabel: A solution of ethyl ether ($CH_3CH_2OCH_2CH_3$) in ethanol (CH_3CH_2OH).

Wax: A term referring to beeswax only, as the hydrocarbon waxes were not available in the eighteenth century.

Whey: The liquid which remains after milk is curdled, usually in the process of cheese-making.

White Arsenic: Arsenious oxide (As_2O_3).

White Calx of Antimony: Mixture of antimony oxide (Sb_2O_3) and potassium oxide (K_2O).

White Copper: An alloy of arsenic (As), copper (Cu), and zinc (Zn).

White Copperas: Zinc sulfate ($ZnSO_4$).

White Lead: Basic lead carbonate ($Pb(CO_3)_2 \cdot Pb(OH)_2$).

White Manganese: Manganous carbonate ($MnCO_3$).

White Precipitated Mercury (Precipitate of the Sublimate of Mercury): Mercurammonium chloride ($HgNH_2Cl$).

White Vitriol: Zinc sulfate ($ZnSO_4$).

Wind Furnace: A reverberating furnace. See text, p. 6.

Wine: Often used more broadly by eighteenth-century chemists to include any potable liquid which had become "spiritous" through fermentation; e.g., beer, cider, and mead.

Witherite: Barium carbonate ($BaCO_3$).

Woad: A blue dye prepared from the leaves of the plant *Isatis tinctoria.*

Wolfram: A mineral substance *Spuma lupi* that was under investigation in the 18th century.

Wood Ash: Potassium carbonate (K_2CO_3).

Worm: A long, coiled tube, usually of copper, attached to the head of a distillation apparatus for the purpose of increasing condensation. A worm commonly was used in distilling spirits.

Wormwood: The plant *Artemisia absinthium,* the leaves of which were used to make an extract by distilliation. Used as a medicinal.

Wort: An infusion of grain, usually malt, which was fermented to produce beer.

Woulfe Bottle: A bottle with two or more necked orifices that was used in distillation.

Yellow: A yellow coloring agent produced by treating indigo with dilute nitric acid. This substance proved to be unstable and seldom was used as a dye.

Yellow Aqua Fortis: Concentrated nitric acid (HNO_3).

Yellow Arsenic: Arsenious sulphide (As_2S_3).

Yellow Ochre: Hydrated ferric oxide ($Fe_2O_3 \cdot H_2O$).

Yttria: A mixture of rare earth elements from the mineral gadolinite. Primarily the trioxide of yttrium (Y_2O_3).

Zaffre (Saffre): A gray or reddish powder composed mostly of cobalt oxide (CaO).

Zeolites: A group of mineral solids which are various hydrated silicates, primarily of aluminum, calcium, potassium, and sodium. Although not really related, they shared the property of swelling and "boiling" under the heat of the blowpipe.

Zinc (Zinco, Zinetum): Regarded in the eighteenth century as a semi-metal because of its relative brittleness.

Notes

[1] Nicolas Le Févre, *A Compleat Body of Chymistry* (London, 1670), part 1, pages 1–12.

[2] George Ernst Stahl, *Philosophical Principles of Universal Chemistry* (London, 1730), page 1. This publication is a translation by Peter Shaw of Stahl's *Fundamenta Chymiae* of 1723. The manuscript from which the original was published predates Stahl's use of the phlogiston concept.

[3] Nicolas Lemery, *Cours de chimie*, 8th edition (Paris, 1696), page 2.

[4] Wilhelm Homberg, "Essais de chymie," *Mémoires de l'Académie Royale des Sciences* (1702), page 33.

[5] Herman Boerhaave, *Elements of Chemistry* (London, 1735), volume 1, page 19. This publication is the authorized translation by Timothy Dallowe.

[6] Ibid, volume, 2, page 2.

[7] Peter Shaw, *Chemical Lectures*, 2nd edition (London, 1755), page 1. Shaw's definition is closer to Boerhaave's than might appear at first glance.

[8] Guillaume-François Rouelle, "Cours de Chimie, ou Leçons de Monsieur Rouelle, Recueilles pendant les années 1754, 1755, et redigées en 1756. Revues, et corrigées, en 1757 et 1758" (manuscript, Science Library, Clifton College, Bristol, England; micofilm copy courtesy Cornell University Library), page 1.

[9] Ibid., page 3.

[10] Pierre-Joseph Macquer, *Élémens de chymie théorique* (Paris, 1749), page 1.

[11] Antoine Baumé, *Chymie expérimentale et raisonnée* (Paris, 1773), volume 1, page 13.

[12] Ibid., pages 2–7.

[13] In the eighteenth century, "analysis" generally meant a decomposition reaction rather than the determination of chemical composition. I try to keep the two meanings straight by using "decomposition" for analysis in the eighteenth-century sense whenever there seems to be some possibility for confusion.

[14] Macquer, *Chymisches Wörterbuch, oder Allgemeine Begriffe der Chymie in alphabetischer Ordnung*, 6 volumes (Leipzig, 1781–1783). Translated and annotated by Johann Gottfried Leonardi.

[15] Macquer, *Dictionnaire de chymie* (Paris, 1766), volume 2, page 9.

[16] Ibid., page 10.

[17] Ibid.

[18] As Macquer (*Dictionnaire*, volume 2, page 4) observed, "In a laboratory where many experiments are made one cannot have too many shelves." Some scientific problems apparently are immutable.

[19] F. W. Gibbs, "William Lewis, M.B., F.R.S. (1708–1781)," *Annals of Science*, volume 8 (1957), pages 122–151.

[20] See, for example, John Read, *Prelude to Chemistry* (Cambridge, Massachusetts, 1966), especially pages 143–145.

[21] Le Févre, *A Compleat Body of Chymistry*, part 1, page 75.

[22] Lemery, *Cours de chimie*, pages 2, 6–8.

[23] Boerhaave, *Elements of Chemistry*, volume 1, pages 237–241.

[24] Macquer, *Dictionnaire*, volume 1, page 503.

[25] See, for example, the several illustrations of laboratories in Fritz Ferchl and A. Sussenguth, *A Pictorial History of Chemistry* (London: Whitefriars, 1939), pages 170–178.

[26] A complicated but intriguing furnace was designed by Peter Shaw (1694–1763) and exhibited in the appendix of his translation (1741) of Boerhaave's *Elementa Chemiae* that was published in 1732. Essentially cylindrical in shape, it was made in sections that could be stacked vertically on a basic firebox. The upper sections were heating chambers that could accommodate vessels of various sizes.

[27] Boerhaave, *Elements of Chemistry*, volume 1, pages 510–511 and plate 13.

[28] Lemery, *Cours de chimie*, page 35.

[29] Ibid., pages 68–69.

[30] Boerhaave, *Elements of Chemistry*, volume 1, pages 241–244. Henry Bolton has recorded that a Fahrenheit thermometer graduated to 600° (not, of course, in exact correspondence to our modern Fahrenheit scale) still survived in Leyden about 1900. See Henry Carrington Bolton, *Evolution of the Thermometer, 1592–1743* (Easton, Pennsylvania: The Chemical Publishing Co., 1900), page 77.

[31] The use of thermometers in chemistry was uncommon at this time. Moreover, the great Swedish chemist Torbern Bergman (1735–1784) could write in 1779 that he "knew a chemist who considered thermometers, and such instrument, as physical subtleties, superfluous and unnecessary in the laboratory." Torbern Bergman, *Physical and Chemical Essays* (London, 1788), volume 1, page xxxiii. (This work is Edmund Cullen's two-volume translation of Bergman's collected works.)

[32] Macquer, *Dictionnaire*, volume 1, page 507.

[33] The magnitude of their problems becomes even more striking when one considers that the conditions outlined above were ideal. For those not fortunate enough to have access to a stable of furnaces there was only the fireplace, the alcohol lamp, and the lowly candle. But as Joseph Priestley's descriptions of his laboratory apparatus and operations proves, the lack of the best facilities did not cripple an adept experimenter.

[34] Macquer, *Élémens de chimie theorique*, page 275. For those historians of technology of the Marxist persuasion, one might remark that this is a very good description of modern pyrex ware.

[35] Boerhaave, *Elements of Chemistry*, volume 1, page 501.

[36] Macquer, *Élémens de chemie theorique*, page 277.

[37] Boerhaave, *Elements of Chemistry*, volume 1, page 501. For a good summary of problems and methods of contemporary eighteenth-century glassmaking in France, see the article "Vitrification" in Macquer, *Dictionnaire*, volume 2, pages 650–673.

[38] See, for example, **Ferchl and Sussenguth**, *A Pictorial History*, passim; and **Read**, *Prelude to Chemistry*, especially pages 75–80.

[39] **Macquer**, *Dictionnaire*, volume 2, page 618.

[40] Cf. **Boerhaave**, *Elements of Chemistry*, volume 1, page 504 and plate 15.

[41] See, for example, A. N. **Meldrum**, "Lavoisier's early work in science, 1763–1771," *Issis*, volume 20 (1934), pages 396–425; and **Douglas McKie**, *Antoine Lavoisier, the Father of Modern Chemistry* (Philadelphia, 1935).

[42] A favorite principle of the adept. After all, what truly *sublime* substance could be prepared in a short time? This view was reflected in Lavoisier's choice of a long experiment, where the length of the process was felt to add to its credibility.

[43] See, for example, **Boerhaave's** excellent example of the extraction of cinnamon in his *Elements of Chemistry*, volume 1, pages 48–49; also pages 4–7 in volume 2 of the same work. For a general review of the problems faced by chemists in the early eighteenth century in their attempts to analyze animal and vegetable matter, see **Louis Lemery**, "Reflexions physiques sur le défout et le peu d'utilité des analyses ordinaires des plantes et des animaux," *Mémoires de l'Académie Royale des Sciences*, 1719, pages 173–188; 1720, pages 98–107 and 166–178.

[44] **Boerhaave**, *Elements of Chemistry*, volume 1, pages 503–507; **Macquer**, *Élémens de chimie theorique*, pages 277–291; and **Macquer**, *Dictionnaire*, volume 2, pages 361–363.

[45] **Macquer**, *Élémens de chimie theorique*, page 176.

[46] **Macquer**, *Dictionnaire*, volume 2, page 5.

[47] **Boerhaave** (*Elements of Chemistry*, volume 1, page 502), for example, strongly recommended the use of a type of bottle with a mouth "secured with a glass stopple, ground nicely to the concavity of the Neck," for storing volatile liquids.

[48] **Le Févre**, *A Compleat Body of Chymistry*, pages 88–90; Lemery, *Cours de chimie*, page 45.

[49] **Le Févre**, ibid.

[50] **Boerhaave**, *Elements of Chemistry*, volume 1, pages 507–515; **Macquer**, *Élémens de chymie theorique*, pages 329–336; **Macquer**, *Dictionnaire*, volume 2, pages 31–32; **Baumé**, *Chymie expérimentale et raisonnée*, volume 1, pages cxviii–cxxvii.

[51] **Macquer**, *Élémens de chimie theorique*, pages 329–336; **Le Févre**, *A Compleat Body of Chemistry*, pages 88–89; **Antoine Lavoisier**, *Oeuvres de Lavoisier* (Paris, 1864–1893), volume 1, pages 332–337.

[52] See, for example, **Lavoisier**, *Elements of Chemistry* (New York: Dover, 1965), plate 10, figure 1; plate 11; and plate 12, figure 8. (A reprint of the 1790 English translation of the *Traité élémentaire de chymie* by Robert Kerr.) Much of this modern-looking apparatus was constructed of metal rather than glass; moreover, Lavoisier had far greater economic resources than most eighteenth-century chemists.

[53] **Macquer**, *Dictionnaire*, volume 2, page 6. Macquer recommended having both concentrated and dilute acids on hand, but he gave no operational method for defining those terms.

[54] Boyle's chemical tests were scattered throughout his writings. For a discussion of this aspect of Boyle's work, see **Marie Boas**, *Robert Boyle and Seventeenth Century Chemistry* (Cambridge, 1958), pages 126–141, and her introduction to the reprint of **Boyle's** *Experiments and Considerations Touching Colours* (New York: Johnson Reprint Corp., 1964), pages vii–xxvi.

[55] These headings admittedly are imperfect since many chemical processes involved several steps. Thus, a separative procedure might involve a reaction which, in turn, was intended to prepare a substance for the next reaction, etc. For most purposes, however, these useful classifications adequately reflect the way in which these procedures were regarded by the chemists of that time.

[56] Thus, fermentation was commonly associated with (chemical) digestion.

[57] **Macquer**, *Dictionnaire*, volume 1, p. 351; also **Nicolas Lemery**, *Cours de chymie*, Baron edition (Paris, 1756), page 42. The latter reference is to an edition prepared by Theodore Baron with considerable notes and additions to bring it up to date; as such, it is an interesting record of the growth of eighteenth-century chemistry, though Baron has many points of view not shared by other, contemporary chemists.

[58] See, for example, **Boerhaave**, *Elements of Chemistry*, volume 2, pages 26, 280; **Lemery**, *Cours de chymie*, Baron edition (1756), page 94 and note; **Macquer**, *Élémens de chimie théorique*, pages 61–63; **Macquer**, *Dictionnaire*, volume 1, pages 233–234.

[59] **Macquer**, *Élémens de chimie théorique*, page 76.

[60] **Macquer**, *Dictionnaire*, volume 1, page 364.

[61] **Boerhaave**, *Elements of Chemistry*, volume 2, pages 48–51; **Lemery**, *Cours de chymie*, Baron edition (1756), page 42; **Macquer**, *Dictionnaire*, volume 1, page 271.

[62] **Macquer**, *Dictionnaire*, volume 2, pages 182–183.

[63] Ibid., volume 1, page 350; **Lemery**, *Cours de chymie*, Baron edition (1756), page 42.

[64] **Macquer**, *Dictionnaire*, volume 2, page 306.

[65] **Lemery**, *Cours de chymie*, Baron edition (1756), page 43; **Boerhaave**, *Elements of Chemistry*, volume 2, pages 90–91; **Macquer**, *Dictionnaire*, volume 1, pages 508–511.

[66] **Macquer**, *Dictionnaire*, volume 2, pages 18–19.

[67] **Lemery**, *Cours de chymie*, Baron edition (1756), pages 44, 448, 725; **Boerhaave**, *Elements of Chemistry*, volume 2, pages 122–127; **Macquer**, *Dictionnaire*, volume 2, pages 358–363.

[68] **Macquer**, *Dictionnaire*, volume 2, page 358.

[69] Although Reaumur had made density measurements on water and alcohol in 1733, the problem was not fully explored until publication of M.-J. **Brisson's** "Mémoire sur le rapport des différents densités de l'esprit-de-vin, avec ses différens degrés de force," *Mémoires de L'Academie Royale des Sciences* (1769 [1772]), pages 433–452. Even then, satisfactory physical means of evaluating alcohol solutions had to await further work by Baumé and Lavoisier.

[70] Although Boerhaave is well known for his interest in thermometers, neither he nor his illustrious student Cromwell Mortimer really were able to apply thermometric techniques to chemisty in a truly systematic manner. See **Cromwell Mortimer**, "Discourse Concerning the Usefulness of Thermometers in Chemical Experiments," *Philosophical Transactions of the Royal Society of London*, volume 44 (1747), pages 672–695.

[71] Lemery, *Cours de chymie,* Baron edition (1756), pages 45, 97, 203–206; Macquer, *Dictionnaire,* volume 2, pages 511–513.

[72] Macquer, *Dictionnaire,* volume 2, pages 329–330.

[73] A glance at the solubility versus temperature curves for KNO_3 and NaCl shows that at room temperature the two plots cross (about 25° C). Thus, in the normal course of crystallization it would be extremely difficult to separate the two solids by this method. Once this problem is recognized, however, these two salts are ideal, for the sodium chloride curve is almost flat over the range from zero to 100° C while the curve for KNO_3 rises sharply from about 12 g. per 100 g. H_2O at 0° C to about 140 g. per 100 g. H_2O at 70° C. The rise of the KNO_3 curve is almost exponential, so a difference of a few degrees above or below room temperature causes a sharp difference in solubility.

[74] Andre Sigismund Marggraf, "Manière aisée de dissoudre l'argent et le mercure dans les acides des végetaux," *Histoire de l'Académie Royale des Sciences et Belles Lettres à Berlin* (1746 [1748]), pages 58–64.

[75] Ibid., pages 58–59.

[76] The informal, even *intime* style which was the standard for scientific literature until the late nineteenth century makes this possible, while modern, third-person passive, which is now the accepted scientific style, does not.

[77] By "perfectly," Marggraf here meant "totally," i.e., the vinegar was as concentrated as one could make it by freezing out the water. This was one more way of controlling quantity, for the glacial method (*concentré par la gelée*) gave a relatively uniform product.

[78] Marggraf, "Maniere aisee de dissoudre l'argent et le mercure," pages 60–61.

[79] Ibid., page 60.

[80] The first half of the eighteenth century was not England's "finest hour" vis-a-vis experimental chemistry. It was in large part dominated by intellectual exercises in Newtonian matter theory and thus was relatively sterile save for the genius of Stephen Hales. Parallel readings of the *Philosophical Transactions* of London's Royal Society and the *Histoire et Mémoires* of the Académie Royale des Sciences of Paris provide a new dimension to the distinction between amateur (English) and professional (French). The limitations of Newtonian matter theory are made clear by Arnold Thackray, *Atoms and Powers* (Cambridge, Massachusetts: Harvard University Press, 1971).

[81] For biographical details on Lewis, see F. W. Gibbs, "William Lewis," pages 122–151, and J. B. Eklund, "William Lewis" in *Dictionary of Scientific Biography* (New York: Scribners, 1973), vol. 8, pages 297–299.

[82] William Lewis, "Experimental Examination of a White Metallic Substance . . ," *Philosophical Transactions* vol. 48, part 2 (1754), pages 638–689. See also William Brownrigg, "Several Papers Concerning a New Semi-metal, Called Platina; Communicated to the Royal Society by Mr. Wm. Watson, F.R.S.," *Philosophical Transactions of the Royal Society,* volume 46 (1749–1750), pages 584–596. Includes some related communications by others.

[83] Brownrigg (ibid., page 587) reported, however, that "the *Spaniards* have a way of melting it down . . . and cast it into sword hilts, buckles, snuff boxes and other utensils."

[84] Only a few years later, Lewis, following Neumann, defined oil of vitriol in terms of a specific gravity of about 1.87. He clearly distinguished among such terms as "power," "activity," and "strength" of acids. He was well aware, of course, of the effect on concentration of a sulfuric acid solution of the hydroscopic nature of the acid. See William Lewis, *The Chemical Works of Caspar Neumann, M. D.* (London, 1759), pages 160–163 and especially notes (m) and (g).

[85] Lewis, "Experimental Examination," page 645.

[86] Ibid., page 652. A comparison of Macquer's treatment of the various metals both in his *Élémens de chemie théorique* and in his *Dictionnaire* shows that fire and the three mineral acids, and sulfur and nitre as well, serve as defining reagents for these substances.

[87] "Liver of sulphur" has disappeared from chemical usage in name as well as in body. Produced by a reaction of potassium carbonate and sulphur, it was not a true compound but an unstable mixture of potassium polysulfides and potassium sulfate that tended to decompose ultimately into the sulfate. J. R. Partington has suggested the following overall reaction: $16S + 12K_2CO_3 = 8K_2S + K_2S_5 + 3K_2SO_4 + 12CO_2$. See J. R. Partington, *General and Inorganic Chemistry* (London: Macmillan, 1946), page 721.

[88] One easily becomes suspicious about the order of the experiments as Lewis presents them. Any eighteenth-century chemist of Lewis' experience would have tried aqua regia long before the many variations of dissolution techniques with "acid spirits" listed by him. In view of the refractory nature of the metal, he may very well have tried it in aqua regia after the first few failures in the furnace and then followed up with other, more esoteric tests for completeness and to obtain possible anomalies. The order of presentation finally given must be in large part a matter of style, but this is important in itself.

[89] Lewis, "Experimental Examination," pages 660–661.

[90] Ibid.

[91] Ibid., page 661.

[92] Although Partington ascribes this process to Rouelle, Macquer claimed Rouelle was unsuccessful. The secretary of the Academie Royale des Sciences, Condorcet, tightroped his way through the problem by remarking that the "difficulte avoit ete reduite par Messrs. Rouelle" and pointing out that de Courtanvaux had studied with G.-F. Rouelle and had been assisted by H. M. Rouelle in the Marquis' laboratory at Comombe. Courtanvaux himself gave Rouelle credit only for the apparatus. See Partington, *General and Inorganic Chemistry,* volume 3, page 94; Macquer, *Dictionnaire,* volume 1, pages 469–470; The Marquis de Condorcet, "Eloge de M. le Mis. de Courtanvaux," *Histoire de L'Académie Royale des Sciences* (1781 [1784]), pages 71–78; M. le Marquis de Courtanvaux, "Memoire sur l'ether marin," *Mémoires de mathématique et de physique presentés à l'académie Royale de sciences par divers savans* (1768), pages 19–36 (paper read 30 April 1762).

[93] De Courtanvaux, "Mémoire sur l'éther marin," pages 19, 22–23.

[94] Its acidity was known to Macquer (see his *Chymie pratique,* volume 1, pages 288–292) and Baron (Lemery, *Cours de chymie,* Baron edition, 1756, page 361, note "o").

[95] DE COURTANVAUX, "Mémoire sur l'éther marim," page 23. For a supposed student of Rouelle, it is curious that the Marquis employed phlogiston in ways his mentor did not.

[96] DE COURTANVAUX, "Mémoire sur l'éther marin," page 25. Curiously, de Courtanvaux did not use the term "allonge," although from his description that was what it was.

[97] Ibid., page 26.

[98] Ibid., page 32.

[99] MACQUER, *Dictionnaire de Chymie* (Paris, 1766). Although he published this work anonymously, Macquer hastened to admit authorship when the *Dictionnaire* was well received. For other editions and translations, see, for example, H. C. BOLTON, "A Select Bibliography of Chemistry, 1492–1892," *Smithsonian Miscellaneous Collections,* volume 36 (1893), pages 68–69. The most common English version of Macquer's *Dictionnaire* usually is thought to be a translation of Macquer's second and revised edition of 1778. However, a comparison of the English "second edition" with the original French first edition reveals only minor changes. Thus, although Robert Schofield has said that Macquer was sending the English translator, James Kier, sections of the new edition as fast as they were produced, it seems clear that Kier's primary interest was in publishing his own revised notes and additions to Macquer's work. In fact, the English second edition appeared in 1777, a year before Macquer's revision was published in France. Macquer's own additions and alterations were published separately by JAMES KIER as *Additions to the Dictionary of Chemistry by M. Macquer* (London, 1779).

[100] MAURICE CROSLAND, *Historical Studies in the Language of Chemistry* (Cambridge, Massachusetts: Harvard University Press, 1962).

☆ U.S. GOVERNMENT PRINTING OFFICE: 1975— 1975 O—575–523