WRITTEN SUMMARIES FROM DISCUSSION GROUPS

(Complete reports are available from the secretary - treasurer)

Group 1. PHYSICAL CHEMISTRY LABORATORY MANUAL
Leader: William C. Oelke, Grinnell College

The meeting opened with seventeen interested participants to consider further plans. Five experiments were distributed, with the intention that they will be tested during the year. Forms for reporting these results were also distributed. A standard write-up procedure was adopted for all experiments. It was agreed that the immediate goal is the assembling of many more such experiments, and the discussion that followed concerned various volunteer efforts toward this end.

Group 2. ROLE OF ANALYTICAL CHEMISTRY IN THE FOUR YEAR CURRICULUM
Leader: Eugene Weaver, Wabash College

The discussion of this topic was started with an attempt to define analytical chemistry. The group concluded that analytical chemistry is the science devoted to exact and dependable measurements of constituents. Various possible approaches to the teaching of analytical chemistry as presented at the Atlantic City ACS meeting were reviewed. The almost unanimous feeling of the Bucknell conferees that elementary analytical chemistry could be redistributed among general, organic and physical was reported by the discussion leader. The Bucknell conferees' insistence on an upper level course (after Physical) devoted to analytical chemistry was also noted.

Some areas, such as stoichiometry, ionic equilibrium, free energy, redox and emf's should be introduced in the first year. In doing this, someone suggested that we should "give the students the truth but not necessarily the whole truth." We will need to build on, and add to, these concepts in later courses.

Certain topics could be handled equally well in Analytical or Physical, whichever comes first, such as: physical character of precipitate, colorimetry, errors and handling of data, and potentiometric titrations and pH measurement. Physical properties of compounds (refractive index, viscosity, etc.) and some acid-base titrations could be included in the organic laboratory.

The topics remaining for an advanced analytical course are: analytical separations, chromotography and ion exchange (might have been introduced in organic), applications of radiochemistry, spectrophotometric analysis, and various electrical methods (coulometry, etc.).

Group 3. THE LABORATORY APPROACH OF ORGANIC CHEMISTRY
Leader: Frank Pennington, Coe College

A report from the Organic Group of the Conference on Undergraduate Chemical Education at Bucknell University was read and discussed. The suggestion that the organic laboratory should include more experiments of a quantitative nature was considered. It was suggested that the merit of the suggestion could be tested by each of us initiating and evaluating a few such experiments with the object of comparing notes at the next annual MACTLAC meeting.

Group 3 (con't)

The Organic Group at Bucknell had questioned the place of the standard Qualitative Organic course and wondered if its fate was going to be the same as the fate of Qualitative Inorganic. In discussing this matter a number of people indicated that they were now including some qualitative analysis in their general organic course. It was felt that a separate Qualitative Organic course should be retained, but it should be more realistic and more quantitative.

The use of standard taper in the organic laboratory was discussed. Its greater cost represented an important drawback although there was general agreement that it was educationally desirable. The comment was made that ball and socket joints might be preferable.

Techniques for evaluating the organic laboratory were considered. It was granted that subjective evaluation was necessary. Still practical examinations that measure the ability of the student to see what is wrong with an experimental setup or that analyze his ability to interpret laboratory directions were found to be useful in making an evaluation of the organic laboratory.

Group 4. NEW APPROACHES TO HIGH SCHOOL CHEMISTRY
Leaders: Ed Haenisch, Wabash College
O. T. Benfey, Earlham College

The Chemical Education Materials Study - Ed Haenisch

An account was given of the current status of this study which began under National Science Foundation support early this year. The steering committee for the study is under the chairmanship of Glen T. Seaborg. J. Arthur Campbell is the director of the study. A rather detailed description of the study is contained in a speech made by Dr. Seaborg on the occasion of the dedication of the American Chemical Society headquarters building in Washington and is reported in CHEMICAL AND ENGINEERING NEWS for October 17, 1960, page 97.

During the summer of 1960 the contributors group of the study completed a trial version of the text and the laboratory manual combination entitled "Chemistry-An Experimental Science." These materials are currently being used in twenty-three high schools located chiefly in the Los Angeles and San Francisco areas in California.

The text assumes that students believe in atoms and molecules, but that they do not understand the reasons behind these beliefs. Introductory chapters present an overview of chemistry in terms of the atomic-molecular nature of substances and develop concepts of behavior in terms of atomic theory and energy changes. The periodic table is introduced as a means of ordering chemical information. The second section deals with some of the most basic concepts of chemistry, again from the experimental point of view. Chapters on energy, rates, equilibrium, acid-base, and oxidation-reduction are tied together in terms of the mole concept, the kinetic theory, and the atomic-molecular concept of behavior in matter. Material designed for the second semester begins with a discussion of atomic and molecular structure and of structural relationships in the various states of matter together with their influence on chemical reactivity. The chemistry of carbon and of typical elements in the periodic table is studied, particularly as to the trends in properties as one moves through the rows and columns of the table. Emphasis in these sections is on the experimental approach with the intent of utilizing the materials and ideas presented earlier to tie chemical knowledge together.

The materials will be revised on the basis of this year's trial. Summer conferences will be held this summer at Cornell University and at Harvey Mudd College, where about 100 more teachers will become familiar with the course for use in their high schools in 1961-62. Before the material is released for general publication, it will be revised as necessary on the basis of the 2-year trial.

Group 4 (con't)

In addition to the text and laboratory material, the study will make movies for high school use and sponsor the writing of monographs, some of which will be tied closely to the text material. Others will be designed to widen the contact of the superior student with chemistry.

Information as to the availability of the materials and further progress of the study may be obtained from the director, Dr J. A. Campbell, Harvey Mudd College, Claremont, California.

The CBA Project - Ted Benfey

An account was given of the Chemical Bond Approach Project, now in its second trial year and being tested in over a hundred schools. The course was developed by nine high school and nine college teachers and is supported by a series of grants from the National Science Foundation. Taking as its central theme the major bond types, the high school course attempts to present a unified picture of chemistry rather than a large number of separate topics. Structure is emphasized as well as energy concepts. The course begins with a simple charge cloud model with which a large number of physical and chemical properties of the smaller atoms and their compounds are explained.

The laboratory is designed to parallel closely the material covered in class. The student often has to develop experimental methods on his own. The better students are asked to develop "extensions" of the laboratory assignment.

Earle Scott, presently traveling among the CBA test schools, and Elton Knutsen, a CBA teacher in the Alexander Ramsey High School of St. Paul, participated in the discussion.

Further information may be obtained by writing to the Chemical Bond Approach Project, Earlham College, Richmond, Indiana

Group 5. CHEMISTRY FOR THE NON-MAJOR
Leader: John Coutts, Lake Forest College

No report

Group 6 CURRENT CONCEPTS OF OXIDATION-REDUCTION REACTIONS
Leader: Wilmer Stratton, Earlham College

This group concerned itself primarily with a discussion of the usefulness and limitations of various definitions of redox reactions. It was generally agreed that there is no sharp dividing line between redox and non-redox reactions, since <u>all</u> chemical reactions involve shifts in electron density to a greater or lesser extent. Many reactions accepted as redox reactions do not involve clear-cut electron transfer, but only partial shifts. It was pointed out that there is no completely satisfactory experimental criterion for defining redox reactions. Although the concept of oxidation number has obvious limitations, this appears to be only reasonable basis yet available for defining redox reactions - i.e., redox reactions are those which involve changes in oxidation number. One member of the group raised the question whether Sanderson's "stability ratio" might provide a useful criterion, and promised to do some calculations. It was agreed that the simple and admittedly arbitrary concepts usually presented to freshmen need to be supplemented later with a more complete discussion, including current information of the mechanisms of electron transter reactions. The group discussed some of the recent work on mechanisms, including bridge atom transfer and electron tunneling.

WRITTEN SUMMARIES FROM DISCUSSION GROUPS

Group 1. PHYSICAL CHEMISTRY LABORATORY MANUAL GROUP
Leader: Dr. William C. Oelke, Grinnell College

The physical chemistry laboratory group met to consider further developments on the manual. A motion was passed to the effect that the position of editor be established, that he be the Chairman of the Committee and have power to carry out the usual function as editor and to appoint members of a group known as the Board of Associate Editors. Dr. W. C. Oelke was unanimously elected to this position and reappointed Dr. J. P. Huselton as secretary. Dr. Oelke, who will be on sabbatical, was authorized to write the theoretical portion of the manual with the understanding that he and any others, as authors, will have publishing rights.

The other part of the manual will be flexible. Only workable experiments should be submitted, but three categories are being considered, namely (1) untested ideas, (2) tested experiments, (3) rechecked work. Research-type and open-end experiments are desirable, though some routine-type are needed as are those affording practice in universally-used techniques. Periodical references should be included as well as information about apparatus (home-made and otherwise) as this is often difficult to obtain. Anyone else wishing to be included in the program is invited to send experiments to J. P. Huselton, William Jewell College, Liberty, Missouri. Adequate credit for these is being given in the manual.

In a discussion of methods of financing the manual, it was brought out that conditions for many grants require that the project be well beyond the initial stages. A motion was passed to the effect that the chemistry departments of all MACTLAC schools be asked to contribute $10.00 toward the MACTLAC Physical Chemistry Laboratory Manual in order to getthe project rolling. This request is to be brought before the general meeting. Before adjournment, the group expressed a desire to meet next year at a time that will permit attendance at other MACTLAC discussions.

Submitted by: J. P. Huselton

Group 2. LABORATORY APPROACH TO INTRODUCTORY CHEMISTRY
Leader: Dr. Jay A. Young, King's College

This group participated in a discussion of the functions of the introductory laboratory and the means by which they might be attained. The introductory laboratory has four major functions as outlined by this group. (1) To generate a lively educated interest in chemistry, dependent upon the notion that though much is known, much more remains unknown. (2) To teach the student how to think systematically for himself. (3) To understand that theory and fact are <u>both</u> important, but that theory depends upon fact; hence, in this sense, laboratory is synonymous with chemistry. (4) To acquire, retain, and use information concerning the chemical properties of selected elements and compounds, manipulative skills, the habit and practices of safety and a respect for reagents (as distinquished from the aspects related to safety).

Five approaches were noted by the group which can be used to fulfill one or more of the functions. In practice, an assigned experiment would often incorporate more than one of these approaches simultaneously or consecutively.

A. The student is given specific directions and notes his observed results and makes his calculations on a printed page in appropriated blank spaces.

B. The student is given an unknown, which is known to the instructor, and is asked to determine constituents or composition, or both.

C. The student is directed to perform certain manipulations and observe the phenomena which ensue. This may require information and or methods from a text, reference work or the literature and suitable modification to meet the unique requirements.

D. Identical with C (above) except that the student is required to rely upon what he has previously learned (and remembered) from the classroom and from related prior experimental exercises; he cannot refer to the literature.

E. The student is asked to synthesize a compound, organic or inorganic.

It was suggested (and this is considered to be one of the most important practical results of the discussion) that many of the defects of the cook-book approach could be remedied by using a seminar-like discussion period. This would be in conjunction with but separate from the laboratory work. At this time the reasons why certain manipulative steps were performed are examined, detailed observations are considered, results are interpreted, and other matters are similarly treated by a critical evaluation which is conducted by the students and led by the instructor.

Synthetic exercises can fulfill all four functions, unless the procedure is lifted directly from the printed page with no attempt by the student to adapt, modify, or question. This is probably the weakest in fulfilling function 4 (information) in that the information learned is usually restricted in scope.

Probably, the best practical solution to instruction in the introductory laboratory is to use two or more of the approaches. One can then proportion the emphasis in accordance with the instructor's opinion of the relative importance of the four functions in terms of the probable future curricular plans of his students.

The group expressed a desire to record its recommendations of a minimum of three to four hours of introductory laboratory, per week, for an academic year. Many felt that more time should be available.

Group 3. SEMINAR, WHY? HOW? WITH WHOM? AND ON WHAT?
Leader: Richard Ramette, Carleton College

The discussion began with reports from 10 to 12 schools on the types of seminars which they now have or have had in the past. Quite a variety of approaches were presented, although they appeared to fall into two main categories: (a) research seminars and (b) special topics seminars. In some schools the seminar is required for all seniors while in others it is required only for honors students (especially where it is a research seminar). In a number of schools, juniors are encouraged to attend. In some schools the seminar has the status of a credit course, while in others it is an "extra", non-credit offering. In a few schools, an interdisciplinary seminar is offered in place of, or in addition to, a departmental seminar. Many schools reported some dissatisfaction with their present type of seminar, but have hopes of better things to come. In particular, there is frequent unhappiness with the quality of student preparation for seminar talks -- a frequent criticism was that students seem to be talking to the faculty rather than to their fellow students.

The group tried to outline the purposes for a chemistry seminar as follows:

1. Opportunity for student oral presentations.
2. Opportunity to cover topics not covered in regular chemistry courses, e.g., history of chemistry, philosophy of science, interdisciplinary topics, current research, special topics, use of scientific literature, aspects of teaching, and "socio-scientific" topics.
3. Review and integration of course work (e.g. in preparation for comprehensives).
4. Informal, co-operative atmosphere between students and faculty.

It was agreed that there is need for students to acquire more historical and biographical perspective on chemistry and that it is probably more meaningful to introduce this at the advanced level (where students have greater maturity and more chemical knowledge) rather than the older practice of including it in general chemistry. A number of useful historical and biographical references were recommended, including the following: (1) the Harvard Case Studies, (2) Alembic Club Reprints, (3) Hildebrand, Science in the Making, (4) Hoffman, Strange Story of the Quantum, (Dover paperback), and (5) Jaffe, Crucibles; The Story of Chemistry (Premier paperback).

Special topics which have been used successfully in seminars include: Use of C-12 for atomic weights; chromatography; least squares fit of data; less well-known elements; the electron microscope and other instruments; "sandwich" compounds; structure proofs; radiochemistry; antimatter; and hydrogen bonding.

By "socio-scientific" topics is meant such things as fluoridation of water, nuclear fall-out, etc. Manchester College has used very successfully a series of films put out by the Washington University sociology department on socio-scientific issues.

As a technique to improve the quality of student participation, some schools ask each student to submit a bibliography on his talk, which is mimeographed and distributed to the other students in advance. Another useful technique is to have a series of student talks on a single major topic, thus creating more student questioning and discussion.

Submitted by: Wilmer Stratton,
Recorder

Group 4 TRENDS IN ENROLLMENTS AND DEGREES IN SCIENCE
Leader: Dr. Arild J. Miller, The Institute of Paper Chemistry

Bachelor's degrees now mainly granted by public institutions (about 60% in 1960), while in 1950 about 50% were granted by private colleges.

The number of Bachelor's degrees in Physics and Mathematics is increasing rapidly; in 1958-59 the number of baccalaureates in Mathematics was greater than the number in Chemistry for the first time. There is some evidence to indicate that the number of Bachelor's degrees in Chemistry is again increasing after being nearly constant for several years.

In terms of percentages; the per cent of baccalaureate degrees with a major in Chemistry has been declining since 1947. At the same time the per cent with a major in Mathematics has been increasing, as has the per cent of those in Physics.

The number of doctorates in Chemistry is greater than the number in Mathematics, Physics, or Biology, and has been stable at approximately 1000 per year since 1949. Physics and Mathematics doctorates are lower, and are also stable for the period 1949-1960.

The proportion of Bachelor graduates who attend graduate school in Chemistry has been increasing; in 1957 only 15% of the ACS certified men went to graduate school, while in 1961, 34% attended graduate school.

Possible reasons for the high rates of increase in baccalaureates in Mathematics and Physics were discussed.

It was agreed that data such as that presented by Dr. Miller should be widely disseminated to chemists, teachers, and high school counselors.

Submitted by: W. D. Larson,
Secretary

Group 5 UNDERGRADUATE RESEARCH - SPONSORS AND OPERATION
Leader: Dr. Enno Wolthuis, Calvin College

I. Which Students Should Participate in Research?

A variety of opinions were expressed as to which students should be allowed to do research. Some thought that freshmen and sophomores are capable of a limited amount of research, and that they should be introduced to it as a means of stimulating their interest in chemistry at an early point in their education. Others felt that the first and second year students needed the more conventional introductory laboratory experience in order to acquire the basic experimental skills which are necessary prerequisites to research. It seemed to be generally agreed that research directed at gathering truly new knowledge should be reserved primarily for the upper-class students. It was suggested that selected lower classmen might be allowed to choose a professor and begin to participate in the professors area of research. This relationship would then be allowed to develop into a research assignment for the student in his junior or senior years. This type of program could well include summer research employment of the same student under the supervision of the professor.

II. Type of Research Problems

It was pointed out that developmental research (e.g. developing new or better methods for solving old problems) was as valid a basis for a research problem as so called "basic research" which sets out to find new information. Developmental research is especially important in preparation for industrial research. A problem should be carefully selected such that it will not be too complicated or long. There should be every opportunity for a successful conclusion to the problem within the allotted time. This will give the student a sense of accomplishment and satisfaction. The problem should be sufficiently difficult to challenge the student and condition him to the difficulties and frustrations inherent in research. This will lend a sense of reality to the students experience in chemistry. It is not necessary to pick a problem on the basis of its research value; i.e., its value to providing completely new knowledge. It is better to pick a problem with instructional and experimental value to the student.

III. The Literature Search in Research

The importance of introducing the student to the chemical literature at an early date was stressed. It was especially important to teach them how to use the literature (e.g. Chemical Abstracts, etc.). It was pointed out that it is usually possible to share or borrow books and journals from other institutions. Also, it is possible to obtain photo copies of required literature references to supplement a limited scientific library. It is helpful to first introduce the students to the literature via an assigned literature research paper of some kind.

IV. How to Conduct Undergraduate Research.

The key to successful research is an enthusiastic professor who is active in research. Faculty research is time consuming, and it is important to sell the administration the need for time, money, and man power for research. Research is expensive in both time and money. It is estimated that directing three research students is the equivalent of teaching one course in time and energy consumed. Research may be run as an honors program or as a special course (e.g. "Chemical Research" or "Independent Studies" etc.). However it is done, it was felt that two afternoons per week were a minimum amount of time if anything is to be accomplished. It may prove very helpful to break a problem into several parts and let 2-4 students attack each part as a team effort. Teamwork is good training for industrial research. Usually a senior thesis and oral examination is included in the research program.

Saturday morning was largely devoted to a discussion of sources of support for research. Questions were answered about such support as is provided by NSF, Research Corporation, Petroleum Research Fund, etc. The flexibility of NSF support was stressed and members left the meeting encouraged to apply for funds.