

# CHEMISTRY AT UNIVERSITY LEVEL IN POLAND

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In recent years, an important effort has been made in Poland for re-constructing chemical curricula and chemical education, since the rapid development of science, especially of chemistry, in the economy and everyday life, has made teaching very difficult.

The educational system has been reorganized in Poland three times since 1945. There is a Ministry of Education Council composed of professors of Universities, Technical Universities and other Schools of University, like the Academy of Medicine, Academy of Agriculture and so on.

Working commissions prepare programmes of teaching at university level, for example, a Commission for Chemistry, Commission for Physics, for Mathematics, for Biology, for different Technical Sciences etc.

I would like to make comments about the new programme with some reference to the methods of teaching introduced at my University recently. I must add that this new programme is of an experimental character and must be subjected, in the near future, to some criticism and correction.

We have three degrees in science; Master of Chemistry, Doctor of Chemical Sciences, and Doctor after 'Habilitation' (Doctor Habilitatus)—recently it was Dozent Habilitatus.

The five-year study of chemistry at University is unified. It ends with the Master of Chemistry degree.

The first three years give general background in mathematics, physics and chemistry. The next three years are more specialized ones. In the course of the first three semesters, lectures on general and inorganic chemistry are given. The idea is to give a general background of chemistry with some elements of the theory of bonding, thermodynamics and structure of chemical compounds. These general aspects are illustrated by considering properties and compounds of the main-groups and of sub-group elements.

For the better knowledge and understanding by students of these aspects, the seminars on the above topics are provided from the beginning of the first year of study. For seminar work students are divided into groups, with no more than 25 students in one group. The students prepare papers from the literature. In that way they learn from the beginning how to do self-sustaining individual work and search through the literature. I should like to add that the students really appreciate this type of work and develop enthusiasm for chemistry. At my University we introduced this type of seminar eight years ago, and the results are quite satisfactory now.

At the same time there are also laboratory experiments from general chemistry for better understanding of the basic principles, chemical processes, properties of matter and syntheses of chemical compounds.

Closely connected with general chemical experiments there are also during the second semester laboratory experiments in quantitative analysis, including not only gravimetric and volumetric methods but even instrumental analysis. The higher courses of instrumental analysis (lectures and laboratory) are offered at the sixth semester.

I would like to emphasize that in *all laboratories* (inorganic, analytical, organic, physical chemistry etc.) students are divided either into groups of 12, or 6 to 8 students each, depending on the subject. Each group is supervised by one assistant, who also acts as tutor. In chemical education the physical-mathematical preparation (background) plays a considerable role. For good understanding of mathematical methods there are courses of mathematical analysis which are important in physics and chemistry (for example, differential equations, theory of probability, group theory etc.). The lectures and special exercises which have seminar character extend over two years. The physics lectures, closely correlated with the general chemistry programme and laboratory experiments and calculations are of two years (four semester) duration.

During two semesters there is a course of organic chemistry (third and fourth semesters and laboratory fifth and sixth).

As part of basic theoretical chemistry (during two semesters beginning with the fourth) the problems of quantum mechanics and chemical thermodynamics are discussed. The main topic of the third year is physical chemistry, lectures, calculation, laboratory work and also (at the fifth semester) crystallography courses with consideration of x-ray diffraction methods.

This programme provides general education and makes it possible for more specialized studies. The seventh and eighth semesters—the so-called 'large specialization' studies—include the courses of advanced inorganic, organic and physical chemistry. Every student has to choose at least two of these classes—lectures and seminar or laboratory work. There are also quantum chemistry, chemical physics, nuclear chemistry and chemical technology courses.

Chemical physics comprises physical methods used in structural investigations like spectroscopy, nuclear magnetic resonance, electron spin resonance etc.

At the eighth semester a student is preparing for individual research. For this reason he has to have advanced laboratory studies, which are the preparation for the master theses. During one semester advanced laboratory work includes the solution of an individual problem for every student on the basis of recent knowledge of chemistry and physics. For example, at my University it is a laboratory course of structural research of chemical compounds.

The last, fifth, year of study is generally provided for preparation of the Master of Science Thesis. It is individual work supervised by a professor or sometimes theoretical work, the results of which must be written as a master thesis (small thesis).

For better training in research there are the special 'monographic' lectures on the chosen topics and a student has to be registered. The type (topic) of the special lectures is related to the scientific problems which are

being studied at any particular university. For instance at the Wroclaw University the courses are concerned with structural methods of investigations, spectroscopy, magnetochemistry, applications of isotopes, x-ray diffraction, kinetics, catalysis etc.

For structural research good knowledge of theoretical methods in chemistry is also necessary, as for instance, quantum chemistry methods, especially in application to the solving of chemical bond problems and structure of the solid state.

During the time that master theses are prepared, seminars are given, which are a preparation for the presentation of the results of research against the broad background of literature. The examination and discussion of master theses finish the five years of study.

Finally, a few comments about the second degree, Doctor of Chemical Sciences. Formerly this was obtained by research over five to eight years carried out by assistants or other younger staff of University, finishing with a Doctor thesis examination and public discussion of the thesis. Now there is a graduate three years (or four years) study after the master degree. This contains special lectures, examination and research supervised by professor or dozent (we call him 'promoter'). The Doctor thesis must contain new results and must be written as a monograph and published in one or two papers. By the end, as before, there are examinations and discussion of theses which need two referees.

The third, even higher, degree is the Doctor Habilitatus. To get this degree it is necessary to have published several papers of which one shall be especially important, to have three referees and to conduct a successful colloquium and discussion with members from more than one university.

The Doctor Habilitatus is an independent scientific worker—he can become a supervisor for Ph.D. candidates.

## DISCUSSION

**T. Urbanski** (*Politechnika, Warsaw*)—I would like to add some comments to the paper by Mme Trzebiatowska, by giving a few details on doctor degrees in Poland.

After obtaining the M.Sc. degree (five year course) young men can work for their doctorate (equivalent to Ph.D. in Western Europe and America). This can be done in two ways, either through graduate courses or on the basis of individual work.

The graduate courses are a novelty which were introduced only recently, not only at universities, but also at Institutes belonging to the Academy of Sciences.

The graduate school consists of six to eight courses for the first two years followed by examinations. Simultaneously, a research project is carried out. The participants of the courses receive scholarships and they must not occupy any paid position.

This system is subject to criticism owing to the fact that it is relatively new and untried. There are complaints that the graduate students attending the courses are overloaded with them and have too many examinations. Personally, I feel that there should not be more than three or four courses and examinations, to leave more time for research.

Candidates for Ph.D. by the second method can be enrolled for a degree on an individual basis. They are usually young people working as teaching assistants, high school teachers, or industrial chemists. They carry out research either at the university or at the laboratory where they are employed. The candidate for the degree is advised to read some particular books, to attend some lectures, but only the final examination is formally required. The examination is much more detailed than in the first method. The duration of the work is usually much longer than in the first group and often lasts four to ten years. In all cases the procedure terminates with a public presentation of the thesis, followed by a discussion in public, and ballot by the faculty.

The next higher degree is Dr. *habilitatus* (Dr.habil.) which corresponds to British D.Sc., French 'Dr. ès science', or Italian 'Liberò docente' and gives the right to lecture at universities. To obtain this degree it is necessary to present a number of published papers and one large monograph or 'habilitation' paper which can summarize several years of activity of the candidate. After the papers are accepted by the faculty, the candidate is subjected to a discussion before the faculty and a ballot.

In both cases it is essential that a substantial research thesis is presented and defended in public. For the graduate course student the thesis can be finished in three years but often extends into a fourth year. For the individual Ph.D. candidate working in industry, or as a teacher, it is often eight years or more before the thesis can be completed.