Modernizing the Beginning Course in Chemistry

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We live in a day when modernizing is quite the rage in most activities of life. It is especially important that the subject matter of all our school courses be overhauled frequently. Many of us remember the shock we received when we first found out that the Santa Claus hypothesis was just a childish myth and must be superseded by a new theory more in keeping with the facts. It seems unreasonable to teach in the name of simplification some half truth or outright falsehood which will have to be unlearned later. It has been my experience that the true explanation is usually more easily understood than the so-called simpler outmoded one. The first principle, then, in modernizing a course is to remove from it any statements which will not bear the test of modern knowledge. Some instructors, for example, believe it is right to teach the classical ionization theory to beginners and to teach the modern 100% ionization for strong electrolytes to advanced classes. This results in confusion which could have been avoided since the modern theory is more easily grasped anyway and explains the facts much more fully.

There are dozens of other places where a similar situation is found, a few of these being: valence, oxidation-reduction, acid-base definitions, etc.

Statements are frequently made that the subject matter of chemistry may be given in any order with due allowance for introductory explanation. Perhaps it is partly true, because chemistry in some ways may be compared to a circle in which one may start almost anywhere and fill in until the circle is complete. However, there is a natural order which appeals to me as reasonable. Chemistry deals with matter. Matter is composed of protons, neutrons, electrons, deutrons, alpha particles and what not. Here is a logical place to bring in this matter of ultimate particles instead of in the middle of the year or later as many books do. Furthermore, this information should be used and not just dragged in and then ignored for the older explanations.

Following this, the simpler aspects of atomic structure should be taught, bringing out the importance of the atomic number which leads to the discussion of the Periodic Chart. This latter can not be gone over in detail because the students are not familiar enough with the elements. Nevertheless they can be taught the principles of the groupings of the chart and its uses. After this the chart should be constantly used by the instructor and all possible facts pigeon-holed in it.

In atomic structure, aside from the atomic number, the number of valence electrons is probably the most important factor. The latter should also be stressed as a background for chemical combination and the study of valence.

Following the traditional method, I formerly found the concept of chemical union an extremely difficult one to explain. How is a mixture of 39 parts of potassium and 127 parts of iodine different from potassium iodide? The orthodox answer is that in potassium iodide the atoms are chemically united. But what meaning does this term have? By introducing the concept of electrons, it is very easy to show that in the mixture each atom has its full quota of electrons but in KI an electron originally belonging to the potassium has been taken over by the iodine. This gives the potassium a positive charge since it has lost one negative particle, and the iodine becomes negative since it has an excess of one negative particle. The two charged atoms called ions are mutually attracted to each other and arrange themselves in a definite crystal lattice. In the case of homopolar or covalent compounds the electrons instead of being transferred are shared and so the two elements are held together. In case this seems to be too much of atomic theory, one could just mention that part of the actual substance in the outer part of the atom (which is known to consist of electrons) is transferred to another atom causing the union.

This explanation has something to it, is true and not beyond the understanding of the beginner. Given this information, the student should be called upon to use it frequently. Hazlehurst[1] has pointed out the exact inconsistency in our teaching where we drag in these newer concepts as more or less extraneous curiosities and then fail to make use of them in any real way. As a matter of fact the material just considered is fundamental to chemistry and not just interesting oddities. Hazlehurst also points out another difficulty when we use the word "abnormal" to describe the behavior of electrolytes as to colligative properties. The beginner studies many more electrolytes than he does "normal" solutes. Strictly speaking they are not abnormal since an ion in a salt such as NaCl has practically as much independence as a molecule of sugar and so one should expect it to have a comparable effect on the freezing point lowering and similar phenomena. Moreover the ions in NaCl are charged and so when free to move due to solution in a suitable solvent or after melting they can carry a current, which the particles (molecules) of sugar for example can not do since they are uncharged.

The study of such material as atomic weights, molecular weights, valence, compounds elements, mixtures, chemical and physical change, should be used whenever it fits in with the concepts mentioned above. The study of oxygen, hydrogen, and water, which usually come near the first part of the course, may profitably wait until at least the most of this background material is completed. It will be at once noted that laboratory work suitable to accompany the introductory material will be difficult to find. I have a strong suspicion that that is why oxygen is introduced so early in most courses. With suitable arrangements, the laboratory time may be used for discussion, lectures, and demonstrations as well as suitable movies until a point is reached where laboratory work will fit in. No doubt a complete revamping of the laboratory work is in order anyway. I am one of the many who are unwilling to substitute demonstrations for individual laboratory work, but some change is in order. The newer laboratory manuals are stressing motivation. If some series of laboratory experiments could be derived where there is the element of the unknown as in the case of qualitative analysis, instructors would find the students as industrious there as in the latter.

LITERATURE CITED

1. Hazlehurst, T. H., J. Chem. Educ. *14*, 316-320 (1937).
2. See the J. Chem. Educ. recent numbers for extensive treatment of modernization.