QUANTITATIVE ESTIMATIONS IN THE QUALITATIVE COURSE

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Whatever the primary objectives of a course in qualitative analysis may be, one of its most important functions is to train the student in the use of laboratory tools and methods. A thorough grounding in laboratory technique should be one of the important results attained by the course; and by laboratory technique is meant not just a certain manipulative skill, but a thorough understanding of the various chemical and physical processes involved in laboratory work. At the same time a careful and painstaking attitude towards details of the laboratory work must be developed.

A method of attaining this objective, which is neither new nor original, consists in the requirement of a moderately precise quantitative estimation of the quantities of the various ions present, each ion being reported in terms of the number of milligrams in the sample analyzed. This system has the advantage of requiring a minimum amount of change in the standard qualitative procedure. It gives the student an excellent idea of the actual weights of material he is handling, and thus of the sensitivity of the tests, a thing which the classification into "large" and "small" quantities fails to do. It also leads directly to the intelligent use of control and blank tests, where the amount of contaminating material is compared directly to the unknown sample. From a practical standpoint, the conditions of analysis correspond more closely to industrial requirements, where the amount of a constituent present is often as important as its identification.

The procedure used in making estimations differs but little from standard laboratory procedure. Each student first runs an analysis on a known solution containing 50 milligrams of each ion in the group being studied, saving each final test in a labelled test tube. After the completion of the known analysis, an unknown solution containing varying amounts of one or more ions in the same group is analyzed in exactly the same manner as the known, each final test being saved for comparison with the known quantities. After the precipitates have completely settled, the student estimates the quantity of each ion by comparison with the known amount, the bulk of the precipitate being assumed to be proportional to the amount of ion originally present. In carrying the unknown solution through the same process as the known, errors due to mechanical losses tend to cancel out. By suitable modifications of the analytical scheme, usually quite minor and readily made, it is easy to obtain an analytical scheme which is satisfactory for this method of analysis.

The precision which the average student is able to attain in quantitative estimations of this sort cannot be judged by any practical analytical standard, but in order to set up a valid system of grading for a class, it is necessary to have a good idea of the precision which is to be expected. A requirement which is not very stringent is to demand that the result lie within limits of 50 and 150 per cent of the amount of material actually present. However, only 56 per cent of the 300-odd ions reported by the class at Knox this year fell within these limits. If the allowable limits of error are increased to 50 and 200 per cent of the amount given, then 67 per cent of the ions given out were reported correctly, so these limits are probably more nearly representative of the ability of the average student. That we can expect better resuls than this from the more skilful members of the class is shown by the fact that the top third of the class reported 82 per cent of their assigned quantities correctly.

It is of some interest to study the effect of the modified procedure on the student. The average student in the qualitative course is apt to be a rather sloppy worker, as he feels that it is possible to obtain a positive test in most cases even if a large proportion of the solution is spilled or otherwise lost. If, however, he is impressed with the fact that to lose a fraction of his precipitate is to ruin his chances of making a good

quantitative estimation, he is going to be much more discreet in handling his materials. There is thus much more incentive for careful and painstaking work, and the results in this direction are distinctly encouraging. Granted that the results of analyses are not so rapidly forthcoming, nevertheless each student, feeling the necessity of recovering every scrap of precipitate, of thorough washing, etc., is much more careful and thorough in his work.

Whether there is a gain in the understanding of the processes comparable to the betterment of the laboratory attitude is perhaps questionable. However, it is doubtless true that the reasons behind the various processes have at least a better chance of being understood, since a little more time is spent on each step of the analysis, and the student has the opportunity to examine each process a little more closely.

In conclusion, it is perhaps fair to state that the results which the student can obtain by a scheme of this sort are not remarkable for their precision, but that they make up for their lack of practical value by their pedagogical value. The extra time and care necessary pay real dividends to the student in increased skill, a sounder attitude towards his laboratory work and a better understanding of the analytical scheme. He is laying a foundation of careful, painstaking laboratory technique which will stand him in good stead no matter where he may go.