

4, a very unpromising lad during the first semester, made requests at three different times during the second semester to report to the class the results of special work done. This work upon special topics was given to those who completed the work upon the assigned topic sooner than some others. Some qualitative analysis was taken up during the second semester and students had an unknown at hand upon which to work when they had completed the work, upon the regular assignment, earlier than some others in the class. This makes the course elastic enough that the weak and strong student will each get the proper amount of work. In this connection, it is interesting to note that students No. 1, 3, 4, and 11 who were low during the first semester, each completed as many unknowns as any member of the class.

The distinguishing features of our change in technique are: (1) the abolition of required home, or outside study; (2) the adoption of a longer period for class work; (3) the abolition of the assigned lesson from a text book to be prepared at home or in the study hall and hashed over in recitation; (4) the basing of the entire course upon an extensive laboratory and reference study of certain units of subject matter; (5) a topical analysis of the course, at the beginning, into teachable units and the mastery of each unit as a whole.

THE VALUE OF VALENCE AND WHEN TO TEACH IT.¹

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In chemistry as in other science there are, in the main, two things to be considered: Method and results. There is no doubt an enormous mass of facts from which we have to select the indispensable things for the beginner, and again there is the general procedure or method by which those facts have been ascertained.

First: The real value of valence to the student.

It is not my object to discuss this part of the question as fully and in such detail as the second part of the question. The writers of chemistry texts do in general agree as to the value of valence although some give to this subject more space than others. No text gives enough drill on this important subject.

Valence is not a fact. It is an attempt to arrange the facts of our science according to the idea of combining power, just as books are classified in a library to subjects. One of its chief values is to assist the student in becoming familiar with the

¹Read at the University of Illinois Conference, November, 1921.

formulas of the compounds; how and why they are written as they are. We all know the subject of chemistry is filled with formulas and equations and it stands to reason that we should devote the proper time to a subject, which assists the student directly in becoming familiar with this something that stares him in the face almost every time he turns a page. If the student knows valence he can reason the formula of a new compound. If he does not know valence, he must first be told what the formula is and then must simply memorize it.

Valence is the backbone of chemistry. Without valence you are a chemical corpse. Without valence you cannot write formulas, without formulas you cannot write equations. If you cannot write equations it is impossible to either predict or understand chemical changes. If you cannot write equations you are at a loss to solve problems. If you do not know these fundamentals of chemistry you are minus the principles of chemistry; you lack the foundation upon which the chemical world is built.

Second: When to teach valence.

This is a problem that many teachers as well as writers of chemistry texts disagree upon. The main difference comes in trying to answer the following question: Should valence be taught before or after formulas and equations? The writer has tried both methods. When valence was taught *after* formulas and equations, the student seemed to be puzzled throughout the entire course in writing formulas and equations. A test on this was made from two of my classes in chemistry. Fourteen students averaging about the same grades in various sciences were divided into two sections, Section A and Section B. To the seven students in Section A, valence was taught before formulas and equations and to the seven students in Section B, valence was taught after formulas and equations. Please remember that pains and interest were taken in both sections to make the three subjects, valence, formulas, and equations clear. After giving five recitation periods of instruction to each section, the two sections were united and given a quiz consisting of the writing of twenty formulas and twenty equations.

Out of one hundred seventy-five letters mailed to different chemistry teachers over the state, 83 replies of a definite nature were received. Personal letters were not requested but 14 personal letters were received, expressing their experience as to the teaching of valence. In thirty-eight of the replies, the

TABLE I.

Section A.

Total Formulas and Equations	Right	Wrong	% Right
Formulas.....140	127	13	90.7
Equations.....140	121	19	86.4
Average			88.5

Section B

Total Formulas and Equations	Right	Wrong	% Right
Formulas.....140	102	38	72.8
Equations.....140	93	47	66.4
Average			69.6

writer expressed his or her desire to have the proceedings and general data from the discussion on this topic sent to them as they would be unable to attend the convention, but were intensely interested in the subject.

More interesting conditions are revealed as the answers to the eight questions are compiled.

TO CHEMISTRY TEACHERS WHO ARE EITHER TEACHING OR
WHO HAVE TAUGHT CHEMISTRY.

It is with particular interest that I am sending you this questionnaire and I hope you will cooperate with us in discussing this great problem, "The Value of Valence and When to Teach It." You will note in the State High School Teachers' Convention to be held at Champaign, November 18, that this is the topic for discussion in the Chemistry Section.

Let me urge you to be present and be prepared to give us your viewpoint on the subject.

May I ask you to please fill out the blanks in the questionnaire and return them to me at once in the self-addressed and stamped envelope?

I wish to thank you in advance very much for your cooperation.

I assure you that your efforts will be worth while and that we will all benefit by it.

The Value of Valence and When to Teach It.
Questionnaire.

1. Do you teach valence before or after equations and formulæ?
2. Why?

3. Do you find it difficult for the average pupil to understand valence?
4. What textbook are you using in chemistry?
5. Is valence placed in your textbook before or after equations and formulae?
6. Will you try and be present at the State convention and discuss this problem with us?
7. To what extent do you use atom models for making the conception of valence clear?
8. What methods do you use for keeping the idea of valence constantly in the mind of the student?

Your name.....
 School.....
 Address.....

Space does not permit a detailed list of the answers to the questions which were asked in the questionnaire and for this reason the answers have been briefly summarized as follows:

Question No. 1.—“Do you teach valence before or after equations and formulae?” Of those who replied, 33 answered “before;” 26 answered “after;” 18 answered “together;” 4 answered “with formulae and before equations;” and 2 answered “after formulae and before equations.”

Question No. 2. “Why?” Of those who replied “before equations and formulae” there were about fifteen who believed that it was impossible to understand formulae and equations without knowing valence. Four felt that valence, when taught first furnished the answer to questions as to why AgCl and BaCl_2 are written in this particular manner and no other. Two considered the memorizing of the valences of the more common ions and then applying them to the formulae as being easier than memorizing the formulae themselves. Five found that this method served as a direct help in understanding formulae. One reason as given was that without valence you cannot write formulas, without formulas you cannot write equations; if you cannot write equations you cannot predict or understand chemical changes. Also without equations you cannot solve problems. And without these you do not know chemistry nor the principles of chemistry and have no foundation to build upon. Hence this person teaches it before. Another teacher gives a simple talk on valence in the beginning of the course and works it in so that the students understand it thoroughly by the end of the first month. A number gave no specific reason for their answers.

Those who teach valence after equations and formulas submitted the following reasons: Ten thought the learning of formulae and their subsequent use in illustrating valence to be the more logical way. Three believed it better to wait till the

learning of equations and formulas caused the students to ask why the elements united in a definite ratio and then use valence as the answer to his question. Two considered that observation came before equation and hence there was no need for valence till there was something to apply it to. One reason given was that formulas learned first gave a visual aid in writing correct formulas using the valence when it was taught. Another chose to follow the discussion of the Atomic theory with the presentation of valence.

Some taught all three together and the reasons given for this method somewhat overlap those given for the other two methods. They are: Equations cannot be balanced and understood without the conception of valence being introduced simultaneously. Four gave this reason. Three gave their reasons as being the fact that this method gave a better and clearer idea of equations. Another considered it impossible to separate the three in teaching them.

Question No. 3. "Do you find it difficult for the average pupil to understand valence?" 42 replied "no;" 29 replied "yes;" 11 replied "rather," and one replied "depends on the teacher and the text."

Question No. 4. "What textbook are you using in chemistry?" The summary of the answers to this question is: Using "Brownlee and others," 36; using "McPherson and Henderson," 17; using "Alex. Smith," 11; using "C. S. Dull," 6; using "Smith and Mess," 4; using "Morgan and Lyman," 2; using "Hessler-Smith," 1; using "B. F. H. S. and W.," 1; using "Newell," 1; using "mimeographed references," 1; using no book, 1.

Question No. 5. "Is valence placed before or after equations and formulae in your textbook?" 35 replied "after;" 29 replied "after formulas and before equations; 10 replied "before;" 4 replied "together," and 5 did not answer.

Question No. 6. Not relative to the paper itself.

Question No. 7. "To what extent do you use atom models for making the conception of valence clear?" About forty do not use models, while some use various types of models. Diagrams and structural formulas are used to some extent by several replying to this question.

Question No. 8. "What methods do you use for keeping the idea of valence constantly in the mind of the student?" It was found that twenty-two simply refer to it constantly in taking up new formulas and equations and in reviewing the old ones.

Twenty-one use frequent drills in formula and equation writing. Regular review with quizzes was the plan followed by seven and another group of seven used structural formulas throughout the work. Other methods used are: prediction of formulas and equations by valence; use of valence in problems and equations; use of tables of valences in class work; writing the valence of each element in every reaction studied. One teacher made use of frequent reference to his own experience in practical industry showing the value of valence in that connection.

You will notice from the data given that nineteen who teach valence after formulas and equations find it difficult for the average pupil to understand and seven do not find it difficult. Twenty-four who teach valence before formulas and equations do not find it difficult for the average student to understand and nine find it difficult. Eleven who teach the three together say "no," and seven say "yes" to the question. Two who replied "with formulas and before equations" say "no" and two say "yes."

From the replies received you will notice the great difference of opinion on the various questions. Attempts should be made to get together on the methods of teaching valence and its connecting topics. You will agree that the various texts differ extremely as to the order of presentation of these topics. It is true that we all have our individual opinions, but there should be one logical order in which to develop the entire subject.

ANNOUNCEMENT.

"ELECTRICAL ACCESSORIES FOR LABORATORY AND COMMERCIAL USE," is the title to Bulletin 18, recently issued by the Standard Scientific Company, Cor. West 4th and Barrow Streets, New York City. This bulletin describes a new type of Loading Rheostat of the carbon compression design which offers wide range, high efficiency. These rheostats will be serviceable in any electrical laboratory where low resistance and large carrying capacity rheostats are required.

They are particularly good either for charging storage cells or regulating the discharge. The novel feature of these rheostats is the fact that they are unusually compact, and can be readily mounted upon the Edison storage cell making a portable equipment for supplying different loads. The flow of current is rendered gradual by means of a new method of control.

The new types of terminals described are of good design and particularly convenient for laboratory and testing purposes. The substantial character of the entire line adapts them for hard usage.

A copy of the bulletin referred to will be mailed on request.