

## Competition — 3rd prize

# Analytical Chemistry — today's definition and interpretation

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### Definition

Modern Analytical Chemistry is a science devoted to the analytical cognition of substances: their properties, composition, structure and state, steric and inner relations, behaviour in chemical reaction systems at all levels of the chemical organization of matter — from individual atoms to complex chemical systems, mixtures and reaction complexes. Analytical Chemistry includes the teaching of identification, qualitative and quantitative determination, of analytical separation, transformation and measurement, of analytical characteristics, and the tasks, tactics and strategy for their solution. It also includes, as its inimitable essence, the laws and rules of chemical interpretation of the results of analytical observations and measurements which form the teaching of chemical interpretation. With the development of this teaching, Analytical Chemistry, in the general system of chemical sciences, is gradually acquiring the statute of a science about chemico-analytical conclusions and proofs.

### Interpretation

An adequate definition of Analytical Chemistry can be formulated only by interpreting the goals which the scientific society puts before this branch of chemical science. The goal of the latter is the chemical cognition of substances whose essence is incarnated in two basic approaches — synthetic and analytical. These approaches can be realised in one and the same, or similar, chemical procedure, but are differentiated by the methodological purposes and the goals set. Because of the logic of these goals Analytical Chemistry must be viewed as a science which studies and develops methods, rules and laws of analytical cognition of substances.

When using the word “science” one must keep in mind that this term is used to define many notions; let us single out science as activity and science as knowledge. Knowledge is so to say the superstructure over activity. It appears in and also directs the process of activity; therefore, the essence of activity and the essence of knowledge are mutually conditioned. In order to understand the development of each of these hypostases of science they should be considered together, not mixing them but keeping in mind that even a routine analysis always brings new knowledge and is consequently science.

Chemical means of cognition and transformation of a substance have been distinctive in man's activity from the outset; in the historical past chemistry was mainly analytical.

Up to the end of the 18th century chemists were mainly engaged in analytical processes. Later on, however, solution of analytical tasks began to stand apart, becoming a separate section of chemical activity, and by the mid-19th century Analytical Chemistry was established as a separate branch of chemistry with its own specific methodological and theoretical problems. A broad professional analytical service was born, and the analytical cognition of a substance did not in any way lose its importance as the notion “chemical analysis” began to be connected only with the act of analytical measurement and its preparation. Correspondingly, the notion of analytical activity narrowed.

The attitude of chemists to analytical problems is clearly shown by those tasks and definitions which they themselves attribute to Analytical Chemistry. For analytical activity that has meant studying the composition of a substance, and for analytical science — the development of the general theoretical basis of analysis and the development and perfection of the methods of analysis imply also the determination of the composition.

Penetrating deeply into all the existing definitions of Analytical Chemistry, one can see that they limit the ultimate end of chemical analysis by obtaining the initial results of the analytical measurement. These definitions also limit the tasks of analytical science by assessing the quality of the measurement and by developing new analytical methods. In this way, the chemical interpretation of analytical results — the most important stage of analytical studies — is severed from Analytical Chemistry. The crux of the matter is that the real ultimate end of the analytical studies lies not in obtaining the results of analytical measurements but in the recreation, with their help, of a chemical image of the object researched.

The chemical image of a substance or object is made up of its composition, chemical structure and state, its properties and its behaviour in the system researched. Depending upon the actual analytical task, the chemical image constructed according to analytical data may have different detail and completeness, but for analytical science the main problem lies not in working out the maximum of detail in the chemical image, but in the rules and limits which help to construct this image from analytical data.

It is evident that a chemist who is solving a more general task does not need peaks from various spectra but rather a chemical (for instance molecular) image which reflects these peaks. In other words, a chemist who orders an analysis to be performed does not need analytical values as such but their chemical interpretation, which only a professional analyst can make satisfactorily. Only a chemist who has a good knowledge of both the potential of the method to solve the problem and the analytical artefacts that may arise can do the interpretation.

Only an analyst can know well that one and the same analytical signal may belong to various chemical images, and that the absence of a signal in many cases does not mean that the fragment which could produce this signal is absent; only he knows that the suppression of an analytical signal may be caused for example by admixtures. Therefore the choice of a course of action (method) and the rules of interpretation of analytical results, doubtlessly belong to the sphere of Analytical Chemistry.

The analytical cognition of matter, including the establishment of the chemical nature of most complex objects of biological origin, is based on the treatment of the results of analysis. The chemical image of these objects is built on the

interpretations of analytical data which appear here in the role of analytical proof. Analytical Chemistry today has not yet brought together all the rules for these proofs, but their parts do exist, and the historical tendency is that Analytical Chemistry is gradually acquiring, within the general system of chemical sciences, the status of a science about chemico-analytical conclusions and proofs.

### Conclusion

Analytical Chemistry today is a science of the analytical cognition of a substance. It studies and works out methods, rules and laws for analytical cognition including rules for the chemical interpretation of analytical observation and measurement. Developing this field, Analytical Chemistry today gradually acquires, within the general system of chemical science, the status of a science about chemico-analytical conclusions and proofs.

This point of view was reported by the author at the Conference on the History and Methodology of Analytical Chemistry in Moscow (November 19–21, 1990).