CHAPTER 1 – INTRODUCTION

A POSITION PAPER ON THE TEACHING OF HIGH SCHOOL CHEMISTRY

by The Education Committee of the
Mississippi Section of the American Chemical Society

(This paper represents a consensus opinion of those faculty members primarily responsible for freshman chemistry instruction in the colleges and universities of Mississippi.)

1. We believe that students entering a freshman chemistry course in college should have had at least one year of high school chemistry with a strong laboratory orientation. Our committee has prepared a list of topics that we think should be included in a first-year high school chemistry course. This list matches closely other lists of topics distributed nationally.

2. First-year algebra should be a prerequisite for first-year chemistry in high schools because learning chemistry involves the use of algebraic expressions. Moreover, it is highly desirable to correlate algebra with problems in chemistry and physics to give students a grasp of the utility of algebra.

3. We strongly recommend that high school students who have taken first-year chemistry elect first-year physics rather than second-year chemistry if only one of the two can be taken.

4. It is recommended that a second-year high school chemistry course consist of a study of special topics. Our committee has prepared a suggested list of topics for the second-year course. Neither a year of organic chemistry nor a year of college-level general chemistry is advised for the second high school chemistry course.

5. We discourage attempts to teach advanced placement chemistry in Mississippi high schools at this time. Most of these courses involve only very little laboratory work which is so essential to an understanding of chemistry. Moreover, we are of the opinion that relatively few persons now teaching high school chemistry in Mississippi have the required training to teach a good advanced placement course in chemistry. High school advisors might instead encourage good students to enroll in advanced placement courses in such subjects as English, mathematics, etc. which don't require laboratory work, but only if teachers capable of teaching college-level courses are on the staff.

6. We endorse the "Guidelines and Recommendations for the Preparation and Continuing Education of Secondary School Teachers of Chemistry" prepared and published by the American Chemical Society.

7. We urge administrators and teachers to cooperate in rigidly adhering to a schedule that gives the correct allotted time for academic subjects. Students should
not be allowed to miss chemistry classes to participate in any extracurricular activities.

8. We urge teachers who plan to take college-level courses for recertification to enroll in content-oriented rather than methods-oriented courses. We believe that our high school teachers already know how to teach but, like all scientists, must constantly work to stay current in the subject matter.

9. We cannot stress too much the importance of the laboratory experience to a good course in high school chemistry. Not only does it stimulate the student to think and enhance his interest in the subject; it is absolutely fundamental to his basic understanding of chemistry. It is our opinion that, with a few exceptions, meaningful chemistry laboratory study is sadly lacking in Mississippi high schools. We therefore urge

**Teachers:** to give more emphasis to laboratory instruction and to prepare themselves through in-service training to better instruct in a laboratory setting.

**Administrators:**

(a) to reduce the number of courses taught by chemistry teachers in order to allow adequate preparation and clean-up time for laboratory instruction.

(b) to develop flexible scheduling to accommodate laboratory instruction. Blocks of time longer than the usual 50-minute periods are necessary for good laboratory instruction.

(c) to budget considerably more money to support good-quality laboratory instruction. Most high schools in Mississippi have a minuscule budget for laboratory equipment and supplies. There must be a large increase in most budgets if quality laboratory programs are to be developed.

(d) to make the necessary arrangements to enable teachers to participate in in-service training in laboratory instruction with minimum personal inconvenience. Teachers should be encouraged to participate by use of appropriate incentives.
WHY THIS BOOK WAS WRITTEN

Colleges and universities today expect students to have studied chemistry in high school. If these students are to do well in college chemistry, they should have earned good grades in a quality chemistry course in high school.

It became obvious in the early 1970s that freshmen by the hundreds were appearing on Mississippi college campuses having no chemistry in their high school backgrounds or having taken courses so poor that they could not pass simple placement examinations. Three choices were open to the colleges and universities: (1) they could put these students into the typically rigorous freshman courses in general chemistry on a "sink or swim" basis, (2) the rigor and quality of the freshman courses could be lowered to accommodate these underprepared students, or (3) remedial sub-freshman courses in chemistry could be developed and offered on college campuses as prerequisite courses for the underprepared student wanting to enter the general chemistry sequence. Option 1 seems unfair to the good student with a poor background; option 2 was never even considered. Therefore, there began a proliferation of remedial chemistry courses at colleges and universities across the state. Today eight post-secondary institutions (including our largest universities as well as our junior colleges) offer such courses. Hundreds of students are enrolled yearly in these courses! Parents who pay taxes for a good high school education for their children must now also pay college tuition for their children to take high school chemistry on a college campus because these remedial courses must be successfully passed by the underprepared freshman before the standard college-level courses can be taken with any expectation of success.

Those college and university teachers most closely associated with the general chemistry programs at their institutions, seeing no improvement in the quality of high school chemistry instruction over twelve years, felt compelled to try to help in some way. Unit- ing under the banner of the Education Committee of the Mississippi Section of the American Chemical Society, they have contacted scores of high school chemistry teachers in Mississippi to try to ascertain the problem and decide how the Education Committee can help to improve the quality of high school chemistry. It soon became obvious that the shortage of high school chemistry teachers has forced numerous school systems to employ as chemistry teachers many persons whose academic backgrounds are in areas other than chemistry. While these persons may have excellent teaching skills, the fact is that they are deficient in a knowledge of chemistry. Frequently this results in classes in which the main activity is merely reading the text. Some teachers voiced the fact that they are literally afraid to perform demonstrations and conduct laboratories because of a lack of knowledge of the chemistry involved and, therefore, a lack of confidence in their ability to use successfully these effective methods of teaching.

The Education Committee concluded that massive state-wide retraining of chemistry teachers in the subject matter is urgently needed. Since such a project will take years, it appeared that the best short-term help might be a handbook for high school chemistry teachers to assist those with a limited background to learn more about the subject and gain the confidence needed to present a better course in chemistry. Subject matter was
carefully selected to make the handbook also useful to well-prepared, experienced teachers of high school chemistry. We see the book as a source of many types of important information that is not found anywhere else in one volume.

HOW THIS BOOK WAS WRITTEN

Beginning in 1983 twelve members of the Education Committee of the Mississippi Section of the American Chemical Society, representing all of the state universities and the larger private colleges in Mississippi, held meetings as time and finances permitted to develop materials to assist high school chemistry teachers.

These materials were so well received by high school chemistry teachers that the authors envisioned an accumulation of materials in the form of a handbook for high school chemistry teachers. A Materials Development Grant from the National Science Foundation in 1984 gave substance to the dreams of the group. Three of the most outstanding high school chemistry teachers in Mississippi were selected for inclusion in the materials-writing group which became known as the Action Group of the Education Committee of the Mississippi Section of the American Chemical Society.

The Action Group, worked independently much of the time, but also met in the spring of 1985 in two intensive one-week workshops to write materials. A number of consultants made brief visits to these workshops to give advice and make recommendations. Members of the Action Group spent hundreds of hours selecting and personally developing demonstrations and experiments which will allow a high school chemistry teacher with a minimum background in chemistry to begin a modest laboratory program with confidence.

Most of the other features of this book are derived from the collective wisdom and teaching experience of the Action Group. An exception is the chapter on safety which was largely written by the high school and junior college teachers who were enrolled in a course, Chemical Safety in the Academic Laboratory, taught by one of the editors (JHB) during the summer of 1985.

In the summer of 1985 the two editor-authors completed the writing, organizing, and editing of the contents of this handbook.
THE DESIGN AND SUGGESTED USE OF THIS BOOK

This handbook is organized around a minimum list of essential topics that should be mastered by the student who subsequently plans to pursue college chemistry. These topics are keyed to pages in several of the more popular current high school chemistry textbooks. A suggested allocation of class time to each topic is given.

Acknowledging the trend to "teach by objectives", a minimum list of learning objectives has been carefully developed and keyed to the essential topics.

Considerable attention is given to the subject of testing the students. Numerous sample tests are included along with suggestions for taking some of the drudgery out of the testing process.

Because the Education Committee is convinced that laboratory experiences are critically important to a good high school chemistry course, much of this handbook has been devoted to laboratory instruction. There are approximately 135 pages of detailed procedures and guide sheets for demonstrations and experiments that are all keyed to the essential topics. It is hoped that this material will help the teacher to involve students in seeing and doing chemistry rather than merely reading about it. All experiments have been designed to: (1) be done in 50 minutes, (2) use low cost materials, (3) be safe, and (4) make a worthwhile scientific point. Action Group members have personally conducted the experiments and, in many cases, have supervised use of them with classes of high school students.

The chapter on safety should be read before attempting to do any of the demonstrations and experiments described in this book. One of the concerns of the authors of the safety chapter is the personal liability assumed by every chemistry teacher who conducts demonstrations and experiments. Reflecting this concern is a brief section of the book devoted to suggestions for minimizing personal liability.

We urge the reader to review carefully the Table of Contents to learn of other useful features to be found in this book.

We want this book be used by teachers. To that end, it is distributed in a 3-hole punched, non-bound format for use in a 3-hole notebook binder. Thus pages of the book may be removed and copied to obtain multiple copies for any instructional purpose conceived by the teacher. Notes made by the teacher can be integrated easily into the handbook to make it a more useful personalized reference.
A WORD TO THE TEACHER

This book does not represent an attempt on the part of the Education Committee of the Mississippi Section of the American Chemical Society to dictate to a high school chemistry teacher what to teach or how to teach. We present in a spirit of helpfulness a minimum number of topics and learning objectives which a college-bound student must master in high school chemistry if he/she is to be well prepared for a general chemistry course in college.

Expansion of these minimum topics, inclusion of other topics, and the "personalizing" of a chemistry course to reflect the personality and innovativeness of the individual teacher are all strongly encouraged.

Many of the demonstrations and experiments described in this book are by design quite elementary in concept and simple in execution. Chemistry teachers who already have an active and successful program of demonstrations and experiments may choose to use only a few, or perhaps none, of those presented in this book. On the other hand, chemistry teachers who, for various reasons, now have little or no laboratory activity in their courses should find this book very helpful in beginning a laboratory program that can be expanded with time.