Report of

Seventh Biennial Conference on Chemical Education

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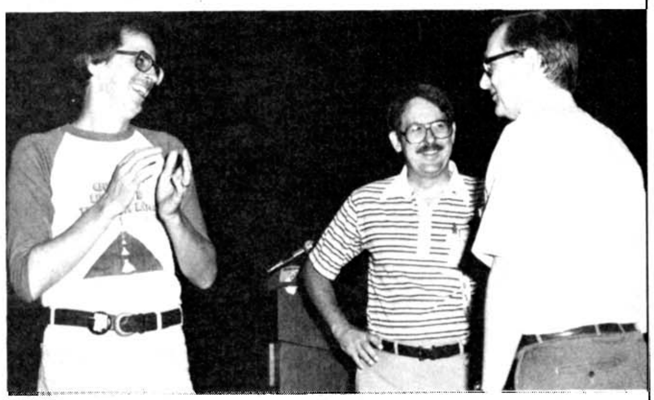

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Plenary Speakers

Ronald M. Haybron
O. Lewin Keller, Jr.
William F. Kieffer
Elaine W. Ledbetter
W. T. Lippincott
Forest L. Poska
Bassam Z. Shakhashiri

Special Projects

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Introduction

It was the best of times, it was the worst of times...
—Charles Dickens, "A Tale of Two Cities"

Chemical education in the United States is experiencing both the best of times and the worst of times. On the one hand, the concern for excellence in instruction, the enthusiasm for sharing chemical knowledge, and the camaraderie among chemical educators is as great now as anyone can remember. On the other hand, the level of public concern for quality science teaching is at a low ebb. Federal support for science education is practically nonexistent; local and state support is indifferent at best. And the quality and quantity of science knowledge of American youngsters lags behind that of virtually every other advanced nation.

Against this backdrop, some 500 chemical educators met at Oklahoma State University last August to assess the condition of chemical education in the United States. The conference theme, "Chemical education ... looking ahead ... looking around ... looking back," reflects our corporate determination to chart a course into the future which anticipates society's needs for the transmission of chemical knowledge by building on the solid foundations of those ideas which have been shown to be effective.

There are, of course, no absolute solutions to problems in chemical education. The dynamic nature of the endeavor is reflected in the variety of solutions which are most appropriate in different places at different times with individual instructors. The session summaries which constitute the bulk of this conference report speak to many of the present concerns of chemical educators. They are the product of the free flow of ideas and represent another iteration in our quest for excellence in the practice of our craft.

I. Dwaine Eubanks
General Chairman

The Report

This conference report is the result of the efforts of 36 reporters whose names, initials, and affiliations are listed below. Since 166 papers were presented at the conference, it is impossible to do justice to them all. Our report attempts to capture the essence of each contribution in just a few sentences. Requests for additional information about a particular paper should be addressed to the author. In preparing the text of this report, only the name of the presenting author has been given, followed by the paper number (from the program) and the initials of the reporter. Full titles and all authors are listed by paper number at the end of each section.

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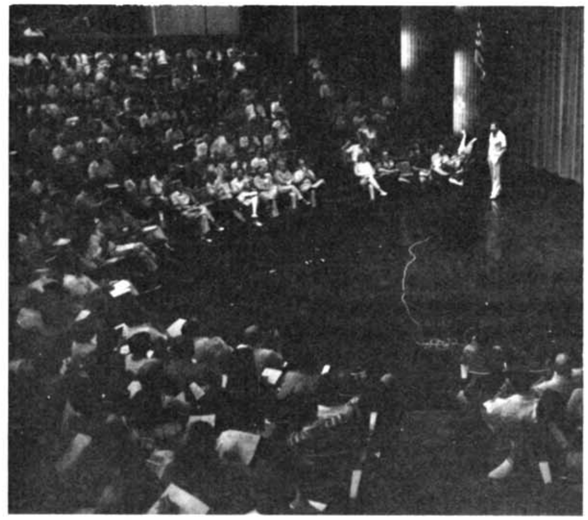
General Lectures: Looking Ahead, Looking Around, Looking Back

Looking Ahead

B. Z. Shakhashiri (*SG1-01, GMB*) led off the conference by urging participants to recommit themselves to chemical education. He likened the problems that confront us to a tidal wave that could innundate us. Shakhashiri challenged participants to defend on moral and scientific grounds the use of chemicals to solve problems of food, energy, and pollution. He called for greater efforts in chemistry courses for those who will not be scientists, for the use of computers as *aids* in our teaching, and for renewal programs for teachers at all levels. He announced the establishment of an Institute for Chemical Education (ICE) at the University of Wisconsin-Madison. Shakhashiri concluded his stimulating address by issuing eight specific challenges to the participants: (1) Increase and improve your own knowledge of chemistry. Make sure you know more chemistry than what is in the books that your students use. (2) Examine your course material and your teaching strategies. If feasible, make appropriate changes. (3) Collaborate with colleagues who teach English and those who teach math to improve your students' abilities to communicate well and to handle numbers. (4) Learn how to use a computer and how to use computers in your teaching. Enslave the computer as an aid to your *teaching.* (5) Establish professional contact with another chemistry teacher in your area. If you teach at the pre-college level, contact a college teacher in your area and develop an arrangement whereby both can meet at least twice a year to discuss matters related to teaching chemistry. If you are an industrial chemist, contact both a college and a pre-college teacher in your area and arrange to talk to their students about a career in chemistry. (6) Spur your ACS local section to conduct programs in chemical education. Be specific in what you suggest and help implement the project. (7) Make a presentation to junior high school students in your area. Emphasize the process of science, the benefits of chemistry, and the safe handling of chemicals. (8) Every month during the two coming academic years, do at least one more lecture demonstration than you have been doing. Display chemical phenomena and illustrate principles. Use each demonstration as a vehicle to teach and not as a magic trick.

F. L. Poska (*MG1-01*, ETW) was also looking ahead in his lecture on the chemistry of synfuels. To obtain convenient gaseous and liquid fuels from coal and oil shale, Poska stated that we need a better understanding of what happens when coal is gasified or liquified, better Fischer-Tropsch catalysts, and catalysts for upgrading coal liquids and the oil obtained from shale. The importance of conversion to our future energy independence and the importance of chemistry to fuel conversion was stressed.

Also looking to the future was **R. M. Haybron** (TG1-01, CLA) in his lecture on science and manufacturing in low-earth orbit. Proposed activities in space during the next five years include increased communications capabilities, remote sensing for potential use in global management of natural resources, the launch of the space telescope to expand greatly astronomical observation capabilities, and advances in materials science and manufacturing in low-earth orbit. The low-earth orbit environment has two characteristics which have important implications for manufacturing: absence of gravity and high vacuum. Zero gravity eliminates density



driven convection currents, sedimentation and buoyancy effects, and hydrostatic pressure (wall effects). Electrophoresis under conditions of zero gravity result in decreased process time and increased purity of product, and this is proposed for pharmaceutical manufacture. Preparation of ultrapure materials in large amounts, preparation of metal foams and new alloys, and supercooling of metals to form glasses are among other processes mentioned for low-earth orbit. Implications for the future include solar collectors which transmit energy to earth as microwave radiation and space communities using materials mined from the moon or near-flying asteroids. The impact of the new tools resulting from the first twenty years of man in space is just beginning to be realized. Educators need to prepare future scientists for the enormous changes they will encounter in their careers.

Looking Around

Shocking, appalling, horrifying, and frustrating were appropriate adjectives to describe the current status of science education as presented by **E. W. Ledbetter** in her general lecture on the Status of Chemical Education in the U.S. In 1982 (*WG1-01*, JMD).

Quoting statistics gleaned from governmental and professional society reports, the speaker indicated the picture is at best bleak. The statistics were highlighted by such facts as: (1) A 68% reduction in employment of new science teachers since 1971, (2) 45% of science and math teachers currently hired are not certified in their areas, (3) the average age of science teachers is 42, (4) 16% of U.S. secondary students take one course in chemistry, while their Russian counterparts take four years.

Three causes were cited: (1) Societal attitudes—an anti-science attitude on the part of the public that science and technology have failed, (2) teen-age employment—75% of secondary school students are employed (this preempts their study time), (3) teacher salaries are not competitive with other professions even when adjusted to a 12-month basis.

To remedy the situation in chemistry the speaker advocated a three-level approach in curriculum: (1) A math-oriented course for students who will pursue scientific careers, (2) an intermediate course for other college bound students stressing the relationship of chemistry to societal and economic problems, and (3) a practical course for terminal secondary students.

Publishers and teachers did not escape indictment: publishers for their reluctance to produce "new" rather than "safe" teaching materials; teachers for their reluctance to depart from classical approaches in order to give students more meaningful content.

In conclusion, Ledbetter called for a concerted nationwide effort by science teachers, professional organizations, and state departments of education to call the attention of legislators to this critical problem. The affiliated organizations of A.A.A.S. are already committed to this effort.

As if the talk were not gloomy enough, several participants also pointed out in the question period that a number of states are in the process of *reducing* science requirements at the secondary level.

Looking Back

Two general lectures with a retrospective view of chemical education were presented by masters of the art of the lecture, W. F. Kieffer and W. T. Lippincott, both former editors of J. CHEM. EDUC. **Kieffer** (*RG1-01*, MWM) outlined changes in chemical education during and subsequent to his tour of duty as editor. The launch of Sputnik by the Union of Soviet Socialist Republics generated profound curricular changes in the United States. The National Science Foundation sponsored CHEM Study and the Chemical Bond Approach. Within a decade, textbooks at both the high school and college level were radically transformed. High level theory trickled down to beginning courses. Focus shifted from moles to molecules. Inorganic chemistry underwent a renaissance. Analytical chemistry was transformed from the old qual-quant wet work to an emphasis on electronic instrumentation.

Lippincott (*RG1-02*, MWM) went back to the very beginnings. The first textbooks of chemistry are believed to have evolved from university chemistry courses taught at the University of Rothenberg an der Tauber, Sedan, and Montpellier from 1592 to 1598. These first academic chemistry courses were conceived and organized primarily to provide medical students with a better appreciation for the nature and production of chemical remedies for illness and disease. The teachers of that period, who appear to have had the greatest long-term influence on chemical education, are also authors of the first two chemistry texts (published in 1597 and 1610)—Andreas Libavius and Jean Beguin. In 1789, Lavoisier wrote his texts using Libavius' basic structure of chemistry instruction. This "textbook tradition" is credited with enabling chemistry to expand continually and improve its influence in the academic world, particularly in the 17th century, but also in the 18th and 19th centuries as well. Some 150 years later, two Scottish chemistry teachers, William Cullen and Joseph Black, made substantial contributions to chemistry, chemical education, and the public image of chemistry. Although both were eloquent and humane teachers with a deep sense of personal integrity, they were also dedicated to developing what was then called chemical philosophy, but which today would be called chemical theory. Just as Cullen and Black earned the greatest respect for their teaching and perceptions of chemistry during the last half of the 18th century, Davy and Faraday won the unrestrained adulation of the social and intellectual elite of London in the early years of the 19th century. They enthralled their audiences, old and young alike, with their brilliant expositions and experimental demonstrations of contemporary science. The teachers in these periods gave chemistry a major lift and a renewed sense of direction without which it could not have advanced as successfully or achieved the level of public acceptance it did. These early chemistry teachers defined and developed the basis for modern chemistry. It may be the destiny of the chemistry teachers of the 1980s to reunify and generalize chemical science so it can be more comprehensible and useful, not only to the lay public but also to preprofessionals in all areas of pure and applied science, even those who would pursue chemistry itself. Valuable legacies have been received, and important lessons have been learned by us as a result of the efforts of our predecessors. Now we must learn from the laetrile situation which showed that the public expects and honors miracles from science but will not yet accept the hard realities that science teaches.

O. L. Keller, Jr., (*WG2-01*, JWH) reviewed the history of the synthesis of the transuranium elements. Developments in the chemistry of these elements led to a reorganization of the periodic table to properly accommodate Th, Pa, and U and to create the actinide series. Use of transuranium elements for space power systems was also discussed.

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(SG1-01) **Chemical Education—Looking Ahead.** Bassam Z. Shakhashiri, University of Wisconsin-Madison, Madison, WI 53706.

(MG1-01) **The Chemistry of Synfuels.** Forrest L. Poska, Phillips Petroleum Company, 266 Research Forum, Bartlesville, OK 74004.

(T1-01) **Science and Manufacturing in Low Earth Orbit.** R. M. Haybron, NASA Headquarters, Washington, DC 20546.

(WG1-01) **The Status of Chemical Education in the United States in 1982.** Elaine W. Ledbetter, 1611 Grape, Pampa, TX 79065.

(RG1-01) **Blast-Off and Reentry: The Space Age Begins for Chemistry in the Classroom.** William F. Kieffer, College of Wooster, Wooster, OH 44691.

(RG1-02) **Lessons, Legacies, and Laetrile.** W. T. Lippincott, University of Arizona, Tucson, AZ 85721.

(WG2-01) **The Transuranium Elements—How to Make Them, How to Work with Them, What They Mean.** O. Lewin Keller, Jr., Oak Ridge National Laboratory, Oak Ridge, TN 37830.

Great Experiments in Chemical Education

W. T. Mooney, Jr., who organized this symposium, was unable to attend the conference. Truman Schwartz presided in his absence.

L. B. Clapp (*RS1-02*, DK) reviewed the history of summer institutes. These began in a small way during the 1940s under the sponsorship of industrial organizations, such as General Electric. The National Science Foundation (NSF) institutes started in 1950, reaching their peak in the mid-1960s, and then declining as appropriations by Congress were cut. These instiues provided a means for communication among high school chemistry teachers and enhanced their knowledge of basic chemistry. Attendance at these NSF summer institutes had a positive effect on the teachers' students and colleagues, as well as on their own morale. This past summer the Dreyfus Institute sponsored an institute at Princeton University; perhaps the summer institute will rise again.

M. Nicholson (*RS1-03*, DK) summarized the history of the CHEM Study Program in high school chemistry, which involved the production of books, lab manuals, 27 topic films, and 17 teacher training films. The books have been translated into 16 languages and the films into 8 languages. CHEM Study books and films are distinguished for their teaching ability, rigor, and orderly presentation. At the height of its popularity, approximately half of the high schools teaching chemistry in the U.S. were using CHEM Study.

B. R. Blaser (*RS1-04*, DK) reviewed the activities of the ACS Committee on Professional Training. One of the important activities of CPT is the monitoring of the ACS Undergraduate Chemistry "Accreditation" program. It also publishes the biennial ACS Directory of Graduate Research which began in 1953. The primary purpose of the CPT is to recommend ways of improving the quality of chemical education in the U.S.

L. C. King (*RS1-05*, DK) recounted the activities of the Advisory Council on College Chemistry (AC_3) which was an independent group of academic chemists formed in 1962 to consider how chemistry teaching might be improved. It effectively ended in 1968 because of lack of funding and was officially terminated in 1970. During its short life AC_3 produced 21 major reports, 17 newsletters, 11 resource papers, 6 books, 34 papers on lab experiments and chemical dynamics, and 49 film loops. It also sponsored (1966–68) 15 regional meetings.

D. A. Daniel, substituting for **M. Passer** (*RS1-06*, DK), reviewed the educational activities of the ACS, which include the High School Chemistry Program, Project SEED, ACS Career Services, the Committee on Professional Training, Cooperative Education, Continuing Education, and support of the Student Affiliate program. The Continuing Education program includes short courses, audio courses, video courses, and computer courses. The High School program includes, a free lending film library and workshops for teachers on such topics as demonstrations and safety.

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(RS1-02) **Great Experiments in Chemical Education: The Summer Institutes.** Leallyn B. Clapp, Brown University, Providence, RI 02912.

(RS1-03) **Great Experiments in Chemical Education: CHEM Study.** Margaret Nicholson, C.S.T.A., Lawrence Hall of Science, University of California, Berkeley, CA 94720.

(RS1-04) **Impact of the Committee on Professional Training on Chemical Education.** Bonnie Blaser, American Chemical Society, 1155 Sixteenth St., N.W., Washington, DC 20036.

(RS1-05) **The AC_3.** Carroll King, Department of Chemistry, Northwestern University, Evanston, IL 60201.

(RS1-06) **Educational Activities of the National ACS.** Moses Passer, American Chemical Society, Washington, DC 20036.

Recommendations of the 6th International Conference on Chemical Education

M. H. Gardner (*WC3-01*, JWH) described the recommendations of the 6th International Conference as a possible agenda for chemical educators for the 1980s. She discussed possible ways to implement these recommendations in American schools. She also surveyed the status of international chemical education in looking ahead to the 7th International Conference in Montpelier, France, in August 1983.

S. Kirchner (*WC3-02*, JWH) proposed the formation of an *ad hoc* "Implementation Committee" to take charge of sending the various recommendations to particular persons in designated groups who would then work on the recommendations. The Committee should follow up to see what progress has been made and inform the international community of chemical educators of this progress.

A. M. Sarquis (*WC3-03*) discussed those recommendations that have special meaning to high school teachers. [The recommendations are listed in J. CHEM. EDUC., **59**, 87(1982).] Sarquis challenged participants to consider the question "where do we go from here?" and made specific suggestions as to what she thought should be done with some of the recommendations.

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(WC3-01) **Recommendations of the 6th International Conference on Chemical Education and a Look to the Future.** M. H. Gardner, University of Maryland, College Park, MD 21157.

(WC3-02) **What to Do with the Resolutions and Recommendations of the 6th International Conference on Chemical Education.** S. Kirschner, Wayne State University, Detroit, MI 48202.

(WC3-02) **Recommendation of the 6th International Conference on Chemical Education and a Look to the Future—Secondary Component.** A. M. Sarquis, Miami University-Middletown, Middletown, OH 45042.

The Chemistry of Everyday

G. Moriber (*MS1-01*, RHH) described the current situation in chemical education and set the tone for the symposium on Chemistry of Everyday. He pointed out that chemical education is at the crisis-end of a cycle and that we can reverse the direction if chemical educators will put more chemical applications into their courses as well as interject their own "force of personality." Chemistry courses must be made more "bearable and humanistic." Teachers will have to get their application examples from industry and other colleagues in education.

J. H. Freeman (*MS1-02*, RHH) described how miniaturization of electronic equipment led to the development of the printed circuit board. The cellulose impregnated phenolic resin boards have given way to woven glass fiber reinforced epoxy resin boards. He described how photographic printing, chemical etching, and the process of simultaneously soldering the connections are used to make a particular circuit.

M. G. Norris (*MS1-03*, RHH) contrasted the mechanism and chemical structure of the older herbicides, 2,4-D and 2,4,5-T, with the newer pyridine systems being studied. Nitrapyrin, a preplant herbicide, is a nitrification inhibitor which puts bacteria that oxidize ammonium nitrogen to nitrite into a "metabolic deep freeze," thus preventing nitrogen loss in the soil. This nitrogen management technique results in disease control, a plant product high in protein, and low in nitrite and nitrate.

L. Benjamin (*MS1-04*, RHH) discussed the physical and chemical structure of hair. He described the physical tests used to measure the thickness, friction, wettability, and stress-strain of hair. The effect of various hair care products was discussed. The chemical reduction caused by the thiol permanents was also presented.

A. J. Rehberger (*MS1-05*, RHH) whetted our thirst for more knowledge of the brewing process. He described the biochemical changes in the nine-day fermentation process, all the way from purifying the water (it's all in the water, you know) to the aging step.

J. R. Hart (*MS1-06*, RHH) told of the many and varied uses of the chemical, ethylenediamminetetraacetate, EDTA, one of the amino-polycarboxylic acid chelating agents used in commercial products. EDTA, as a food preservative, complexes trace quantities of cations which catalyze the oxidation of fats. When used in cleaning formulations, it simply complexes cations to make soft water. EDTA acts as a disinfectant for gram-negative bacteria by complexing the Ca^{+2} ion in the cell structure, thus allowing for collapse of the cell wall. In plant food, cations are incorporated into a negatively charged species, making them mobile in the negative matrix of the soil. EDTA alters the redox potential of complexed ions, and this phenomenon is used in color film processing.

D. B. Bright (*TS1-01*, KOB) discussed cleaning agents "from black oil to clean detergent." Beginning with a brief discussion of the synthesis of ethoxylated alcohols, he then discussed their uses in several types of cleaning agents such as laundry detergents (both powders and liquids), shampoos, dish detergents, and liquid hand soaps. Analyses of several typical products emphasized differences in cleaning, foaming, and other properties dependent on the composition of the preparation.

F. J. Waller (*TS1-02* KOB) gave a presentation which, along with the subsequent paper, formed a pair of discussions on catalytic systems in the transformation of olefins by various processes. In this presentation, Waller described several typical palladium catalysts used in the carbomethoxylation of olefins. Data was presented to demonstrate the effect of acidity on the "turnover" rate. Waller also described the regiospecificity of these catalysts. Other conclusions indicated the cationic nature of the catalysts, the type of dissociative mechanism, and the steric effects important to olefin coordination with the catalyst.

W. C. Drinkard (*TS1-03*, KOB) described the processes related to the hydrocyanation of olefins. He developed data to demonstrate the ability currently available for controlling the extent and direction of additions by the selection of the appropriate catalyst, acidity conditions, and temperature. He listed typical processes in which this type of catalytic system is useful. Specific applications were presented to demonstrate the general application of this process to the transformation of olefins.

M. P. Mack (*TS1-04*, KOB) gave a brief history of drag reducers, compounds which reduce friction and drag on oil as it flows through a pipe. The polymeric material, when added to oil at the level of a few parts per million, has been shown to reduce drag from 10–25%, depending on such factors as specific properties of the crude, the size of the pipe, and the velocity of oil in the pipe. The use of additives in gasoline is well known to the public, but this additive, one which offers significant advantages to the oil industry, is only now being described to the public. Of particular interest is the fact that though the product has a high molecular weight, it apparently produces no subsequent problems in refining.

J. W. Hill (*TS1-05*, KOB) described systems of drugs (alcohol, nicotine, cocaine, barbituates, and phencyclidine) that serve as the basis for the illustration of chemical principles. Typical were discussions of the effect of pH on solubility (due to the fact that most drugs are weak acids or bases), effect of polarity and intermolecular attractions on absorption, the importance of molecular shape on the activity of the drug, and the important principles of chemical equilibria. Hill presented typical problems to illustrate those principles.

D. T. Meshri (*TS1-06*, KOB) gave a review of the history of fluorine compounds to introduce the typical chemistry of those compounds in industrial applications. Typical fluorine compounds were used to illustrate the importance of fluorine in such diverse areas as refrigerants, blood substitutes, tranquilizers and other pharmaceuticals, lubricants, and consumer polymers.

D. A. Katz (*TS1-07*, KOB) demonstrated and described many applications of chemistry commonly found among the toys and magic displays in stores. Demonstrating a variety of chemical systems from soap bubbles and polyurethane foam polymers to Silly Putty® and Magic Sand®, Katz showed the strange chemical and physical properties that make the materials popular. He also described the chemistry and, in some cases, provided recipes for preparation from common materials.

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(MS1-01) **The Chemistry of Everyday: Keynote Address.** George Moriber, Brooklyn College, Brooklyn, NY 11210.

(MS1-02) **Chemistry of Printed Circuit Substrates.** J. H. Freeman, Westinghouse R&D Center, Pittsburgh, PA 15235.

(MS1-03) **Chemical Tools in Agriculture.** M. G. Norris, Jr., Dow Chemical USA, Agricultural Products Department, P. O. Box 1706, Midland, WI 48640.

(MS1-04) **Scientific Studies of Hair as Related to Hair Care Products.** L. Benjamin, Proctor & Gamble Company, Miami Valley Laboratories, P.O. Box 39175, Cincinnati, OH 45247.

(MS1-05) **Brewing Biochemistry and Related Problems.** Arthur J. Rehberger, Milwaukee, WI.

(MS1-06) **Chelating Agents in Everyday Consumer Products.** J. Roger Hart, Organic Chemicals Division, W. R. Grace & Co., Poisson Avenue, Nashua, NH 03061.

(TS1-01) **Synthesis and Application of Ethoxylated Alcohols.** D.

B. Bright, Shell Development Co., P.O. Box 1380, Houston, TX 77001.

(TS1-02) **The Use of Perfluoroalkanesulfonic Acids in the Palladium-Catalyzed Carbomethoxylation of Olefins.** F. J. Waller, E. I. du Pont de Nemours & Co., Central Research and Development Dept., Experimental Station, Wilmington, DE 19898.

(TS1-03) **Synthesis of Chemical Intermediates by the Hydrocyanation of Olefins.** W. C. Drinkard, E. I. du Pont de Nemours & Co., Wilmington, DE 19898.

(TS1-04) **Speeding the Flow of Oil Through Pipelines Using a Polymeric Drag Reducing Additive.** M. P. Mack, Conoco, Inc., R&D East, P.O. Box 1267, Ponca City, OK 74603.

(TS1-05) **Consumer Applications of Chemical Principles: Drugs.** John W. Hill, University of Wisconsin, River Falls, WI 54022.

(TS1-06) **An Exciting Role of the Unusual Element ^{19}F in Our Daily Life.** Dayaldas T. Meshri, Ozark-Mahoning Co., 1870 South Boulder, Tulsa, OK 74119.

(TS1-07) **Chemistry in the Toy Store.** David A. Katz, Community College of Philadelphia, 34 South 11th Street, Philadelphia, PA 19107.

Using "Real World" Examples in the Teaching of Chemistry

J. D. Hostettler (*MC1-01*, NEG) introduced the session with a clarification of his definition of examples that are "real world" and those that are not. He explained why real world examples should be used and described sources of real world examples including texts, magazines, television, science museums, and personal experience. A six-page handout was given to participants.

C. P. Anderson (*MC1-01*, NEG) described an evening course about chemistry of interest to consumers. She told of the widely varying types of students that attend and, using a T-shirt emblazoned with "Chemistry is Entertaining," told of using visiting speakers, plant trips, show-and-tell demonstrations, etc., to maintain high levels of interest.

C. P. Anderson (*MC1-03*, NEG) also described a summer project undertaken by an undergraduate to gain experience in laboratory and research skills. PCBs were used as a readily available toxic substance which can be used without major precaution. The project involved sampling, extraction, concentration by evaporation, thin-layer chromatography, and infrared spectra. It was made clear that special care must be taken in disposal of samples.

J. N. Aronson (*MC1-04*, NEG) described some lecture demonstrations which are given periodically to maintenance crews about substances they use routinely and some of the potential dangers associated with these substances. He described some of the suggestions that were made and other information that was given. He ended his presentation with demonstrations of the flammability of a furniture polish and the generation of Cl_2 from bleach mixed with a strong acid.

H. G. Friedstein (*MC1-06*, NEG) described a workshop on chemistry and cooking—"chemistry used every single day." She gave some brief examples involving toast, hard-boiled eggs, steak, and vegetables. She recommended that teachers consider adding some experiments involving food in order to build interest.

A. W. Kozlowski (*MC1-07*, NEG) has developed a course called "Chemistry in Everyday Life" which includes a two-hour laboratory component. She described three kinds of assignments used to teach certain topics. Preparation of a soluble plant food is used to teach about mass and volume. Preparation of solutions of salt, sugar, bleach, and ammonia were used to clarify the concepts of moles and molarity. Reading labels of common products is a regular exercise.

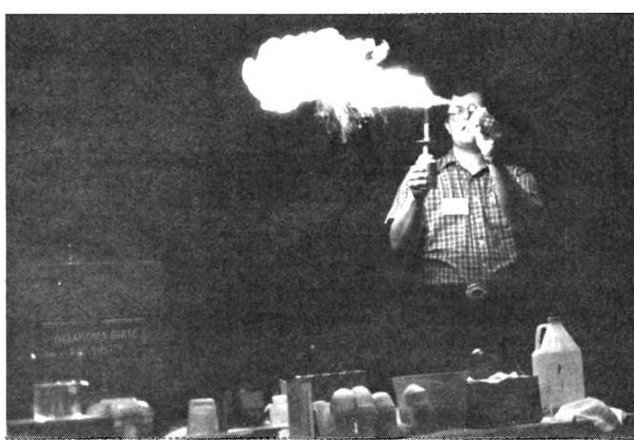
K. W. Watkins (*MC1-08*, NEG) described some experiments he performed on the rates of temperature change versus time using some chemicals and a microwave oven. Polar molecules were found to change the most. The power check equation for microwave ovens (Watts = $\delta T(°F) + 17.5$) was explained, and the idea of friction associated with polar molecules aligning in electrical field was given using the analogy of a rock falling a great distance through water. Some references for further information was given.

A. E. Kruse (*TC1-01*, EK) described five types of activities which he has used at the undergraduate level (nonscience majors) to link chemistry to students' interests outside the classroom: (1) writing by students of one-page analyses of media articles/programs; (2) announcement and discussion of TV science programs; (3) announcement of local science activities; (4) discussion of newspaper/journal articles; (5) inclusion of newspaper/journal articles as testable material. Such sources allow him to adapt instruction to specific student interests. A generous list of sources was made available to those attending the session.

High school students in the classroom of **J. Mattice** (*TC1-02*, EK) are involved in three types of special projects to link chemistry to their lives: (1) students produce a current news booklet, (2) interview a local chemist, and (3) read and report on a technical paper. Students are taught how to perform each activity (e.g., "getting started" questions for an interview are provided). Mattice handed out some practical guidelines for these activities which minimized difficulties and maximized learning.

M. W. Moy (*TCl-03*, EK) described how she uses an eclectic mix of current sources for improving her high school students' attention to chemicals (comics as sources to accommodate low levels of reading; financial page data to relate exotic metal prices to economics and politics). One important focus of her classes is the study of sodium in the diet. The sodium content of common foods and drink was presented. Such content can be used to teach consumer issues and health issues as well as traditional chemical content (such as how to calculate the molarity of Na^+ in various foods.)

R. W. Ridgway (*TC1-04*, EK) made a case for bringing college students and their teachers into the real world of chemical industry through cooperative education and intern programs. Since 61% of chemists work in industry and only 6% of industrial chemists work in basic research, he argued for



a more practical education that includes significant amounts of industrial work. The criteria for a strong co-op program and the advantages of such a program were described.

M. K. Schumm (*TC1-05*, EK) described two projects which students in her sophomore organic laboratory course must perform: dehydration of an alcohol and a multistep synthesis of benzonitrile. The details of both experiments must be worked out by students, requiring them to use and evaluate the literature. Students are taught how to keep a laboratory notebook at a professional level. A final report (including a cost analysis of their products) for each project is required.

G. H. Stevens (*TC1-06*, EK) performed a demonstration which he uses to initiate a discussion of heat versus temperature in his high school classes. He drops several drops of vigorously boiling water on his hand (with minimal damage); then he asks for a volunteer to allow an entire beaker of boiling water to be poured over his/her hand (no takers!). Building on such an intuitive understanding of heat as an extensive property, a discussion of heat versus temperature follows. As a bonus, the polymerization of paper clips (P.C.) into a long chain +P.C.+_n was performed before an appreciative audience.

For ten years **D. R. Weill III** (*TC1-07*, EK) has offered a six-week intensive summer program in environmental chemistry for 20 students. Through field work students experience the evolution of industrial processes and their effect upon the environment. After these experiences, students return to the school laboratory to design and build equipment related to some aspect of their field work (for example, small scale smokestack scrubbers). Discovery learning at its best!

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(MC1-02) **Consumer Questions: How an Evening Course Can Have Answers for the Harried Homemaker.** C. P. Anderson, University of Connecticut at Avery Point, Groton, CT 06340.

(MC1-03) PCB: **Lost and Found.** C. P. Anderson and Sam Hedman, University of Connecticut at Avery Point, Groton, CT 06340.

(MC1-04) **Chemistry Workshops to Prolong the Life of Your Favorite Janitors.** John N. Aronson, SUNY-Albany, 1400 Washington Avenue, Albany, NY 12222.

(MC1-06) **Basic Concepts in Culinary Chemistry.** H. G. Friedstein, Rochester Institute of Technology, 50 W. Main Street, Rochester, NY 14614.

(MC1-07) **A Laboratory Program for a Chemistry in Everyday Life Course.** Adrienne W. Koslowski, Central Connecticut State College, New Britain, CT 06050.

(MC1-08) **Heating in Microwave Ovens: An Example of Dipole Moments.** K. W. Watkins, Colorado State University, Ft. Collins, CO 80532.

(TC1-01) **Chemistry from Outside the Classroom.** Alan Kruse, Pima Community College, 2202 W. Anklam Rd., Tucson, AZ 85709.

(TC1-02) **Special Projects that Relate the Real World of Chemistry to High School Students.** Jacqueline Mattice and Wayne Mattice, 1525 Hood Avenue, Baton Rouge, LA 70808.

(TC1-03) **Chemistry—Is It Useful?** M. W. Moy, University of Houston, Central Campus, Houston, TX 77004.

(TC1-04) **Cooperative Education—Learning About the Real World by Direct Experience.** R. W. Ridgway, Office of Cooperative Education, American Chemical Society, Washington DC, 20036.

(TC1-05) **Touch of Realism in the Sophomore Organic Chemistry Laboratory.** M. K. Schumm, Montgomery College, Rockville, MD 20850.

(TC1-06) **Heat versus Temperature.** G. H. Stevens, Lansing High School, 300 Ridge Road, Lansing, NY 14882.

(TC1-07) **Operation of an Environmental Chemistry Program.** D. R. Weill III, Shady Side Academy, 423 Fox Chapel Road, Pittsburgh, PA 15238.

Coping Strategies

The Changing Student Population

E. S. Kean (*MS2-01*, RGS) gave an overview of problems related to the changing student population. We will have fewer traditional students, but more minority, foreign, handicapped, and older students. They will come to us with such discrepancies as poor reading skills, little experience in formal reasoning, weak problem-solving skills, and poor study habits. The symposium focuses on some possible solutions.

J. M. Daly (*MS2-02*, RGS) uses a group process approach to cope with the problems presented by a nontraditional student population. He feels that group processes minimize external factors such as lifestyle, family background, and psychological differences. He uses group discussion and group assignments in his chemistry course for health science students.

A. B. Swanson (*MS2-03*, RGS) contends that having handicapped students in the classroom can work to the advantage of all the students. At present, 2% of college students are handicapped; that percentage is rising. Barriers to the handicapped are both structural and attitudinal, with the latter the more serious. Swanson discussed special considerations necessary for some handicapped students, most of which are easy to implement. She gave many suggestions for teaching the handicapped in both lecture and laboratory courses. Above all, she stressed that the handicapped are highly individual, and each must be treated as a special case. By paying special attention to teaching techniques and laboratory safety for the handicapped, we can be more effective teachers and have safer labs for all our students.

J. M. Flowers (*MS2-04*, RGS) discussed coping strategies at an urban college with a largely black and hispanic student body. Many of these students have a poor high school background, especially in mathematics, and poor study habits. The college remediation program is excellent, but it is only a partial solution. Flowers gives weekly help sessions, hands out exams from the previous semester, and uses other strategies to reduce anxiety and help the students cope with chemistry. His most important strategy is being available and willing to help his students.

L. T. Pryde (*MS2-05*, RGS) listed a variety of strategies for coping in a community college with 50% minority enrollment. She uses peer tutoring, computer-assisted instruction, test files, and review sessions in her general chemistry course. Pryde also makes extensive use of audiovisual materials and encourages the formation of study groups. Attitude is important for coping. Pryde uses the 5F method—a teacher should be fair, firm, frank, friendly, and (occasionally, at least) funny.

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(MS2-01) **Responding to the Changing Student Population: Why and How.** Elizabeth S. Kean, Chemistry Tutorial Program, University of Wisconsin, 1101 University Avenue, Madison, WI 53706.

(MS2-02) **Old Wine in New Bottles . . . Group Process as a Means of Coping with Nontraditional Students.** J. M. Daly, Bellarmine College, 20011 Newburg Rd., Louisville, KY 40205.

(MS2-03) **Physically Handicapped Students in Your Chemistry Curriculum—Everyone Can Benefit.** Anne B. Swanson, Edgewood College, 855 Woodrow St., Madison, WI 53711.

(MS2-04) **Coping Strategies in General Chemistry at a Minority Institution.** J. M. Flowers, Division of Natural Sciences and Mathematics, Medgar Evers College of CUNY, 1150 Carroll St., Brooklyn, NY 11225.

(MS2-05) **The Special Challenges of Teaching and Learning General Chemistry at a Community College.** Lucy T. Pryde, Southwestern College, 900 Otay Lakes Road, Chula Vista, CA 92010.

Minipapers

C. L. Ayers (*MS2a-01*, AEK) used feedback lectures for her remedial chemistry course. The format consists of a 15–20 minute lecture, a one-or-two question quiz which is immediately gone over in class, another 15–20 minute lecture, and a final quiz. The advantages of this method include reinforcing understanding, facilitating the identification of misunderstandings immediately and increasing students' attention.

J. E. Danieley (*MS2a-02*, AEK) described a modified Keller Plan for his general chemistry class which included students of heterogeneous backgrounds. His method includes videotaped lectures, an extensive study guide, and computer-assisted instruction.

G. Danzone (*MS2a-03*, AEK) related his efforts to incorporate writing in a more structured format in the general chemistry lab. Each lab report includes a memo which summarizes the essential findings of the experiment. This memo is graded solely on the students' writing ability and makes up 10% of the total report grade. As might be expected, the teaching assistants did not initially welcome these new grading procedures, but it appears that the program is now running smoothly.

R. G. Silberman (*MS2a-04*, AEK) has developed twenty new lab experiments based on the learning cycle model of Robert Karplus which consists of an exploration phase, a discovery phase, and an application phase. The students work in groups of three or four, use a notebook format for the write-up, and are graded pass/fail on the basis of how they approach the problem.

P. H. Suter (*MS2a-05*, AEK) found that more and more of her students in general chemistry had been out of school for five or more years. She has used a modified Keller Plan (although tests are given at scheduled times) to help them. The one-year course is available on 46 slide-tape units which the students can check out. She has also found that these older students are very receptive to advice concerning study habits.

J. E. Bauman, Jr., (*MS2b-01*, LTP) discussed the design of a one-semester course for engineering majors. Since this has been taught over a period of 12 years at the University of Missouri, the evolution of the course during periods of rapidly changing enrollments was traced. Problems, solutions, and the future of the one-semester course were discussed.

C. B. Brown (*MS2b-02*, LTP) meets the need for individualized instruction in a first-year high school chemistry classroom by using learning activity packets. The design of these packets and their success in meeting the needs of a wide spectrum of students were discussed.

D. S. Plumlee, Jr., (*MS2b-03*, LTP) described a multifaceted NSF CAUSE project. The project focused on development of curriculum, faculty, and students, looking particularly at the relationship of cognitive style to learning. The end product included microcomputer hardware and software as well as audiovisual materials.

M. J. Pribble (*MS2b-04*, LTP) described an elderhostel program, which is a program of intellectual inquiry aimed at those sixty or older. Very few of the 1982 offerings included chemistry, and the speaker, who has been both a participant and a presenter of a course, urged others to become involved in reaching an audience who might otherwise not have much contact with chemistry. The successful course "Chemistry of Glass" was briefly described.

J. E. White (*MS2b-05*, LTP) addressed the special concerns of older students in general chemistry. Their motivation, maturity, and real desire to learn are sometimes obscured by their poor backgrounds as well as self doubts about their ability to fit in and succeed. It was suggested that the professor can help by being prepared to listen and to be flexible enough to make little concessions that do not compromise standards.

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(MS2a-02) **Personalized Instruction in General Chemistry.** J. Earl Danieley. Elon College, Elon College, NC 27244.

(MS2a-03) **Technical Writing in General Chemistry Laboratory.** G. Sanzone and L. I. Middleman, VPI & SU, Blacksburg, VA 24061.

(MS2a-04) **Learning Cycle Laboratory Program for General Chemistry.** Robert G. Silberman, S.U.N.Y. at Cortland, Cortland, NY 13045.

(MS2a-05) **Teaching the Non-Traditional Student with Supplementary Audiovisual Study Lessons.** Patricia H. Suter. Del Mar College, Corpus Christi, TX 78404.

(MS2b-01) **Chemistry for Engineers.** John E. Bauman, Jr., University of Missouri, Columbia, MO 65211.

(MS2b-02) **Teaching First Year High School Chemistry in a Heterogeneously Grouped Classroom.** Carol B. Brown, Incarnate Word High School, 727 E. Hildebrand, San Antonio, TX 78284.

(MS2b-03) **Preparing for Change with a Cause Grant.** D. S. Plumlee, Jr., Northern Virginia Community College, Annandale, VA 22003.

(MS2b-04) **Elderhostel—An Unusual Opportunity to Teach Chemistry.** Mary Jo Pribble. Glenville State College, Glenville, WV 26351.

(MS2b-05) **The Older Student in General Chemistry.** J. Edmund White. Southern Illinois University, Edwardsville, IL 62026.

Coping with the High Cost of Teaching Chemistry

H. J. Mueh (*MC4-01*, AMW) reported that rising costs of equipment and reagents resulted in the development of microlab equipment made from readily available inexpensive commercial material. One of the first problems encountered is to get the institution to accept the idea of cheaper, smaller equipment, and alternate materials. Mueh showed a student-made analytical balance that cost about 25¢, and he demonstrated making a drop buret from a commercial plastic dropper. Chemical costs are reduced 100:1. Volume of reagents, preparation time, and experimentation time is dramatically reduced. Safety and waste hazards are eliminated when doing the kinetics-I_2 clock-reaction this way, and the error was no greater than before. The cost was about 6% of the original.

M. K. Schumm (*MC4-02*, AMW) discussed how to save money. First the freshman course combined three separate experiments into one by testing the pure alum synthesized from scrap aluminum for purity, water of hydration, melting point, and the gravimetric determination of sulfate. Secondly, the organic laboratories increased the number of analytical experiments and decreased the number of synthesis experiments which saved money on reagents and equipment.

G. H. Stevens (*MC4-03*, AMW) gave a procedure for the reclamation of silver nitrate from solutions used in CHEM Study labs. The purity of the $AgNO_3$ is good enough to use again as a starting solution. Also, a booklet of gold leaf may be used for many things including the replacement of a leaf in an electroscope.

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(MC4-02) **Recycling Materials and Organic Identification without Instruments.** Margot K. Schumm, Montgomery College, Rockville, MD 20850.

(MC4-03) **Savings in Silver and Gold.** G. H. Stevens, Lansing High School, 300 Ridge Road, Lansing, NY 14882.

Coping in Organic Chemistry: What Should Be Left Out?

This discussion (KEK) centered on the content of organic chemistry courses. Apparently few instructors treat all the subject material present in today's massive organic texts in their first year courses. "Special Topics" such as polycyclics, heterocyclics, sulfur and phosphorus compounds, most organometallics, extended treatment of free radicals, and molecular rearrangements are usually omitted. Sugars and proteins, if treated, are done so very briefly. Emphasis today is on mechanistic, logical reasoning based on the study of a rather limited number of organic reactions. Present courses do include a rather extended treatment of modern stereochemistry. Spectroscopy, too, is included with emphasis on proton NMR, some treatment of IR, and a little on mass spectroscopy. Distillation of the massive amount of information available in today's texts is a key function of the instructor.

Laboratory Safety and Chemical Hazards

R. Bayer (*MW1-01*, CEO) listed the objective of the workshop as a means to increase the priorities in all aspects of chemical safety. A variety of practical examples and reference material were available to workshop participants.

J. J. Fitzgerald (*MW1-02*, CEO) gave a short course on toxicology and chemical hazards. A review of various terms was given at the outset. Toxicity and the target organ approach were discussed along with methods to detect and evaluate toxicity in a target organ. Various mechanisms and factors which relate to the entry of particular chemicals into various organs were discussed under the concept of portals of entry.

B. Hudson (*MW1-03*, CEO) challenged the group to begin immediate work on developing departmental or college-wide safety policies and a safety manual. Five specific policies were cited as a model for consideration.

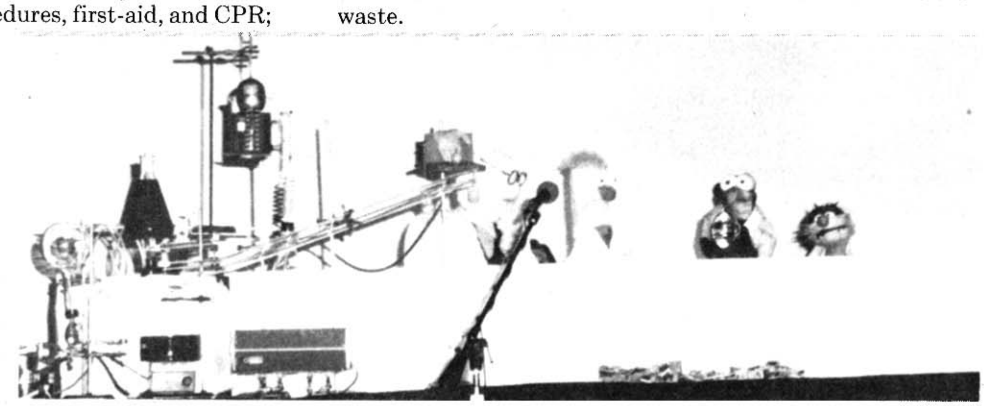
R. Gass (*MW1-04*, CEO), a lawyer, took great pains to explain carefully the legal terminology and principles relating to our legal responsibilities in the laboratory. A general translation of a laboratory instructor's duty to exercise ordinary care includes the following items: warn of hazards involved and demonstrate the essential portion of the activity; actively supervise in person or through suitably trained aides; give academic instruction to make the activity understandable; be trained in emergency procedures, first-aid, and CPR; and finally, be sure that the place of activity is reasonably safe.

R. Watkins (*TW1-01*, JLS) summarized the procedures used at Carroll College to store chemicals. He emphasized that there are no pat answers, but a systematic approach is necessary. The approach will depend upon the local physical layout and evolving information about chemical storage. At Carroll College, chemicals are dated and classified as to shelf life when they are received; then an annual inspection is made to discard those reagents past their assigned shelf life.

R. Bayer (*TW1-02*, JLS) described an experimental approach to determining the adequacy of ventilation. Discussion indicated that adequate ventilation is a universal problem, but there are no easily applied guidelines to follow. Bayer discussed the model Carroll College developed to attempt to evaluate ventilation problems.

R. Watkins (*TW1-03*, JLS) described the Carroll College approach to evaluating experimental hazards. It was generally agreed that students don't appreciate the hazards associated with chemistry laboratories. At Carroll, an objective basis for evaluating student experiment hazards was developed. Each faculty member than evaluated his own experiments with respect to the hazards. Few experiments were eliminated but changes were made in several as a result of the survey.

R. Bayer (*TW1-04*, JLS) discussed the problem of disposing wastes. A detailed model has been developed based upon the capacity of their local community's waste treatment plant. The federal, state, and local guidelines are hard to interpret. Sources of information regarding waste disposal are included in the Program Notes of the workshop. A suggestion was made that students be used to evaluate the levels of waste.



K. Vos (*TW1-05*, JLS) described how the laws governing safety with respect to chemicals have grown in the last twenty years but that these laws only tangentially refer to the teaching laboratory. He emphasized that there are no zero-risk chemicals; a risk/benefit judgement must be made, either by individuals or society. Reasonable risks are acceptable. To decide what a reasonable risk is and to determine how to act, a plan is necessary. Even if data is not unequivocal, it is still best to formulate a plan based on the information available rather than postponing a decision to sometime in the future. Such action will help to insure teaching laboratories are safe to work in and that students are aware of sound safety practices.

M. C. Nagel (*TW1-06*, JLS) discussed the publicity related to school laboratories which is often exaggerated by the media. For students, it is crucial to demonstrate safe lab practices and insist on adherence to these practices in the lab. Again it was emphasized that methodical planning to anticipate problems is required. Information needs to be shared among teaching colleagues, both at secondary and college level.

In the discussion following the papers, teachers were urged to solicit outside help; i.e., industrial safety officers, fire departments, and professional organizations like ACS. The difficulty of finding reliable, and understandable guidelines was discussed. The problem of implementing good safety practices given budgetary constraints was discussed. Administrators must be made aware of problems in writing.

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(MW1-02) **Toxicology and Chemical Hazards.** John Fitzgerald, South Dakota School of Mines and Technology, Rapid City, SD 57701.

(MW1-03) **Departmental Safety Policies.** Bud Hudson, Carroll College, Waukesha, WI 53816.

(MW1-04) **Chemistry and the Courtroom.** Ric Gass, Milwaukee, WI.

(TW1-01) **Storage of Chemicals.** Richard Watkins, Carroll College, Waukesha, WI 53816.

(TW1-02) **Ventilation.** Richard Bayer, Carroll College, Waukesha, WI 53816.

(TW1-03) **Experiment Hazard Evaluation.** Richard Watkins, Carroll College, Waukesha, WI 53816.

(TW1-04) **Waste Disposal.** Richard Bayer, Carroll College, Waukesha, WI 53816.

(TW1-05) **Needs of the Future.** Ken Vos, S. C. Johnson & Son, Inc., Racine, WI.

(TW1-06) **"Safety Tips" for Secondary Teachers.** M. C. Nagel, Avon High School, 510 West Avon Road, Avon, CT 06001.

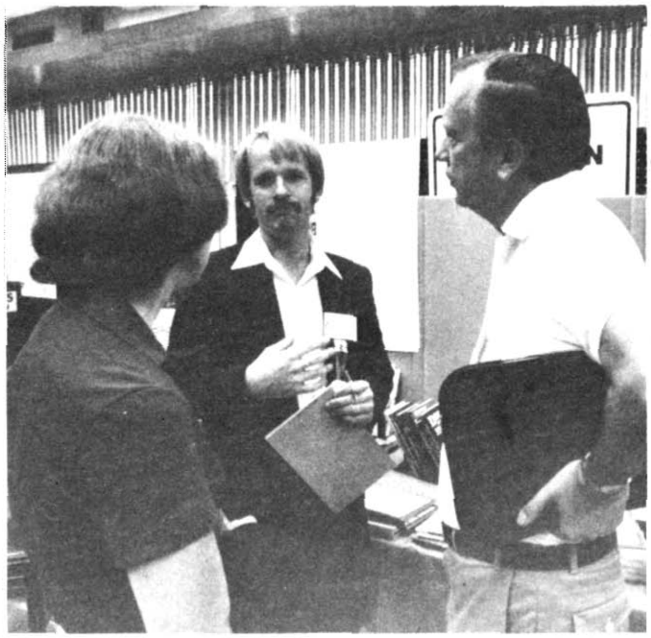
Educational Strategies

D. W. Brooks (*TC3-01*, DER) described a first semester mainstream freshman course he teaches at the University of Nebraska-Lincoln. He uses a combination of techniques emphasizing structured class notes, lap-dissolve slide presentations synchronized by audio-tapes, image-magnified lecture demonstrations, and questioning led by a senior lecturer. This combination of techniques was extremely well received by students. Learning at least equaled if not surpassed that observed with traditional methods. Initial set-up costs were high.

D. A. Daniel (*TC3-02*, DER) updated the services being offered to secondary teachers through the ACS by a slide-tape presentation. Prepared by the Office of High School Chemistry, this presentation discussed all of the services and programs developed for the high school community by the ACS Division of Chemical Education and the Education Division.

J. E. Danieley (*TC3-03*, DER) described a special summer program in chemistry and mathematics underway at Elon College for gifted students who have completed grades 4–9. All the work is done in a laboratory. Experiments are selected so that the students become familiar with some common elements, learn some elementary techniques, perform some simple analyses, and learn some quantitative math when it is appropriate. A number of fun demonstrations are included. Interest was very high, with a demand for repetition the following year.

M. M. Julian (*TC3-04*, DER) described an "abstract reasoning" unit she devised for gifted 4th, 5th, and 6th graders. This unit consists of 3 parts: introductory algebra, geometry, and computing. Topics emphasized were variables and graphing, the postulate system, and an introduction to BASIC, taught to the level of calculating simple averages with NEXT loops. These are principles normally taught to 14–15 year olds. Followup data will be forthcoming during the next school year. This class served as a part of a laboratory school project for the University of Connecticut.



R. R. Festa and **M. M. Julian** (*TC3-05*, DER) described some of the brief biographies of crystallographers written by Julian as contributions to "Profiles in Chemistry," a feature series in J. CHEM. EDUC. Her biographies form an integrated resource as an aid to introducing X-ray analysis and X-ray crystallography into high school and undergraduate courses.

N. Kletzly (*TC3-06*, DER) emphasized "hands on" experiments she uses to develop formal thought processes necessary to understand some of the formal concepts in first-year chemistry. A brief comparison of Piagetian and psychological maturation processes suggested clues to yield a better understanding of these formal concepts. An article on Piagetian processes (*Science Teacher*, V. 49, 1982) was highly recommended.

G. X. Thyvelikakath (*T3-07*, DER) presented a philosophical viewpoint that teachers must assist their students in designing and devising their own methods of learning; i.e., the teacher is only a guide. The main classroom criteria should include a good atmosphere, good attendance, the right attitude, and properly established boundaries.

D. A. Daniel (*TC3-08*, DER) gave a slide-tape presentation introducing 'combating the Hydra,' a middle school/junior high curriculum enrichment unit designed by the ACS Education Division. This unit integrates science and society topics into the general and physical science classroom, presenting material for as many as 20 lessons.

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(TC3-03) **Adventures in Chemistry/Mathematics for Pre-High School Students.** J. Earl Danieley, Department of Chemistry, Elon College, Elon College, NC 27244.

(TC3-04) **Abstract Reasoning and Preparation of Gifted 4th, 5th, and 6th Grade Students in Mathematical Techniques Needed for Quantitatively Analyzing Data from Science Projects.** Roger R. Festa, Dept. of Education, University of Connecticut, Storrs, CT 06268 and Maureen M. Julian, Science Dept., Woodlawn School, 2005 East Main Street, Salem, VA 24153.

(TC3-05) **Introducing Crystallography via Brief Biographies of Crystallographers from "Profiles in Chemistry," A Feature Series in the Journal of Chemical Education.** Roger R. Festa, Dept. of Education, University of Connecticut, Storrs, CT 06268 and Maureen M. Julian, Dept. of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.

(TC3-06) **Right Brain Techniques for Teaching Left Brain Concepts.** Nellie E. Kletzly, C. L. McCullough High School, 3800 S. Panther Creek Drive, The Woodlands, TX 77380.

(TC3-07) **You and Your Chemistry Student.** George X. Thyvelikakath, Oral Roberts University, Department of Natural Science, Tulsa, OK 74171.

(TC3-08) **"Combating the Hydra" ... A Science and Society Curriculum Infusion Experiment.** D. A. Daniel, Educational Services, American Chemical Society, 1155 16th Street, N.W., Washington, DC 20036.

The Art of the Lecture Revisited

D. A. Davenport (JED), the undisputed master of the platform, gave an introduction and overview to the symposium in his inimitable manner. Utilizing slides with selected quotations from Michael Faraday and Lawrence Bragg and "Davenport-style illustrations," he presented "Hints for Lectures." The lectures which followed were given by winners of CMA awards in teaching who had been asked to present "typical teaching as illustrative of the best in our classrooms." It was not unexpected that even these award-winning teachers get so "caught up" in their teaching that they must be reminded that the time has expired and the "class is over." No one can terminate speakers more gracefully than Davenport. The session was unusual in concept and approach and highly appreciated by the participants.

M. N. Gonce (*WS1-01*, JED) made effective use of creatively designed overhead transparencies in her review lecture emphasizing the importance of understanding and using the periodic table of the elements. Her lecture was liberally flavored with her natural good sense of humor as she outlined what the students would be expected to know when tested on some "cold, dark, rainy Friday." Students are fortunate indeed if they have a teacher who has such a good understanding of the chemistry being studied and who communicates so clearly what should be learned and how it can be learned.

J. L. Burmeister (*WS1-02*, JED) expressed the widely held belief that too few students are able to predict the products to be expected from fairly common inorganic reactions. He illustrated his approach to the problem by explaining a mechanistic approach to predicting inorganic reaction products for substitution reactions. His clearly stated analogy to the person who thinks "what would I do?" and his theme "have pair-will share" should make it easier for the student to make more reasonable and dependable predictions and to accumulate a find of chemical knowledge in a relatively painless manner.

J. J. Lagowski (*WS1-03*, JED), after setting up his audience by expressing his doubts about his effectiveness as a lecturer, did an unusual job of debunking the idea that because we "know" that silver chloride is a white solid "under normal conditions" that we also "know" that it cannot be a "pale-green gas" under other conditions. He used the occasion to give a description of matrix isolation spectroscopy and to emphasize that "we know what we know from the results of experiments." The essence of chemistry, he stated, "... is to ask finely-honed questions" starting with experiments and arriving at theory.

D. Kolb (*WS1-04*, JED) used well-designed slides outlining the material covered in her lecture, including photographic slides of appropriate experiments, and live demonstrations to illustrate her introductory lecture on reaction rates. Her engaging manner, her quiet voice, which demands that you listen carefully, and her painstaking efforts to make her points clearly mark her as an award-winning teacher.

E. L. King (*WS1-05*, JED) carefully, clearly, and competently explained the role of entropy change in establishing the position of equilibrium for the vaporization of water and the synthesis of ammonia. Lecturing without notes and making effective use of colorful graphs, he left those of us whose understanding of physical chemistry is "shaky" at best wishing we had him as a teacher. It is refreshing to see and hear such a detailed, carefully organized, and understandable exposition of an important concept.

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(WS1-02) **The Prediction of Inorganic Reaction Products or Silver Chloride is a White Solid.** John L. Burmeister, University of Delaware, Newark, DE 19711.

(WS1-03) **Is AgCl Really a Pale-Green Gas?** J. J. Lagowski, The University of Texas at Austin, Austin, TX 78712.

(WS1-04) **Reaction Rate.** Doris Kolb, Illinois Central College, East Peoria, IL 61635.

(WS1-05) **The Change of Entropy in a Chemical Reaction: Its Role in Establishing the Position of Equilibrium.** Edward L. King, University of Colorado, Boulder, CO 80309.

High School Chemistry

Preparation for College or Preparation for Life?

J. D. Herron (*TC2-01*, RRF) pointed out the concerns of the American adolescent—the student taking high school chemistry. These young people have immediate questions and needs which address their preparation for survival in the world—here and now questions addressing preparation for life. These questions can be answered by the high school program which includes chemistry. For example, quantitative reasoning in chemistry is preparation for life, because students must have math skills and analytical skills to survive. Thus, although chemistry prepares for college, it also prepares for life.

J. A. Harris (*TC2-02*, RRF) suggests two types of chemistry courses: college prep courses and "regular" chemistry courses. Both courses should prepare students for life! Both courses should present scientific knowledge, stress applications, problem-solving, and career information. Varied "relevant activities" are offered to make chemistry a true "preparation for life" experience for general students. These same activities can be accelerated for the college prep course.

E. T. Walford (*TC2-03*, RRF) discussed critical periods in science education: Charles Eliot/Josiah Cooke and the lab-only curriculum, and Sputnik and the CBA/CHEM Study revolution in chemistry. The latter came to an end when it was recognized that the curriculum was too quantitative and was only addressing the top students. Thus, fewer students are taking chemistry today (16%), but the same number of students (2%) are entering chemistry as a profession. Thus, fewer nonscience students are taking chemistry in high school. These are the "general students" who will need chemistry as a preparation for life. Elective systems allow students to opt out of science when science is NOT a graduation requirement. The McMaster conference recommendations were considered, including the addition of more descriptive chemistry and the elimination of more theoretical materials. Thus, we want to present a curriculum which will address the life needs of the students.

J. A. Bell (*TC2-04*, RRF) described a 1924 study which suggested that the lab should be the center of the curriculum. But who takes chemistry? College-bound students, so their academic needs should be addressed! When we succeed in attracting more students (general students) into high school chemistry, they must be prepared for life. Bell's three recommendations are "The teacher—the teacher—the teacher"—The chemistry teacher matters most!

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(TC2-01) **High School Chemistry—Preparation for College or Preparation for Life?** J. Dudley Herron, Department of Education, Purdue University, West Lafayette, IN 47907.

(TC2-02) **High School Chemistry: Making It Relevant for All Students.** Jan. A. Harris, Cy Fair High School, Rt. 12, Box 8B, Houston, TX 77040.

(TC2-03) **High School Chemistry—Preparation for College or Preparation for Life?** Edward T. Walford, Cheyenne Mountain High School, Colorado Springs, CO 80906.

(TC2-04) **Who Takes High School Chemistry Anyway? Shouldn't They Get What They Need?** Jerry A. Bell, Simmons College, Boston, MA 02115.

Working Conditions for High School Chemistry Teachers

G. A. Crosby (ELS) reported that the Society Committee on Education recommends guidelines similar to those of the American Association of Physics Teachers. The overwhelming majority of those present voted that such guidelines, supported by the ACS, would be helpful. The guidelines should consider class size, safety, professional growth, facilities, and funding, among other issues. Comments are invited. Send them to G. A. Crosby, Department of Chemistry, Washington State University, Pullman, WA 99164.

Continuing Education for High School Chemistry Teachers

E. R. Bank (*WC2-01*, JEW) described a series of workshops for high school teachers. The workshops were held on one Saturday per month for nine months, lasting about ten hours. Some participants earned one quarter-hour credit by formally registering and paying a small fee. The topics covered in the first two years and those planned for the 1982–83 were listed. Following formal presentations in the morning, usually made by a local professor or teacher, the afternoon is devoted to informal activities such as field trips and sharing of demonstrations. A few biology and physics teachers have joined the chemists, and enthusiasm of participants has been high, some traveling 150 miles. A booklet is being prepared as a guide for organizing such a program.

J. A. Bell (*WC2-03*, JEW) discussed revival of the summer institutes. In the summer of 1982, fifty high school chemistry teachers participated in an institute which was supported by the Dreyfus Foundation through a grant to the Woodrow Wilson National Fellowship Foundation. Following the theme of "Electrons in Motion," one week each was spent on study of molecular bonding, electron transfer processes, kinetics and catalysis, and how people learn. Supplementary activities included instruction on the use of computers in teaching and development of demonstrations and labs. Packages of curricular materials were developed for the first three areas listed. Also there is a listing of available computer programs, arranged by category and rated as to usefulness. The next stage is "outreach," in which the participants, now designated "1982–83 Dreyfus Master Teachers," will pass on to local and state colleagues their rejuvenated enthusiasm and new knowledge and will explain the prepared materials. This may occur in workshops, at conferences, or by other means. Whether additional institutes will be funded is uncertain, but this one may encourage further use of private funds to provide continuing education opportunities for high school chemistry teachers.

Four of the participants in the Dreyfus/Wilson Summer Institute (see previous paper) gave their impressions and comments (WC2-03, JEW) and helped the director (J. A. Bell) in answering questions. Although the Institute activities had moved at a rapid and tiring pace, all teachers were quite enthusiastic. All had become intimately and personally involved in work groups and in preparation of the curricular materials. Particularly exciting was the interchange between concerned persons focusing on the teaching of students. Valuable contributions and stimulation came from guest speakers who spent one or two days with the group. The general discussion and questioning by the audience revealed a great interest and a desire for more such institutes to reach more teachers. It was pointed out that participants did not receive a stipend but were reimbursed for costs. Procedures for distributing the packages of materials have not been determined. Perhaps local ACS sections will assist the Master Teachers by sponsoring meetings and duplicating the packages. The material is not copyrighted. In Texas, some Master Teachers are arranging to appear at meetings and conferences. Publicity will appear in *Chemunity* and THIS JOURNAL. It is hoped that other private foundations will make grants to support similar programs.

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(WC2-01) **Saturday Workshops for High School Teachers.** E. R. Bank, Westminster High School, Westminster, CO.

(WC2-02) **Summer Institutes for High School Chemistry Teachers: A New Beginning?** Jerry A. Bell and Judith Himes, Woodrow Wilson National Fellowship Foundation, Box 642, Princeton, NJ 08540.

How Can High School Teachers Get Help from Industry?

G. A. Stahl (*WC4-01*, JWH) described a workshop and science circus for science teachers. An evening lecture was followed the next day by more lectures, demonstrations, and exhibits. The purpose was to stimulate communication between teachers and research scientists.

Bibliography

(WC4-01) **Green County Science Teachers Workshop.** G. Allan Stahl and Jerry W. Regan, Phillips Petroleum Company, Research Center, Bartlesville, OK 74004.

High School Chemistry Texts: Form and Function

D. Gabel (*RS2-01*, BRC) stated that textbooks have a great influence in what is taught. Recent texts have greatly increased content although the length of the textbook remains approximately the same with large increase in theoretical treatment. Attempts to condense material have resulted in a decrease in basic qualitative introduction of concepts, resulting in memorization without understanding. Improvements in texts have been made mainly in teaching aids.

W. N. Moore (*RS2-02*, BRC) of Holt, Rinehart and Winston, contends that there have been great changes in publishing and marketing of chemistry texts. The recent increase in the number of chemistry texts and costs of publication present problems to publishers. Moore feels that the practice of state adoptions impedes progress in textbook changes. Changes in texts are possible but radical innovations are extremely difficult to implement.

J. D. Herron (*RS2-03*, BRC) holds that teachers and textbooks are the first and second most important factors in teaching. Textbooks should be effective teaching tools and should be carefully chosen by teachers on the basis of contents in relation to the existing context of students. Herron says that the types of questions in texts greatly influence the level of learning. Good teaching methods should have a major influence in texts.

J. W. Ring (*RS2-04*, BRC) holds that a course should be considered with the teacher as translator to relate phenomena to basic principles. Texts can be considered on the basis of the relation of a number of focusing statements to relational statements employed and to the space given to difficult subjects.

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(RS2-02) **Who Teaches High School Chemistry?** W. N. Moore, Holt, Rinehart and Winston, 383 Madison Avenue, New York, NY 10017.

(RS2-03) **What Research Says and How It Can Be Utilized.** J. Dudley Herron, Department of Education, Purdue University, West Lafayette, IN 47907.

(RS2-04) **A Technique for Assessing Conceptual Development in Chemistry Texts.** John W. Ring, Harding Senior High School, St. Paul, MN.

Measurements, Standards, and the SI

D. T. Goldman (*MC2-01*, PHS) reviewed the history, present status, and possible future of SI. SI had its origin in a resolution adopted by the National Assembly of Revolutionary France in 1791. The British Association for Advancement of Science proposed centimeters-gram units, and introduced the concept of the second as a fundamental unit. The Convention of the Meter (1875) established an International Bureau of Weights & Measures and a general conference on weights and measures to approve actions taken. This is composed of about 30 scientists today whose job is to oversee standard measures used by various countries. After World War II a single system, MKSA, was adopted by all signatory countries of the Meter Convention. In 1960 this became SI with six base units. In 1971, a seventh base unit—the mole—was added. These units cannot be derived from one another. A new definition of the meter will be issued late in 1983.

W. G. Davies (*MC2-02*, PHS) presented the algebra of units. Units will cancel only if we handle the algebra correctly. SI lends itself to this. Dimensions must be the same on both sides of equality. If we divide two things with different dimensions, a pure number does not result. Teachers must be consistent in the use of algebra.

W. C. Fernelius (*MC2-03*, PHS) noted that recent printings of the periodic table have the letters "A" & "B" displaced. This has led to much confusion. Future confusion can be averted by adopting a system for designating periodic groups which does not use "A" & "B" designation for subgroups.

R. D. Freeman (*MC2-04*, PHS) discussed the new standard-state pressure unit which has been changed from 1 standard atmosphere to 1 bar (10^5 Pa or 100 KPa). This has already been published by NBS in "Selected Values of Chemical Thermodynamic Properties." This runs counter to a long tradition of the standard-state pressure being defined as 1 atmosphere and will require recalculation of thermodynamic tables.

Freeman (*MC2-05*, PHS) also recounted that we don't have a name for the concept of the mole. Freeman introduced a new term to describe a quantity of matter by specifying both the number and kind of matter. Freeman introduced the name "numerity" because that name connotes number and the initial letter corresponds to the IUPAC symbol for "amount of substance."

G. Gorin (*MC2-06*, PHS) suggests the term "chemical amount" as more representative of "amount of substance" or the mole. The use of this name facilitates the definition of derived quantities such as molar mass (mass/chemical amount) and concentration (chemical amount/volume).

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(MC2-02) **The Algebra of Units.** W. G. Davies, Hampden-Sydney College, Hampton-Sydney, VA 23943.

(MC2-03) **Confusion in the Periodic Table of The Elements.** W. Conard Fernelius and Warren H. Powell, Kent State University, Kent, OH 44242 and Chemical Abstracts Service, Columbus, OH 43210.

(MC2-04) **The New Standard-State Pressure—1 bar (10^5 Pa).** Robert D. Freeman, Oklahoma State University, Stillwater, OK 74078.

(MC2-05) **Crucial Difficulty with the "Mole Concept".** Robert D. Freeman, Oklahoma State University, Stillwater, OK 74078.

(MC2-06) **"Chemical Amount," Molar Mass, Concentration and the SI Units of These Quantities.** George Gorin, Oklahoma State University, Stillwater, OK 74078.

Requiem for Qualitative Analysis

G. Baca (*MS3-01*, LCL) described a program which has been structured to attempt to eliminate the traditional "cookbook" approach to qualitative analysis. The ions are limited to ten in number. Students study three or four reactions involving each separate ion (using a "cookbook" approach). A flow chart for separation is composed by the student after four ions have been studied. The procedure is repeated until all ten ions have been examined. Unknowns are used to evaluate each student's progress. The number of reagents in the lab is limited, preventing the student's use of other, more traditional textbook qual schemes.

K. Berry (*MC3-02*, LCL) discussed three specific benefits that occur from qualitative analysis: (1) qual develops the ability to exercise judgements (decisions different from reading a buret), (2) builds confidence (confidence is gained from the successful conclusion of an experiment—the identification of an unknown), and (3) develops a systematic, organized example of the behavior of substances.

C. W. J. Scaife (*MC3-03*, LCL) contrasted two chemistry courses where the qual scheme was used. In a course for nonmajors (which is a laboratory only course) the students test solid elements and compounds, making simple observations. Decision making in the presence of not enough evidence (the frustration of interpretation) is stressed. Participation by the instructor is important to the success of the program. In a majors course, five cation solutions are tested with acids, bases, flame, sulfides, etc. As a result of these experiments, students write balanced reactions, answer questions, prepare their own separation schemes, practice unknowns (constructed by fellow students), and complete unknowns furnished by the instructor for grade.

P. L. Samuel (*MC3-04*, LCL) has developed lecture demonstrations of portions of the qual scheme due to limited time available for laboratory. The three tests described were (1) a test for arsenates, by precipitation of silver arsenate, (2) the separation of cobalt and manganese, demonstrating the effect of pH on redox potentials in hydrogen peroxide solutions, and (3) the identification of iron(III) and cobalt(II) in the same solution.

R. Rich (*MC3-05*, LCL) stressed the use of iodo- and bromo-complexes in a qualitative analysis scheme. An example was presented describing a separation scheme starting in 3*M* hydrobromic acid solution. References available from the author are (1) a table summarizing major group reagents for various qual schemes, and (2) procedural information for the schemes discussed.

Following the presentations the comment was made that a "cookbook" procedure is not necessarily bad since good cookbooks explaining procedures, allow development of direction-following skills, establish a "feel" for the procedures and results, and help reduce anxiety of the unknown. However, many participants felt that the qual emphasis should be on the student designing the analysis scheme—not following blindly.

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(MC3-02) **Five Reasons for Not Teaching Qualitative Analysis.** Keith Berry, University of Puget Sound, Tacoma, WA 98416.

(MC3-03) **Qual is Not Dead.** Charles W. J. Scaife and Charles F. Weick, Union College, Schenectady, NY 12308.

(MC3-04) **Mining the Qualitative Analysis Scheme.** Patricia L. Samuel, Boston University, Boston, MA 02215.

(MC3-05) **Qualitative Analysis, With Periodicity, for "Real" Solutions.** Ronald Rich, Bluffton College, Bluffton, OH 45817.

Honors and Advanced Placement Chemistry Courses

Operating on the premise that the laboratory is the place where the rate of learning can be improved, **M. S. Newman** (*TS2-01*, KJD) has emphasized research both in his summer school program for high school students and in his organic chemistry course. The high school summer program was incorporated into Newman's research grant for "expediting" getting people into chemistry. The organic course encouraged students to pursue extensions of lab problems—for example, by altering variables in order to improve yields.

W. F. Coleman (*TS2-02*, KJD) views the honors general chemistry program as an excellent vehicle to interest and challenge good students, many of whom are recruited through high school visitations. With the course emphasizing structural relationships, students are taught to be problem-solvers and how to adapt. Such a program allows for topics to be covered in depth, with a concentration on current research. Students are also encouraged to pursue undergraduate research.

W. C. Wolsey (*TS2-03*, KJC) proposed a one-semester accelerated course as a means to challenge chemistry students, while possibly helping to recruit chemistry majors. A math aptitude test essentially dictates which students enroll in the course, although AP test results are also considered. A variety of approaches have been used. Depending on the instructor, these include the Keller plan, seminars, term papers, and the writing of problem-solving explanations. A primary feature is the open-ended laboratory component.

According to **F. S. Quiring** (*TS2-04*, KJD) "the biggest mistake is grouping all high school (chemistry) students in the same high school course." Two courses "Quantitative Chemistry" and "Qualitative Chemistry" accommodate the "bright" student and the "average" student, respectively. Students in both courses are college-bound, but the courses differ in the type of thinking required. Students are channeled into each course based on teacher/counselor recommendation as a result of previous science performance.

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(TS2-02) **Looking Forward in Retrospect—A Decade of Honors General Chemistry Teaching.** William F. Coleman, University of New Mexico, Albuquerque, NM 87131.

(TS2-03) **Chem 13, An Accelerated General Chemistry Course.** W. C. Wolsey and E. J. Slowinski, Macalester College, St. Paul, MN 55105.

(TS2-04) **Let's Give the Gifted Students a Break.** Frank S. Quiring, Clayton High School, 1 Mark Twain Circle, Clayton, MO 63105.

Minipapers on Honors and AP Chemistry

S. B. McGrath (*TS2a-01*, JMF) discussed the advantages and disadvantages of students taking advanced placement chemistry as the first high school chemistry course. The advantages are that (1) gifted students can take more than one AP science course since the senior year is free to take these courses, (2) an honors math sequence can be taken concurrently, and (3) the recommended syllabus is followed to offer bright students a genuine challenge. The disadvantages are that (1) students are under great pressure, (2) there is a lack of mathematical sophistication in some students which causes frustration, and (3) the time compression produces laboratories that are "less than university level" in some cases; the schedule allows for no double lab periods. This last disadvantage is considered to be the most important one.

The AP course described by **J. D. Mullins** (*TS2a-0a*, JMF) is a double-period course which meets 10 hours/week. Since many bright students have not developed good study habits, the course is designed to provide the students with a routine similar to a college atmosphere. Lectures in the course are given in one hour periods three days a week as in many college general chemistry courses. The other seven hours are devoted to the laboratory. The hours are often scheduled around the lunch hour which can allow for even more time if that is necessary. Four or five experiments are assigned which are to be completed within 4 to 5 weeks.

Sequential writing activities in the field of chemistry which lead to the students writing a paper on atomic theory were described by **R. D. Suits** (*TS2a-03*, JMF), the prewriting activities begin with a "brain-storming" session to determine what students already know about atoms. Each student in the class then picks an idea, particle, or person from the list developed about which he would like additional information. The student gathers the additional information in the library, and later presents an oral report. The composition activity begins with two short writing activities: (1) each student writes in class a letter to a colleague describing some recent experiments he has conducted on electric charge and (2) writes a page on the Santa Claus theory of the appearance of Christmas presents under the tree using the garbage collector theory in the text as a model. These activities culminate in a paper presenting the experimental evidence for the atomic theory and concluding with the atomic model. The format is that of a paper in a scientific journal with an introduction, experimental section, results, discussion, and conclusions. The in-class time required for this project is about three hours.

According to **D. D. Ensor** (*TS2b-01*, GKE), the honors freshman chemistry students at Tennessee Technological University are required to do an independent research project under the supervision of one of the faculty. Limitations include lack of background in lab techniques, time and complexity of experiment. Chemical equilibrium studies have proven effective in introducing a variety of laboratory techniques and in being practical for the freshman level. Two such experiments dealing with lanthanide compounds were discussed in terms of the experimental techniques taught.

W. F. Kinard (*TS2b-02*, GKE) describes the Chemistry Honors course at the College of Charleston as an avenue for recruiting chemistry majors, generating enthusiasm for chemistry, and creating a feeling of being "special". Goals for this course include a rigorous grounding in fundamentals; the development of good study habits, lab skills, and scientific curiosity; and an appreciation for the role of chemistry in today's society. The students benefit by smaller class size, more personal contact with the faculty, and an opportunity for experience not available in the general program. Problems encountered with the honors students are inadequate high school backgrounds, a heavier work load for the students, whether to grade so as not to "penalize" students for being in the honors class, potential student burn-out, and what to use as a follow-up after the freshman year.

E. Koubek (*TS2b-03*, GKE) says students at the U. S. Naval Academy are required to take two semesters of chemistry unless able to validate, or exempt, the course. Honors students are placed in the course based on several criteria. Computer terminals and equipment are available in the labs. Thermodynamics and kinetics are taught with calculus. A disadvantage of the placements into honors is the perception by some students that their class standing is affected adversely by not being in the general chemistry course.

J. S. Landers (*TS2b-04*, GKE) says freshmen entering the U. S. Air Force Academy are generally well-prepared and approximately 10% of the top 15% choose the honors chemistry program. Limitations on the students include athletic requirements, heavy academic loads, and a 100 minute restriction per lesson or lab. Formal lab reports are required, and use is made of microlabs which necessitate construction of some equipment to be used later. Guest lecturers and field trips are used to supplement course work. Introduction to problems which may be encountered by the students in their future careers is made when possible.

G. L. Swartz (*TS2b-05*, GKE) says Michigan Technological University's Department of Chemistry and Chemical Engineering is in the process of completing a self-study, and the honors program is also being assessed. Questions posed are related to the role of an honors program at a technical university, the pace of the course, and whether there should be a separate course for higher ability students. Reactions from honors students included initial apprehension, the presence of competition which encouraged better performance, the advantage of students being on a similar level, and more personal interactions.

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(TS2a-02) **A Two-Hour Advanced Placement Chemistry Course.** J. D. Mullins, Plano Senior High School, Plano, TX 75075.

(TS2a-03) **The Atom Paper: Writing Skills Taught in High School Chemistry Classes.** Robert D. Suits, David H. Hickman High School, 1104 N. Providence Rd., Columbia, MO 65201.

(TS2b-01) **The Design of a Research Problem for Chemistry Honors Students.** D. D. Ensor, Tennessee Technological University, Cookeville, TN 38501.

(TS2b-02) **The Honors Chemistry Course at the College of Charleston.** W. F. Kinard, College of Charleston, Charleston, SC 29424.

(TS2b-03) **Honors Level Chemistry at the U. S. Naval Academy.** Edward Koubek, U.S. Naval Academy, Annapolis, MD 21402.

(TS2b-05) **The Honors Program—Evolution or Extinction?** Grace L. Swartz, Department of Chemistry and Chemical Engineering, Michigan Technological University, Houghton, MI 49931.

Getting Freshman into Equilibrium

D. A. Lewis (*WC1-01*, PKW) contends that beginning acid/base discussions with the auto-ionization of water is the root of his students' problems with the concept of hydrolysis. His students view the process as one which required water molecules to "fall apart" into the ions $OH_{(aq)}^-$ and $H_{(aq)}^+$. He suggests starting with a neutralization viewpoint instead. He contends that this approach would eliminate the need for the concept of hydrolysis as defined (a reaction of an anion with water which produces a solution which has a pH $\neq$ 7).

G. Sanzone (*WC1-02*, PKW) offered the suggestion that the teacher should help the student discover or uncover a topic rather than just cover a topic. In that context, the abstract nature of thermodynamics was better understood by students on the basis of known particulars from their common experience or chemical experience. For example, students can follow the thermal equilibrium reached by two objects at different temperatures which are placed in contact and allowed to reach the same final temperature. Likewise, they easily visualize the events as the mechanical equilibrium is reached within the system where two gases at different pressure are separated by a locked but movable wall and the lock is released.

B. L. Stump (*WCl-03*, PKW) contends that there are three flaws to the kinetic justification for an equilibrium condition where K is equated to the ratio K_f/k_r. (1) It encourages students to write rate laws for the forward and reverse reactions just from the stoichiometric equation for the reaction. (2) Equating the rate laws for the forward and the reverse reactions does not necessarily produce the form of Q for the reaction. (3) The postulated mechanisms for many reactions would not have all the reaction participants present as explicit terms. Stump contends that enough thermodynamics must be covered, before introducing the concept of chemical equilibrium, to allow the development of the forms for the equilibrium relationships from thermodynamic phenomenon, not a kinetic one.

D. R. Weill III (*WC-04*, PKW) discussed several systems in his lectures for which each had some problem which prohibited demonstrating the changes which occurred as the system reached equilibrium from initial conditions or as the system at equilibrium was subject to some stress and then was allowed to relax again to equilibrium. The demonstration system with the blue tetrachlorocobaltate(II) and the red hexaquaocobalt(II) ion in equilibrium was chosen because of the obvious color changes in the system when displayed upon the stage of an overhead projector. A copy of the demonstration examination which the students employed during the demonstration was discussed as the demonstration proceeded through the steps.

W. F. Coleman (*WC1-05*, PKW) reiterated that the concept of a dynamic equilibrium is a kinetic concept but that the position of dynamic equilibrium is a thermodynamic phenomenon. He contended that a rigorous treatment of ionic equilibrium should be delayed until after the students are knowledgeable in chemical thermodynamics so that those complex calculations will be done with an appreciation for their validity. He suggested that the equilibria be introduced as actual chemical applications and that we delay or eliminate the complex calculations from the undergraduate offerings.

P. L. Samuel (*WC1-06*, PKW) suggests that the presentations often appearing in general chemistry texts where either partial pressure or concentration data is presented and the equilibrium constants are derived by trial and error, or where a kinetic justification is based upon the ratio k_f/k_r being equal

to the equilibrium constant should be avoided. Instead she feels we should employ the techniques of deriving the equilibrium constant expression from the dependence of the free energy upon concentrations. At the point of introducing equilibrium calculations by this latter procedure, the student would have had a thermodynamics discussion and the experimental data associated with phase equilibria. One should derive the relationships for relating $\Delta G°$ to the appropriate K's including ionic equilibria and solubility equilibria before discussing acids and bases. This way the acid/base discussion can focus upon the acid/base properties without having to develop the equilibrium relationships at the same time.

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(WC1-04) **A Demonstration Examination of an Equilibrium System for the First-Year Chemistry Classroom.** D. R. Weill III, Shady Side Academy, 423 Fox Chapel Road, Pittsburgh, PA 15238.

(WC1-05) **Equilibrium in the General Chemistry Course—When, How, and How Much?** William F. Coleman, University of New Mexico, Albuquerque, NM 87131.

(WC1-06) **A Free Energy Path to Equilibrium.** Patricia L. Samuel, Boston University, Boston, MA 02215.

Poster Plus Presentations

Computers in Chemistry and Chemical Education

R. H. Anderson (*TP1-01*, AJB) reported on the use of GPPLOT, an interactive point-plotting program, in physical chemistry courses. Several programs, written in FORTRAN, for laboratory calculations and general mathematical operations were also described. A PLOT library which incorporates all these programs has been developed.

C. L. Bair (*TP1-02*, AJB) described a series of instructional computer programs developed for general chemistry for the Apple II microcomputer. Written in PASCAL, these programs demonstrate many topics discussed in general chemistry courses.

W. Butler (*TP1-03*, AJB) demonstrated programs which were originally developed for the Commodore CBM and their "translated" versions (Apple II plus, and TRS-Model III). Many of the problems which arise on translating a program from one machine to another were discussed and remedies for some such problems suggested.

R. D. Cornelius (*TP1-04*, AJB) has developed a nine-disk set of computer exercises covering the introductory course in general, organic, and biological chemistry for the health sciences. The programs, designed for the Apple II microcomputer, used the graphics and color capabilities of this machine to great advantage, topics cover the gamut from significant figures to DNA base-pairing.

J. O. Currie (*TP1-05*, AJB) discussed the development of microcomputer programs which aid lecture demonstrations on acid/base titrations. The programs extend previous curve generating routines by allowing direct electrode input. Data may be stored at the end of a titration, and numerous titration plots superimposed on the HI-RES screens of the Apple II microcomputer.

L. P. Davis (*TP1-06*, AJB) presented a simulation of a pH titration experiment for use in general chemistry course. The simulation, developed on a VAX11/780 interfaced with TERAK 8600 terminals, uses color graphics and allows the students to direct the experiment in a manner paralleling the "adventure" type games.

C. W. Eaker (*TP1-07*, AJB) described a program for an S-100 bus which displays the motions of the atoms in the prototype chemical reaction, H_2 + H. The program demonstrates molecular collisions in the system, and allows the user to view the effects of certain parameters on these collisions.

K. Emerson (*TP1-08*, AJB) described problems arising in the algorithms for analyzing student titration data. Several numerical methods were explored, and a method for fitting titration curves using a derivative free, non-linear least squares approach was suggested as a solution.

H. D. Frame (*TP1-09*, AJB) demonstrated a set of programs for plotting experimental data. Data can be fitted with linear least squares equations or plotted in several alternative formats (reciprocal, logarithmic, etc.) Provisions have been made for axis labelling, data editing, and replotting. In addition, the programs, written for the Apple II, allow the user to display and label several data sets simultaneously.

W. E. Godwin (*TP1-10*, AJB) described a program which generates the Fisher projection of a molecule with two possible chiral centers. The program, designed for use by students in organic courses, randomly selects six groups from a list of twenty possible groups to provide practice in the specification of stereochemical configuration.

A. E. Herbner (*TP1-11*, AJB) exhibited a series of programs for use in organic courses. The programs display, in animated form, organic mechanisms. Those displayed included nucleophilic and electrophilic substitutions, addition and elimination reactions. The programs use the color graphics and programmable characters of the VIC-20 Personal Computer.

R. J. Ouellette (*TP1-13*, AJB) described the use of Commodore computers (networked to dual-disk drive units) by students in general chemistry at Ohio State. Programs are used for computer-assisted instruction and prelaboratory simulation. The author described increased student examination performance, and reduced times required for laboratory experiments as benefits of this systems.

G. S. Owen (*TP1-14*, AJB) demonstrated a set of programs implemented on the Apple II computer for drawing and manipulating molecular structures. Extensive manipulation capabilities allow the user to rotate the molecules, to scale the structure, and to zoom in on any atom. While the program is currently able to display molecules with up to 64 atoms, the authors feel that the practical limit for viewing a whole molecule on the Apple II is about 30–40 atoms.

D. A. Phillips (*TP1-15*, AJB) described a series of computer simulations to assist introductory chemistry students in some of the concepts of statistical thermodynamics. The programs range from simulations of coin-flipping to exercises in the methods of calculating energy distributions.

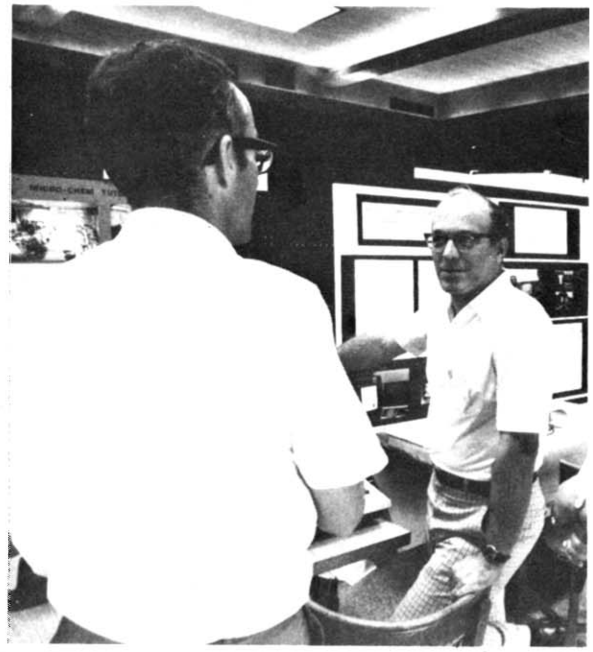
J. W. Schilling (*TP1-16*, AJB) described the use of several programs with applications in both general chemistry and physical chemistry classes. Some applications include a demonstration of factors affecting the conduction of electrical current by an electrolytic solution and a model for demonstrating the kinetic basis of equilibrium.

J. C. Templeton (*TP1-17*, AJB) described a series of interactive computer programs for use by general chemistry students. The programs, written in FORTRAN IV on an HP-3000 computer, are designed for use following the completion of laboratory experiments. The authors reported that the extensive question and answer format were useful to students in relating experiment to theory, analyzing their data, and organizing and writing the final laboratory report.

C. R. Ward (*TP1-18*, AJB) described a low-cost alternative to the production of computer graphics in computer-assisted instruction. An interface which allows the microcomputer to control a projection device was exhibited. The author feels that the use of such a device frees the instructor from the task of writing computer graphics code, and makes the graphics display independent of the model of microcomputer being used.

J. F. Zimmerman (*TP1-19*, AJB) reported on a series of programs developed for use in advanced analytical chemistry courses. The programs, written for the Apple II computer, are drawn from topics including spectrophotometry, electrochemistry, chromatography, equilibrium, electronics, and data acquisition.

R. C. Morrison (*TP1-20*, AJB) described the development of a microcomputer based Universal Laboratory Training and Research Aid (ULTRA) for handicapped students in undergraduate chemistry laboratories. The ULTRA system has been interfaced to pH electrodes, visible spectrophotometers, infrared spectrophotometers, gas chromatographs, analytical balances, temperature sensors, and titration devices. The author feels that while some procedures may require an assistant, the student will be able to control data collection and to perform the calculations.



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(TP1-02) **The Pascal Language and Chemistry CAI for the Apple II.** Clark L. Bair and M. Lynn James, University of Northern Colorado, Greeley, CO 80639.

(TP1-03) **A Comparison of the Personal Computers Available for Computer-Aided Instruction in Chemistry.** William Butler, University of Michigan, Ann Arbor, MI 48109.

(TP1-04) **Microcomputer Programs for General, Organic, and Biological Chemistry.** Richard D. Cornelius, Wichita State University, Wichita, KS 67208.

(TP1-05) **Comprehensive Microcomputer Program for pH Titrations.** James O. Currie, Pacific University, Forest Grove, OR 97116.

(TP1-06) **A Titration Simulation for Freshman Chemistry.** L. P. Davis, D. M. Storch, and C. J. Dymek. United States Air Force Academy, CO 80840.

(TP1-07) **Computer Animation of a Chemical Reaction.** C. W. Eaker and E. L. Jacobs, University of Dallas, Irving, TX 75061.

(TP1-08) **Computer Processing of Student Titration Curve Data.** K. Emerson, Montana State University, Bozeman, MT 59717.

(TP1-09) **Graphing with Microcomputer in Lab and Lecture.** H. D. Frame, Southwestern Oklahoma State University, Weatherford, OK 73096.

(TP1-10) **A Microcomputer Program for Practice in Specification of Configuration in Molecules with Two Possible Chiral Centers.** W. E. Godwin, University of Arkansas at Monticello, Monticello, AR 71655.

(TP1-11) **Applications of the Commodore VIC-20 Personal Computer in Teaching Organic Chemistry.** R. E. Herbener, Hillsdale College, Hillsdale, MI 49292.

(TP1-13) **Microcomputers as Tutors for Large Enrollment Chemistry Courses.** R. G. Ouellette, The Ohio State University, 140 West 18th Ave., Columbus, OH 43210.

(TP1-14) **Molecular Modeling for the Masses.** G. Scott Owen, Atlanta University, Atlanta, GA 30314 and James O. Currie, Pacific University, Forest Grove, OR 97116.

(TP1-15) **Boltzmann for the Billions.** D. A. Phillips, Wabash College, Crawfordsville, IN 47933.

(TP1-16) **Computer Simulation in General and Physical Chemistry.** J. W. Schilling, Trinity University, San Antonio, TX 78284.

(TP1-17) **Laboratory Report Writing in General Chemistry Using Computer-Assisted Instruction.** J. Charles Templeton and Carmen Lorenz, Whitman College, Walla Walla, WA 99362.

(TP1-18) **Microcomputer Controlled Graphics Display for CAI.** C. R. Ward, University of North Carolina at Wilmington, Wilmington, NC 28406.

(TP1-19) **The APPLE in Advanced Analytical Chemistry.** J. F. Zimmerman, Wabash College, Crawfordsville, IN 47933.

(TP1-20) **Microcomputers that Talk and Listen: Microcomputer-Assisted Instruction for Disabled College Chemistry Students.** Robert C. Morrison and David Lunney, East Carolina University, Greenville, NC 27834.

Instructional Innovations

C. L. Ayers (*WP1-01*, RHA) used guided design in a one-semester physical chemistry course. A slide show described this use of the new educational strategy developed by Wales and Stager at the University of West Virginia. Most of the course involved small groups of students working on the problems which were tackled in steps. It was well accepted by the students and seemed to increase their incentive.

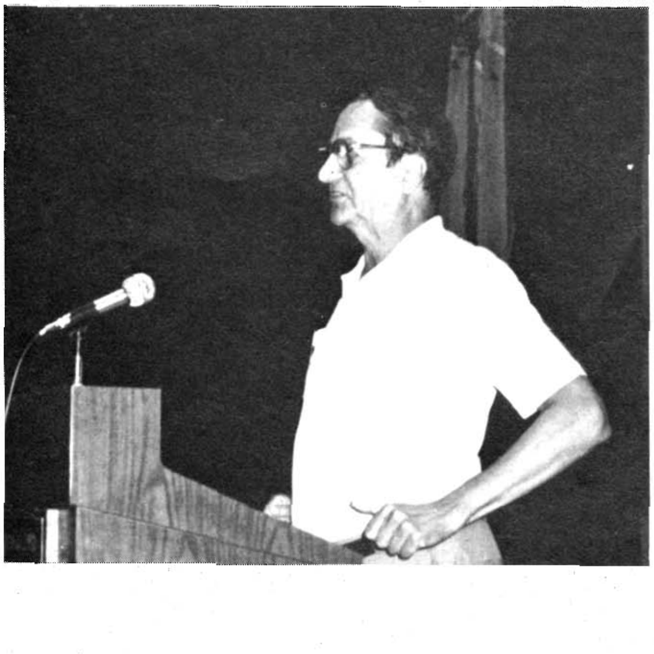
P. W. Ayers (*WP1-02*, RHA) used the guided design method for an applied problem of industrial organic chemistry. It gave the students experience working together and using the library to solve practical problems with stepwise guidance and checking by the teacher. Only about one third of this course dealt with organic industrial chemistry.

C. R. Baker (*WP1-03*, RHA) described a more detailed analysis of multiple choice questions using computer generated graphs of quintile averages in addition to frequency of each choice of an answer. He maintained that good questions require considerable evolution with quality control such as quintile and item analysis.

J. A. Beran (*WP1-04*, RHA) described a rather complete procedure for training and supervising general chemistry laboratory assistants. These procedures were developed after complaints that some assistants were unprepared and lacked needed knowledge. A proper preparation of assistants can change the laboratory into the most interesting and exciting learning center on the campus.

T. J. Tipton (*WP1-05*, RHA) showed a videotape on safety in the laboratory. This new module has been added to the previous modules prepared by Project TEACH, sponsored by Exxon Education Foundation. It showed rather graphically what can happen if safety glasses are worn on the forehead instead of over the eyes. Materials can be ordered from Project TEACH, Dept. of Chemistry, University of Nebraska, Lincoln, NE 68588.

B. R. Condray (*WP1-06*, RHA) described ten modules for use by general chemistry students. They involve small experiments done using an experimental kit. Each student is to complete this work in the week prior to the lectures on the material. The purpose is to give the student some background and experience with direct observations and real world chemicals and their properties. Each module has objectives and a pretest, experimental kit, taped instruction, a study guide, workbook, and a self test. The kits are similar to Alyea's armchair chemistry kits.



B. W. Glorvigen (*WP1-07*, RHA) described a sequence of experiments for the organic laboratory. They involve synthesis, isomerization, use of TLC, column chromatography, and UV spectroscopy. The sequence is adaptable from two to five weeks. *Syn-* and *anti*-forms of oximes from 2-hydroxybenzophenones are the starting point. Dramatically different product ratios are produced under different reaction conditions.

M. E. Kastner (*WP1-08*, RHA) showed videotapes developed for the terminal chemistry course at Boston University involving health care students. They are used in the laboratory to instruct in basic laboratory skills, data analysis, and to enrich the students' understanding of the relevance of chemistry to their health-science careers.

J. L. Lambert (*WP1-09*, RHA) described the oxidation of thiosulfate with periodate. The associated pH change from 4 to 11 over a period of 15 to 30 seconds permits various color changes using different indicators.

R. G. Landolt (*WP1-10*, RHA) described the use of three NSF Undergraduate Research Participation Grants to support nine students from four colleges in applied summer research at Battelle Laboratories. These URP grants have introduced many students to research. A plea was made to "Help Save URP."

E. W. Ledbetter (*WP1-11*, RHA) described methods used to individualize her high school text, *Keys to Chemistry.* If chapters are completed ahead of the deadlines, a reward is given. If a test must be repeated, the score is limited to 70%. The unit tests consist of a deck of 25 cards from which a student draws five at random—one in each of the following areas: laboratory skills, math skills learned in the unit, facts, data interpretation, and the application and understanding of concepts and principles. Honor cards with extra points are available if 80% is obtained. Extra credit can be obtained for special extra experiments or creative written work.

L. C. Lewis (*WP1-12*, RHA) described physical chemistry experiments based on measuring the solubility of HCl in an organic layer in equilibrium with a 12 *M* aqueous solution. Solubility is related to dielectric constant, concentration of an ether in the organic layer, and the temperature. Complex formation with aromatic hydrocarbons can be measured.

C. E. Ophardt (*WP1-13*, ARN) has a collection of demonstrations of oxidation-reduction reactions, emphasizing that a reducing agent will react with an oxidizing agent of more positive potential. The demonstrations provide motivation for the student to look up further information about the ions and molecules involved.

D. S. Plumlee (*WP1-15*, ARN) has devised an entrance test for a high level freshman chemistry course, and a preparatory course for those who do not pass the test. The objectives of the latter course are entry skills required for the former, and the steps in teaching these objectives have been worked out in detail.

R. W. Ridgway (*WP1-16*, ARN) of the ACS Office of Cooperative Education exhibited the society's program to promote cooperative education in chemistry. Since the program began in 1979, the number of co-op programs in the U.S. has grown from 132 to 203, and the number of participating students from under 600 to over 1200.

A. M. Sarquis (*WP1-17*, ARN) tells everything needed to write a paper for THIS JOURNAL except the chemistry.

C. W. J. Scaife (*WP1-18*, ARN) has a set of experiments for a course in descriptive inorganic chemistry. The emphasis is on properties and reactions to avoid the pale-green gas problem.

W. D. Smith (*WP1-19*, ARN) writes examinations in which the answer to each question determines what the next question shall be. After marking his answer, the student develops a latent image to find the number of the next one. Reliable short-quiz grades can thus be obtained with fewer questions.

G. H. Stevens (*WP1-20*, ARN) showed the slowness of diffusion in liquids, galvanic cells, and the differing densities of liquids with balls floating at several heights in a cylinder.

'D. Taiwo (*WP1-21*, ARN) improves his tests by keeping track of the difficulty and discriminating power of test items.

A. M. Wilson (*WP1-22*, ARN) has prepared posters, slides and tapes for a biochemistry laboratory. Topics include operation of equipment, graphing, and safety. Slides show details of experiments and relation to current news events.

R. K. Wismer (*WP1-23*, RN) draws examples for his general chemistry course from industrial chemistry. Each student must write a concise paper on one of the C&EN top 50 chemicals.

G. Wulfsberg (*WP1-24*, ARN) has learning cycle (exploration → frustration → invention → application) experiments in descriptive inorganic chemistry for a first course. The experiments precede the lectures on the same topics, thus generating interest in the theory.

R. G. Silberman (not listed in abstracts, ARN) uses cognitive-cycle (exploration → invention → application) experiments in general chemistry. One result has been an improved student attitude toward the laboratory.

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(WP1-01) **The Use of Guided Design in a One-Semester Physical Chemistry Course.** Caroline L. Ayers, East Carolina University, Greenville, NC 27834.

(WP1-02) **An Industrial Chemistry Course Using Guided Design.** P. Wayne Ayers, East Carolina University, Greenville, NC 27834.

(WP1-03) **Writing Better Multiple Choice Questions.** Charles R. Baker and Erwin Boschmann, 925 W. Michigan St., Indianapolis, IN 46202.

(WP1-04) **A Comprehensive General Chemistry Laboratory Program.** Jo A. Beran, Texas A&I University, Kingsville, TX 78363.

(WP1-05) **Project TEACH Revisited.** David W. Brooks, Edward J. Lyons, and Thomas J. Tipton, University of Nebraska-Lincoln, Lincoln, NE 68588.

(WP1-06) **Introductory Experimental Modules for General Chemistry.** Ben R. Condray, East Texas Baptist College, 1209 N. Grove, Marshall, TX 75670.

(WP1-07) **Nucleophilic Displacements on Azomethine Nitrogen.** Bradley W. Glorvigen, College of St. Thomas, Box 4001, St. Paul, MN 55105.

(WP1-08) **Videotapes for Life Science Chemistry—Techniques, Calculations, and Enrichment.** M. E. Kastner and S. C. Mohr, Boston University, 685 Commonwealth Ave., Boston, MA 02215.

(WP1-09) **School Colors and a Red-White-and-Blue Reaction.** Jack L. Lambert, Michael J. Chejlava, Gary T. Fina, and Nina L. Luce, Kansas State University, Manhattan, KS 66506.

(WP1-10) **Cooperative Academic/Industrial Undergraduate Summer Research.** R. G. Ladolt, E. R. Gerlach, and C. A. Alexander, Texas Wesleyan College, Fort Worth, TX 76105; Muskingum College, New Concord, OH 43762; and Battelle Laboratories, 505 King Avenue, Columbus, OH 43201.

(WP1-11) **A Self-Paced Chemistry Program for the General Student.** Elaine W. Ledbetter, 1611 Grape, Pampa, TX 79065 and Jay A. Young, 12916 Allerton Lane, Silver Spring, MD 20904.

(WP1-12) **Physical Chemistry Experiments Based on HCl Solubility.** L. C. Lewis, Sioux Falls College, Sioux Falls, SD 57101.

(WP1-13) **Reduction Potentials, Demonstrations, and Descriptive Chemistry.** C. E. Ophardt, Elmhurst College, Elmhurst, IL 60126.

(WP1-15) **Using Learning Hierarchies in College Chemistry.** D. S. Plumlee, Jr., M. W. Sellers, W. M. O'Brien, F. L. Alcorn, and M. A. Jones, Northern Virginia Community College, Annandale, VA 22003.

(WP1-16) **Cooperative Education—What Is It and What Is ACS Doing About It?** R. W. Ridgway, Office of Cooperative Education, American Chemical Society, 1155 16th Street, N. W., Washington, DC 20036.

(WP1-17) **Metamorphosis: From Idea to Published Article.** Mickey Sarquis, High School Editor, JOURNAL OF CHEMICAL EDUCATION, Miami University-Middletown, Middletown, OH 45052, and other feature editors of Secondary Section of THIS JOURNAL.

(WP1-18) **Some Experiments in Inorganic Chemistry.** Charles W. J. Scaife and Richard L. Dubs, Union College, Schenectady, NY 12308.

(WP1-19) **The Fifteen Minute Final: Response-Contingent Testing.** Wesley D. Smith, Ricks College, Rexburg, ID 83440.

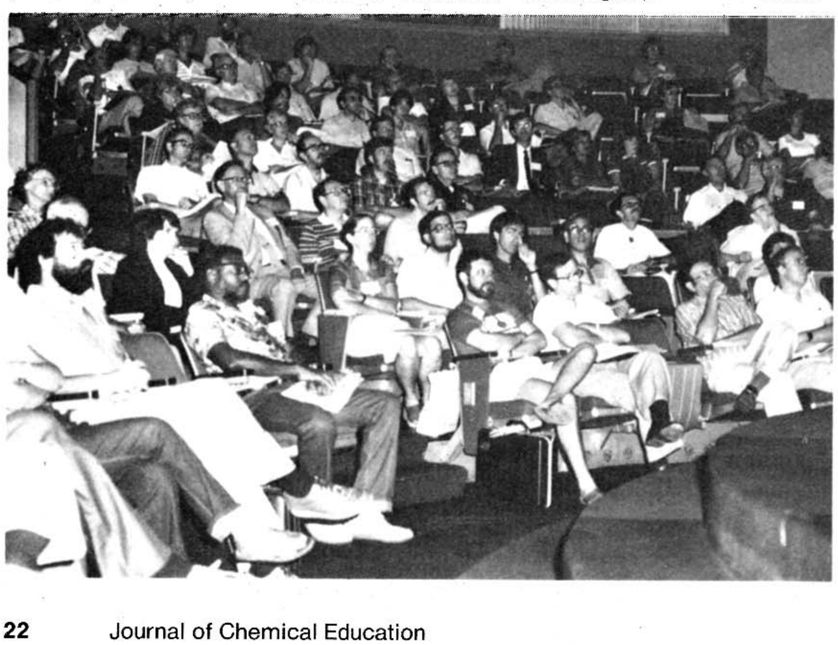
(WP1-20) **Inexpensive, Teacher-Devised Services for Elementary Demonstrations in Chemistry.** G. H. Stevens, Lansing High School, 300 Ridge Road, Lansing, NY 14882.

(WP1-21) **A Strategy for Evaluation of High School Chemistry.** 'Diran Taiwo, Faculty of Education, University of Ife, Ile-Ife, Nigeria.

(WP1-22) **Inexpensive Visual Aids for an Undergraduate Biochemistry Course.** Anna M. Wilson, Department of Biochemistry, Purdue University, W. Lafayette, IN 47907.

(WP1-23) **Teaching Descriptive Chemistry Via Industrial Chemistry.** R. K. Wismer, Millersville State College, Millersville, PA 17551.

(WP1-24) **Descriptive Inorganic Chemistry Taught via Piaget Learning Cycle Labs.** Gary Wulfsberg, Doctor of Arts Program, Box 405, Middle Tennessee State University, Murfreesboro, TN 37132.



Workshops

Microcomputer Tools for Chemists

This workshop (JG) focused on three areas: (1) Ideas on how computers might be used to enhance chemistry teaching. Examples were drill on chemical nomenclature, pre-laboratory exercises, simulations, and tutorials. (2) Examples of commercially available software from a variety of sources. Included were topics specific to chemistry teaching as well as general purpose packages for plotting and curve fitting. (3) A discussion on four ways to connect a microcomputer to a laboratory experiment. The methods discussed were game paddle interfacing, parallel and serial analog-to-digital converters, and the IEEE-488 (GPIB) interface bus.

Writing Software for Microcomputers

J. W. Moore (AGS) presided at this workshop attended by approximately 100 participants. Whereas prior workshops for microcomputers had involved principally "hands-on" experience for those participating, the intent of this program was to provide information and illustrated examples (via a large-screen TV set connected to various computers) for higher-level programming techniques. A second purpose of the workshop was to provoke discussion on what should and *should not* be done with microcomputers in educational settings.

Seven speakers, all programming experts as well as chemists, discussed aspects of their own work in CAI. P. Cauchon described the use of the random-number generator function to prepare reproducible problem sets for homework checking. P. Flath spoke about computer programs written to simulate stream analysis by the Petersen mark-and-recapture method. J. Suits presented examples of computer-based lab exercises used for large classes of first-semester freshmen who take chemistry lecture only, without lab. P. Schatz provided a number of helpful tips on using PET computers, including graphics emulation through the use of keyboard shapes and shape tables. M. Butler spoke about the facilities needed to run a network of PETs from a single one-megabyte disk drive, and described the conversion of a substantial number of PET programs to run on Apple II machines. R. Cornelius demonstrated a variety of commercially-available software programming techniques for Apple II computers, including animation, character set generation, and use of keyboard overlays. The final speaker was S. Smith who described and illustrated a new commercially available software package enabling rather detailed answer-processing and graphics use in CAI. The facility represents a rather successful translation of some of the powerful PLATO editing features for those primitives among us who must still soldier on in one of the BASIC dialects.

Project SERAPHIM Instructional Computer Programming Contest

This contest (JWM) attracted 17 programs. These were judged by a panel of expert programmers and by any attendees who visited the busy computer room and tried out several of the programs. Authorship of programs was evenly divided between college and high school teachers, with eight programs in the high school division, eight written by college teachers, and one by a college student. The Apple was the predominant computer, with 14 of the seventeen entries written for Apple. Games and programs that incorporated graphics got higher ratings, while programs that did not trap errors and did not make clear what options were available next were downgraded. A great deal of time is required to test an instructional program thoroughly, and the organizer of this contest felt that more computer time should have been available for the judges to do a really thorough job. Indeed, some programs may have gotten lower ratings simply because there was not enough time to try out all of their features. Careful review and user testing of all programs, including commercial ones, are essential, and these are activities that Project SERAPHIM, in cooperation with THIS JOURNAL, will undertake during the next year. Winners of the contest were—First prize (tie): Clark Bair, U. of Northern Colorado, and Jerry Bell, Simmons College. High school prize: Paul Groves, S. Pasedena High School. (The high school prize was supported by the Office of High School Chemistry of the ACS Education Division.)

Workshop on Preparing 3-D Photographs of Models and Structures

This workshop features a lecture demonstration that showed the importance of three-dimensional perspectives. Preprinted stereo prints were used and Polaroid® cameras were employed to photograph various molecular and crystal model structures.

Reflections on Stillwater

The memories that we participants have of the Seventh Biennial Conference are no doubt as varied as the individuals in attendance. All of us will long remember the outstanding organization and splendid hospitality provided by our Oklahoma State University hosts. The Chemical Muppet Show put on by the students from Iowa State University brought down the house—as well as our program chairman, who found a real pitfall in his assignment. Many of us will long remember the splendid outdoor performance of the musical "Oklahoma" at Discoveryland near Tulsa. We will also fondly recall the ride to the theater on the wayward bus, getting directions from the pistol-packing Okie, and defying the laws of physics on the 5-ton weight-limit bridge on the way back to Stillwater.

Sixty-one participants will remember the Cimmaron Sprint in the early morning light, spurred on perhaps by John Gelner's snake and tarantula. Several runners received handsome trophies for their efforts; the rest of us can find consolation in that we burned a few calories of all the food we consumed during the conference—whether at the banquet, the picnic by the pool, the continental breakfast in Willham, or the outstanding food service in the student center.

The many social events were indeed pleasurable, but the technical program was stimulating as well as fun. Although many sessions were concerned with the sad plight of secondary school science, the high school participants at the conference were concrete evidence that there are still many outstanding teachers at the secondary level. Who can ever forget that beautiful artful lecture on the periodic table by Mary Nell Gonce, the heat versus temperature demonstration by George Stevens, or the environmental chemistry course described by David Weill, to mention only three out of many outstanding performances.

Certainly one of the highlights of the conference was David Katz's "Chemistry in the Toystore," which kept a large, attentive, and appreciative audience enthralled through the lunch hour and beyond. John Hostettler's marvelous introduction to "Real World Examples" was widely discussed by participants. And who wouldn't go to the end of the Earth (some participants seemed to think we had) to hear such magnificent lecturers as Derek Davenport, Bill Kieffer, and Tom Lippincott?

Twice-daily newsletters, edited so ably by Maureen Julian and Roger Festa kept us informed and entertained. Crossword puzzles by Virginia Orna provided daily challenges. Jane Copes' efficiently run Trading Post let us load our baggage with a lot of useful materials at little cost.

The conference was a rousing success. This report is an attempt to capture a portion of the spirit of the gathering. It is made possible by the hard work and dedication of 36 reporters, to whom the report editor is profoundly grateful.