quantitative analysis, the student can be greatly enriched by a course giving the practice prescribed by the majority of our contributors, in the full and reliable qualitative analysis of varied materials. This sort of plan is followed at the University of Chicago. Two quarters are given in elementary qualitative analysis, including an exhaustive analysis of ordinary salt mixtures and twenty or more simple unknowns. "After these two quarters," writes Professor STIEGLITZ, "students are admitted to quantitative analysis and, if they intend to go into technical positions, they take later a third quarter in qualitative analysis, in which they get commercial products, ores, minerals, pigments, some rare element work, cyanides, etc." In the introductory course "special stress is laid also on instruction from the general chemistry point of view." A similar plan is probably in force elsewhere.

Those teachers who wish may also point out in the later course how the nature of the material excludes certain constituents. All should make clear the light that is afforded by the solubility observations. Furthermore, some additional theoretical applications can be elucidated and, in general, an eminently satisfactory and profitable treatment of qualitative analysis concluded. This subsequent finishing-course seems to offer a solution of the main problem of our discussion.

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SUGGESTIONS AS TO CERTAIN DESIRABLE CHANGES IN CHEMICAL NOMENCLATURE.

BY EDWARD BOOTH.

The nomenclature of chemistry is better and in every way more serviceable than that of any of the other sciences, but it is still far from perfect. It has not yet reached the point at which betterment is impossible. This paper is a plea for further improvement. In 1787, a century and a quarter ago, Lavoisier, presenting a paper to the French Academy said: "It is time to free chemistry from obstacles of all kinds which retard its progress, to introduce into it a true spirit of analysis: and it is by the perfecting of the language that this reform is to be effected." And he then proceeded in the same paper to suggest a nomenclature which was promptly adopted by the Academy, which with the few changes and additions required by the growth of the science is still in universal use and which has completely fulfilled the expectations of the great man who devised it.

It is unnecessary to enter into historical details, yet a brief résumé may not be inappropriate. Up to the time of Lavoisier's paper chemical nomenclature was in a chaotic condition very much as are those of some of the other sciences at the present time. Names had been given in most arbitrary and unreasonable ways: sometimes suggested by a physical property, or a fancied resemblance to some material in common use;

sometimes to honor the discoverer or to commemorate the place of discovery; and not infrequently the names were given by the alchemists with the intention of conveying as little information as possible and of adding mystery to a subject which, in the public mind, was closely associated with necromancy and witchcraft. But in the latter part of the eighteenth century chemistry was beginning to emerge from its medieval darkness and the need of a better language had begun to be felt. Various abortive attempts at improvement had been made but it was not until Guyton de Morveau read a paper before the French Academy in 1782 that the subject received the attention that it deserved. Morveau's suggestions did not prove acceptable but they contained the germ of the modern system. The Academy recognized the importance of the matter by appointing a committee consisting of Lavoisier, who was then in his prime, of Fourcroy and Berthellot. These three, aided by Morveau, originated the present system, which was reported to the Academy by Lavoisier and is believed to be mainly his work.

Since Lavoisier's day few, if any, radical changes have been made. Lavoisier realized the true significance of a scientific nomenclature—that it should be founded on underlying principles and should be elastic enough to accommodate itself to the natural and inevitable growth of the science. Yet Lavoisier, sanguin as he was, could never have foreseen the wonderful growth of his loved science, nor have imagined the perfection of the name-system that he recommended. A few changes have been made in the past century but these changes, as to principle, are insignificant; and we are to-day using practically the names advocated by him. Various attempts to improve this system have been made or suggested from time to time, such as the cumbrous method proposed by Gmelin, but nothing has been found equal to the names proposed by the French committee. This paper does not suggest changes in this nomenclature, it recommends a closer adherence to it than has yet been given. We have not yet advanced quite to the point where Lavoisier stood more than a century ago. We recognize the value of a perfect nomenclature, yet we are unwilling to adopt it in its entirety. We still cling pertinaciously and unreasonably to our old errors. We still use names that should have been forgotten long ago. A century ago it was recommended that such unscientific names as oil of vitriol, butter of antimony, liver of sulfur and sugar of saturn should be abandoned and their more scientific equivalents used; but we still talk of aqua regia, cream of tartar, caustic potash, microcosmic salt and a score of others of similar character. We have nearly abandoned liver of sulfur but adhere firmly to flowers of sulfur. We do not now describe lead acetate as sugar of saturn but we haven't entirely abandoned the name sugar of lead.

My work at the University of California brings me in contact every year

with large numbers of students who have studied chemistry in the high schools of the country. These students, when they enter the university, are supposed to have a knowledge of the elements of the subject; and it must be confessed that their knowledge is often very elementary in character. But what smatterings of knowledge they do possess are often partly neutralized by the inconsistencies in nomenclature which they have encountered. The same substances are differently named in different text books, and on entering the university are found to have still other names. One who has not had this experience cannot appreciate its seriousness to the beginner, nor can he realize the time wasted by the student in trying to ascertain whether copper sulfate and cupric sulfate are identical and are both the same as sulfate of copper; whether there is any difference between barium chloride and baric chloride; whether he can use argentic nitrate when his instructions are to use nitrate of silver or silver nitrate. Every one who has had dealings with beginners has had like experiences. And the fault is by no means confined to the elementary schools. It is wide-spread and is, in many cases, the result of carelessness. Old labels and old names are apt to remain even on university shelves; and a student is to be pardoned if he thinks that potassium has a higher valence behind a label of "potassic hydroxide" than behind one of "potassium hydroxide," or if he becomes completely befuddled in trying to ascertain how arsenic trioxide contains less oxygen than plain arsenic oxide. I recently glanced over a number of text books prepared for high school use and noted the variety of names used and the entire lack of harmony. Such variations as caustic soda, sodium hydrate and sodium hydroxide were practically universal and in one case, that of hydrogen sodium carbonate, I found six different names used. Of course, at the same time, it must be stated that in most cases the proper scientific names were used.

I realize that to an older chemist, one who has passed far beyond the alphabet of the science, these criticisms may seem trivial; but to the beginner such difficulties are very real and discouraging; and, as Lavoisier said a century ago—"it is time to free chemistry from obstacles of all kinds that retard its progress."

There is really no good reason why these inconsistencies should continue to exist. We know better and have known better for more than a century. We fully realize the superiority of the scientific method but we do not put it into effect as completely as we should. We use names that should have been long consigned to the rubbish pile, and we do not even use the scientific names themselves with the proper care.

There can be no question as to the desirability of reforms in these directions—the only question being as to the best way of bringing them about. Possibly the most efficient way would be the adoption by the American

Chemical Society of a standard nomenclature. A committee appointed for this purpose could make a report which, if adopted by the Society, would be gladly adopted by the majority of chemists in America. I have suggested a few of the inconsistencies that exist. Some of these might not prove of sufficient importance to correct, and, undoubtedly many exist that I have not pointed out.

In 1881 Prof. A. W. Williamson presented to the British Association for the Advancement of Science a paper somewhat similar in purpose to the one now presented for your consideration. As a result, a committee on the reform of chemical nomenclature was appointed, containing, among others, such eminent men as Roscoe, Dewar and Frankland. Reports were presented on three successive years, 1883, 1884 and 1885. The first of these was merely an application for more time. The others contain much interesting matter and a number of tabulated statements showing the variety existing in the use of different names, but unfortunately not making explicit recommendations for reform. The reports are really more useful as showing the need of reform than as suggesting remedies. Two years before Williamson presented his paper, Watts, who was editor of the Journal of the London Chemical Society, issued a set of instructions on this subject to be used by abstractors of that Journal and if these instructions could be adopted by the American Chemical Society even without change, they would greatly improve the conditions at present existing. It is interesting, as illustrating the lack of harmony existing, that whereas Watts instructed abstractors to use the term "normal" in connection with salts formed by the complete replacement of the hydrogen of an acid, instead of the term "neutral;" yet exactly the opposit use occurs in the report of the eminent chemists who made up the committee of the British Association.

If such a committee as I have suggested should be appointed, its recommendations would, of course, meet with opposition, but opposition never yet prevented the ultimate adoption of improvements. Some chemists of the present day are, undoubtedly, as conservative as their progenitors of a hundred years ago, and will urge the retention of old names like aqua regia merely because they are old. Lavoisier's report had hardly been published before opposition arose. In the *Annales de chimie* for 1789 is a long account of the criticisms made by Gadolin, who asserted that as every one knew the old names, only those should be abandoned that are obviously absurd. And as an illustration he states that every one knows that the saline substance formed by the action of vitriolic acid with a metal is called a vitriol; and he thinks it unwise to change such well-established names, recommending the retention of these names in a slightly modified form as vitriolum potassae, and he further suggested the formation of new names by the use of such terminations as

"atum," "as" and "is;" and he gives as illustrations "phosphoratum ferri," and vitriolas ferri "and vitriolis ferri." Opposition of this kind is to be expected at all times, but may be disregarded.

It is useless to try to present a full list of the existing inconsistencies. The number is larger than one who has not considered the matter would think. But if such a committee as I have mentioned were appointed, I should recommend that it take action on such points as these:

1. That old, unscientific names, many of which are of alchemical origin, should be replaced by their scientific equivalent. This would include such names as aqua regia, microcosmic salt, borax, red lead, magnetic oxide of iron, cream of tartar, tartar emetic, caustic soda, and a score of others.

2. That a definit usage of scientific names be recommended to overcome such inconsistencies as I have already referred to. In his "instructions" Watts recommends that all chemical names be written without the terminations "ic" or "ous," unless it is intended to indicate the valence, and that names like "potassium hydroxide" be used instead of "potassic hydroxide." Such a definit system would be a welcome change.

3. That proper prefixes and suffixes should be used, or where more than one can be used, a selection should be made. Originally "bi" was applied wholly to the negative part while "di" played a corresponding part with the positive. So that "potassium bichromate" was something quite different from "potassium dichromate." It may not be advisable to return to the older usage, but at any rate it would clarify the language if one of the two terminations were abandoned. And this is merely an illustration of numerous similar cases.

4. The partly scientific names given to many substances should be revised so as to make them conform to good usage. This would include such names as silica, alumina, hydrogen sulfide, and probably arsine, phosphine, stibine, etc. In fact the names of the hydrogen compounds are badly in need of scientific revision. Possibly, too, at this place would come such meaningless names as alcohol and acetic acid. Of course, right here, opposition would be very strong.

5. The names of many of the laws and theories should be revised so as to make them as scientific as the names of materials. There is no more reason why a certain doctrin should be called Avogadro's hypothesis than that a certain salt should be called Glauber's salt. We have recognized the folly of the system in connection with the salt; it is time to recognize the folly in connection with the theory. Avogadro and the other discoverers are entitled to all honor, but let us honor them in some other way. Do not let us interpose obstacles in the study of chemistry as a method of honoring these men.

6. The question of reformed spelling should be considered. When a student learns that a sulphide is a very different thing from a sulphite and a sulphate he surely should be pardoned if he thinks that a sulfide is a representative of still another class and a sulfid of a fifth.

I offer these suggestions in the hope that, even if not acted on at the present time, they will cause thought and may be acted upon in the future. I am firmly convinced of the desirability of most, if not all of the changes suggested and I am also firmly convinced that such reforms would make the study of the science far easier for beginners; would remove some of the obstacles to which Lavoisier objected so strongly; and would make the nomenclature of chemistry more nearly perfect than it now is.

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Some of the points which are covered in the preceding paper have already been provided for in the usage of the Journal of the American Chemical Society and Chemical Abstracts. Especially, these journals never use the ending "ic" for elements which have only one valence or where the valence is not specifically in mind. Thus the words potassic and argentic are never used. Also the term hydrate is never used where hydroxide is intended. A good many rules which are followed in these journals will be found in the Directions for Abstractors, which were published in Chemical Abstracts for June 20, 1910. These rules, in the main, follow the usage of the London Chemical Society and are designed to secure as complete uniformity as possible in such matters. Some of the other points brought up by Professor Booth will be considered later by the Board of Editors of the Journal of the American Chemical Society, to whom the question was referred at the Minneapolis meeting.—EDITOR.

INSTRUCTION IN PHYSICAL CHEMISTRY: TWO MODIFICATIONS.[1]

BY RESTON STEVENSON.

In teaching physical chemistry at the College of the City of New York, there have been advantageously introduced two practices which are not common. The first is the use of a station for each experiment instead of a desk for each student; the second is the study and tabulation of the errors involved in each experiment.

1. *The System of Stations.*—No student has a desk with a meager assortment of apparatus that is seldom used. Instead, there is arranged in a series of desks, a large and varied collection of all kinds and sizes of chemical apparatus. In this way, any student has at his disposal a sufficient amount and large diversity from which to make his selection and

[1] Communicated with the sanction of Dr. Charles Baskerville, Director of the Dept. of Chemistry, College of the City of N. Y.