REVISED MINIMUM STANDARDS FOR CURRICULUM FOR UNDERGRADUATE PROFESSIONAL TRAINING IN CHEMISTRY

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In recent years the Committee on Professional Training of the American Chemical Society has followed with interest the many experiments in curricular revision at the college level and the revisions and modernization of secondary school courses in science and mathematics. The Committee is aware that the rapidly increasing scope of chemistry has raised the level of achievement expected of the adequately prepared chemistry major at the bachelor's level. Whether such a student enters directly into the profession or continues with graduate training, he is expected to have a broad, basic knowledge based on physical chemical principles, and he must be ready for almost immediate specialization.

Mathematics and physics underlie physical chemistry which in turn underlies much of modern chemical development. The early introduction of physical chemistry in the college training is desirable and usually necessary as a prelude to advanced undergraduate work in all the other branches of chemistry -- inorganic, organic, analytical and biochemistry.

Adequate preparation must start in the secondary school program. The Committee has prepared a statement regarding this preparation which is now included in the booklet published by the Society entitled "Chemistry and Your Career." This statement is included and appended to these Standards.

The following changes have been adopted in the Minimum Standards. These pertain to the curriculum or minimum course requirements. It is not expected that significant changes will be made in the other sections of the Minimum Standards, such as the Introduction, Faculty, Facilities, and Organization and Budget.

CURRICULUM

1. Chemistry - Although the following requirements are expressed in terms of length of contact of the student with the courses, the intent is to suggest the level and scope which the student should attain upon completion of the program.

An indication of the level of competence is given by the types of questions appearing in the booklet entitled "Planning for Graduate Work in Chemistry." The requirements in terms of lecture and laboratory hours for the courses described in the following, with the exception of the introductory courses, are defined in section (g).

(a) Introductory Courses (General Chemistry and Elementary Quantitative Analysis) - In accordance with the philosophy underlying the changes in the Minimum Standards, the amount of time devoted to these courses is left up to the individual departments. No more than three semesters of lecture and laboratory work should be necessary for this introductory work, depending on the excellence of the high school preparation.

(b) Organic Chemistry - two semesters. The course should include synthetic methods and some discussion of theories. Some training in qualitative organic analysis by modern methods should be included either in the first course or in an advanced course.

(c) Physical Chemistry - two semesters. This course is to be taught as early in the curriculum as adequate preparation in calculus and physics is achieved and is to be started no later than the junior year. Emphasis should be placed on thermodynamics, kinetics, and modern structural concepts.

(d) Analytical Chemistry - one semester. This course requires a prerequisite of one semester of physical chemistry and the second semester of physical chemistry corequisite. The course should include instrumental methods such as spectrophotometric, electro-analytical and chromatographic techniques. Earlier training in the fundamental techniques and theoretical background of classical quantitative analysis is presupposed (refer to paragraph (a) above).

(e) Inorganic Chemistry - one semester. This course requires a prerequisite of one semester of physical chemistry and a corequisite of the other semester of physical chemistry. The course should include the application of physical chemical principles to the study of inorganic systems. Earlier training in descriptive and

synthetic inorganic chemistry and methods of separation of ions in aqueous solutions is presupposed (refer to paragraph (a) above).

(f) Advanced Courses - two semesters. These courses require prerequisites normally including one year each of physical and organic chemistry. These advanced courses may be in any of the fields of chemistry already specified -- organic, physical, analytical, inorganic -- plus

Biochemistry (based on physical chemistry)

Independent Study and Research

Independent Study and Research (including summer research following the junior year) may be used in partial satisfaction of the certification requirement. (It is not necessary that academic credit be earned for the summer research work.)

A course in advanced mathematics or in advanced physics (requiring the use of calculus) may be acceptable as one of the advanced courses.

It is highly desirable that breadth of offering of advanced courses be adequate to provide the student with options.

(g) The lecture work in courses under (b)-Organic Chemistry, (c)-Physical Chemistry, and (e)-Inorganic Chemistry should involve substantially the equivalent of three 50-minute class periods per week for each semester of 15 weeks. For courses listed under (d)-Analytical Chemistry and (f)-Advanced Courses (with the exception of Independent Study and Research) substantially the equivalent of two 50-minute class periods per week for a semester of 15 weeks is a minimum requirement.

A minimum of 180 hours of laboratory work in (b)-Organic Chemistry is required. This total may include laboratory work in both the first level as well as an advanced organic course. However, if the full 180 hours are committed to the first level organic course, any additional laboratory hours for advanced courses such as qualitative organic analysis may be counted as part of the general laboratory requirements for advanced courses.

A minimum of 225 hours of laboratory work in the courses listed in (c)-Physical Chemistry, (d)-Analytical Chemistry, (e)-Inorganic Chemistry, and (f)-Advanced Courses

is required. Any time in the introductory courses (a) is not to be included in this minimum of 225 hours. Independent Study and Research should not ordinarily be counted for more than 45 hours of the requirement of 225 hours.

Although the Committee is reluctant to restrict the action of departments by specifying detailed distribution of laboratory time, it is clear that unsound programs could meet the requirements as stated. For example, if a student were to spend 135 hours in physical chemistry laboratory, and 120 hours in qualitative organic laboratory the required number of hours would have been exceeded even if no laboratory work were done in connection with the course in analytical chemistry listed under (d). Such a program would obviously be inadequate unless an extraordinary amount of modern analytical work were included, with proper study of analytical theory, in the other laboratory courses. It is expected that the allocation of time spent in meeting the 225-hour laboratory requirement will ensure that students receive an adequate introduction to laboratory practice in each of the several specified disciplines.

2. Physics - No change from present Minimum Standards, but present standard will be rephrased to read -- "Physics (a prerequisite to the course in physical chemistry), comprising the equivalent of two semesters of instruction with three lectures or recitations a week and three hours of laboratory a week. If at all possible the subject should be taught with the use of calculus. It is highly recommended that a student have more than one year of instruction in physics."

3. Mathematics - No change from present Minimum Standards, but present standard will be rephrased to read -- "Mathematics, comprising the equivalent of at least one year of differential and integral calculus, including partial derivatives and simple differential equations. The calculus should precede the required course in physical chemistry. Appropriate mathematics beyond the minimum is strongly recommended."

APPENDIX

Statement Concerning Secondary School Preparation from "Chemistry and Your Career" (A Vocational Guidance Pamphlet, Prepared and Distributed by the American Chemical Society)

What courses shall I take in high school effectively to prepare myself to major in Chemistry in college?

Regardless of what branch of science, engineering, or medicine you may later elect to study in college, it is essential to take enough mathematics in high school so that you will be ready to enter the college-level course in analytical geometry and calculus as a college freshman. This will normally entail four years of college-preparatory mathematics in high school. Should you change your mind and major in social science you will still find mathematics helpful. Even if you are not sure of your future plans, do not slight mathematics in high school.

You should take both physics and chemistry in high school. Biology is also desirable. If it is possible for you to elect courses in these sciences based upon such curricular studies as have been prepared by The Physical Science Study Committee, The Chemical Education Material Study, The Chemical Bond Approach or The Biological Sciences Curriculum Study, you should do so. These curricular studies have been supported by the National Science Foundation and represent the collective efforts of many teachers and research workers.

For a language you should elect two, and preferably three or four, years of German. If German is unavailable, French or Russian is an appropriate substitute.

You will need strong training in written and spoken English (preferably four years work), and in the social sciences (two or three years work).

An advanced course in chemistry should not be taken if any of the previous suggested courses is thereby eliminated.

As a prospective chemistry major you should realize that if you enter college without the courses recommended, you may be unable in four years of collegiate training to attain the level which the Committee on Professional Training of the American Chemical Society deems adequate for professional training at the Bachelor's degree and for entrance into graduate training in Chemistry without further course work at the undergraduate level.