

**THE ELEMENTS OF QUALITATIVE  
CHEMICAL ANALYSIS WITH SPECIAL  
CONSIDERATION OF THE APPLICATION  
OF THE LAWS OF EQUILIBRIUM AND OF  
THE MODERN THEORIES OF SOLUTION**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649572281

The Elements of Qualitative Chemical Analysis with Special Consideration of the Application of the Laws of Equilibrium and of the Modern Theories of Solution by Julius Stieglitz

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**JULIUS STIEGLITZ**

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BY  
JULIUS STIEGLITZ  
PROFESSOR OF CHEMISTRY, THE UNIVERSITY OF  
CHICAGO



THE KENT CHEMICAL LABORATORY OF THE  
UNIVERSITY OF CHICAGO  
CHICAGO (1908)

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Stanhope Press  
F. H. GILSON COMPANY  
BOSTON, U.S.A.

## PRELIMINARY STATEMENT.

PART I of this book, which is in preparation, will contain the theoretical development of the subject of Qualitative Chemical Analysis as presented in the lectures of the author in the University of Chicago for the last thirteen years. It will include a discussion of the development and experimental foundations of the modern theories of solution; of the application of the laws of chemical and physical equilibrium to reactions used in analytical chemistry; of the theory of complex ions; and of the electric theory of oxidation and reduction; all with special attention to substantiating the theoretical treatment by lecture experiments.

Parts II and III, which are given in the present book, include the instructions for laboratory work introductory to systematic analysis and for systematic analysis. The attempt has been made, in particular, to bring the laboratory work, which otherwise follows the usual lines of instruction in systematic analysis, *also into closest relations to the development of the scientific foundations of analytical chemistry*, as presented in Part I. It is believed that the subject matter lends itself especially well to such a close interweaving of the two sides of the study, without any special loss of time to the student, and with the result, it is hoped, of a greatly increased interest on his part and an increased stimulus of the habit of scientific thought.

In the theoretical treatment the author is indebted to the original articles of van't Hoff, Arrhenius, Ostwald, Nernst, Bodlaender, Walker, etc., and, in particular also, to Ostwald's "Wissenschaftliche Grundlagen der Analytischen Chemie" which in 1894 first suggested the teaching of analytical chemistry along the lines followed here. For more extended reference on subjects of descriptive general chemistry, Alex. Smith's "General Inorganic Chemistry" and Remsen's "Inorganic Chemistry (Advanced)" are used. In the systematic analytical treatment, acknowledgment is due especially to Fresenius' Qualitative Chemical Analysis (frequent reference is made in the text to H. L. Wells' translation) and, for some special matters, to the work of W. A. Noyes of the University of Illinois, and of A. A. Noyes, of the Massachusetts Institute of Technology.

Special thanks are due to Professor Lauder W. Jones of the University of Cincinnati and to Dr. H. I. Schlesinger of the University of Chicago for their critical scrutiny and assistance in the preparation of the manuscript and correction of proof.

THE AUTHOR.

CHICAGO, May, 1908.

iii

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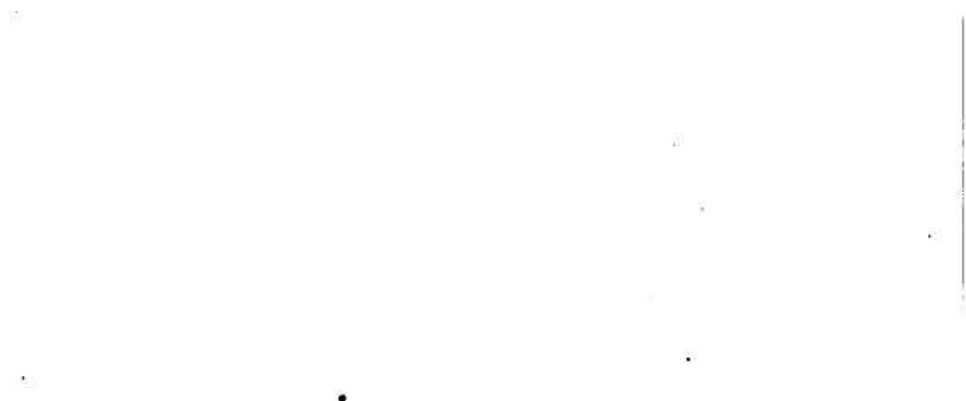


Figure 1: A graph showing the relationship between the number of particles (N) and the number of clusters (C). The x-axis is labeled 'Number of particles (N)' and the y-axis is labeled 'Number of clusters (C)'. The data points form a curve that starts at the origin (0,0) and increases, eventually leveling off. The curve is labeled 'C(N)'. A vertical line is drawn at N=10, and a horizontal line is drawn from the point on the curve at N=10 to the y-axis, indicating the number of clusters at that particle count.

10

10

10

10

10



## QUALITATIVE ANALYSIS.

### PART II

#### A. REACTIONS OF THE METAL IONS

##### THE FIRST OR ALKALI GROUP

*Potassium, K<sup>+</sup>; Sodium, Na<sup>+</sup>; and Ammonium (NH<sub>4</sub>)<sup>+</sup>, Ions.*

1. Test aqueous solutions of each of the following compounds with neutral (violet) litmus paper, comparing the tints with that of a piece of the paper put into pure water:

(a) Potassium, sodium and ammonium hydroxide; test also the vapor above the solutions. Interpret the results.

(b) Sodium chloride, potassium carbonate. The interpretation of the results will be given in the "Aluminium Group."

2. (a) Add a little water to some calcium oxide in a small beaker to slake it, then add a few c.c. of ammonium chloride solution, and place a watch-crystal over the beaker with moist pieces of neutral and red litmus paper sticking to the lower side of the watch-crystal. Judging by 1 (a), would potassium and sodium salts react in the same way as ammonium chloride?

(b) Repeat the test in 2 (a), using lime-water in place of slaked lime. Compare (a) and (b). Which gives the better result? Which will give a more concentrated solution of ammonium hydroxide? Express by the equilibrium law applied to the dissociation of ammonium hydroxide into ammonia and water how the concentration will affect the test.

3. Heat a little of each of the following solid salts in a porcelain dish or crucible with the free flame, but below red heat: potassium, sodium and ammonium chlorides; sodium ammonium hydrogen phosphate. Observe which salts are volatile. If any fumes are given off, test them with moistened neutral litmus paper.

2 QUALITATIVE ANALYSIS.

4. Get 1 c.c. of a 10 per cent solution of chloroplatinic acid from the storeroom.

(a) Add one drop of it to a drop each of solutions of potassium, sodium and ammonium chloride. Is there any difference shown in these tests?

(b) Repeat the tests, but first dilute the drop of each of the salt solutions with 10 c.c. of water. Why does this method of testing not prove conclusively the absence of the metals which according to (a) gave precipitates of chloroplatinates? Evaporate the solutions obtained in (b) to dryness in porcelain dishes over a water-bath, and add two or three drops of cold water to the contents of each dish.

Can we distinguish potassium from sodium salts by this test? Potassium from ammonium salts? According to the result in (b), what are the necessary conditions for applying this test successfully?

5. Heat a little of the following salts on the end of a clean (test?) platinum wire in the non-luminous flame:

(a) Potassium, sodium, ammonium chloride, each separately. Clean the wire until it gives no color to the flame, allow it to cool, touch it with the fingers and hold it again in the flame. What difference is there between the behavior of this minute trace of sodium chloride and the larger quantity of sodium chloride in the flame test?

(b) An intimate mixture (e.g., the mixed solutions) of approximately equal parts of potassium and sodium chloride.

(c) (a) and (b) may be repeated, the flames being examined with the aid of the spectroscope. Consult the instructor.

6. Using the results obtained in 1 to 5, devise a scheme of analysis for detecting potassium, sodium and ammonium salts in the presence of each other, without the use of the spectroscope. Show the scheme to the instructor or assistant and ask for an "unknown."

*Characteristic of the alkali metals is that all their common salts are easily soluble in water. The hydroxides of sodium and potassium are very strong bases, the hydroxide of ammonium a weaker one, but still moderately strong. (Lecture.)*

1. The first step is to identify the problem. In this case, the problem is that the company is not meeting its sales targets. This is a clear and measurable issue that can be addressed through a structured process.

2. The next step is to analyze the data. This involves looking at sales trends, market conditions, and internal factors that may be affecting performance. Data analysis helps to identify the root causes of the problem and provides a basis for developing effective solutions.

3. Once the data has been analyzed, the next step is to develop a plan. This plan should outline specific actions that will be taken to address the problem, including identifying key responsibilities and setting clear deadlines. A well-defined plan is essential for ensuring that the company stays on track and achieves its goals.

4. The final step is to implement the plan and monitor progress. This involves putting the plan into action and regularly checking in on the results. If necessary, adjustments should be made to the plan to ensure that the company is making steady progress towards its sales targets.

5. Finally, it is important to evaluate the results and learn from the experience. This involves reviewing the outcomes of the plan and identifying any lessons learned that can be applied to future sales efforts.