About This Manual

In the first chapter (Notes to the Coordinator), we have presented the general structure of Fun with Chemistry camp and the duties of the coordinator. This chapter also gives the coordinator an idea of the tasks involved in organizing the program, a time line with which to follow, and in general an assessment of how to run a program based on the experiences of UW–Madison staff. Included in this section is an important discussion on safety in the laboratory. The second chapter contains notes for the group leader orientation, and a packet of helpful hints to assist the group leaders through the daily sessions. The third and final chapter contains all the information necessary for the laboratory personnel to prepare and set up the daily sessions, including a master chemical and equipment list for shopping convenience.

As shown in Chapter 1, the structure and content of the pre- and post-laboratory discussions can change from program to program. For this reason, the content of the outlines is quite general. Certainly, there may not be time to perform all of the demonstrations listed; the list simply provides a sampling to choose from. We encourage the addition of demonstrations with which you are familiar and would like to incorporate into the program. The outlines should be only a springboard for generating your own agenda. Explanations of the demonstrations are not provided in the outlines. However, explanation is important and will use a significant portion of the discussion time. Many of the demonstrations can be found in the four volumes of *Chemical Demonstrations* by Bassam Z. Shakhashiri, et al., or other texts (Appendix A). Along with instructions on preparation and performance of specific demonstrations, these books explain in detail the chemistry behind the observed phenomena and provide important safety and disposal information.

Finally, the appendices provide a brief list of references, suggested suppliers for harder-to-find items, labels for Days 3 and 5, and a summary of the safety rules for demonstrators.

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Notes to the Coordinator

Program Structure

The Fun with Chemistry program provides 16 hours of instruction in five 3.25-hour sessions. The program focuses on a selected topic of study each day. Since the inspection of a given topic is completed within the allotted time each day, sessions may be scheduled with flexibility. They could be held on consecutive Saturdays during the school year or on weekdays during the summer. Each session is generally split into four parts: two discussion periods, a short break, and laboratory experimentation. A typical daily schedule would be

1:15-1:45 p.m. Pre-Laboratory Discussion
1:45-2:00 p.m. Break (with refreshments)
2:00-4:00 p.m. Laboratory Work
4:00-4:30 p.m. Post-Laboratory Discussion

Pre-Laboratory Discussion

For the pre-laboratory discussion, students are assembled in one large group. During this period the instructor provides general information regarding chemical principles and techniques to orient the student to the laboratory topic for that day. This is accomplished by probing background knowledge and preconceptions about a topic, defining pertinent terms and clarifying difficult concepts through the use of discussion.

Many demonstrations are also used to illustrate the concepts being covered. The lecturer often explains and demonstrates the procedures necessary for the lab activities. Student interaction is encouraged in the form of questions, comments, and participation in demonstrations. The demonstrations are developed in the context of the scientific method, with students making observations, predictions, and conclusions about each experiment. The pre-laboratory discussion also provides an opportunity to discuss safety considerations for the activities of the day.

Break

The break is a time for students to have refreshments while talking quietly (we know this may be difficult) and getting to know one another. Juice or milk and cookies are the standard refreshment at the University of Wisconsin.

Laboratory Work

Under the direct supervision of the staff of experienced group leaders, each student works in the laboratory learning safe and effective ways to handle equipment and chemicals related to a specific daily topic: Elements, Acids & Bases, Ions & Chromatography, Metals & Alloys, and Crystal Growing & Polymers. Within each topic, appealing ("NEAT!", "WOW!") laboratory activities have been selected. These activities include growing crystals, converting copper into brass, and identifying the contents of mystery solutions. Many of the activities encourage students to use their reasoning skills, and at least one activity each day results in a product that students can take home.

At the beginning of the lab (especially on Day 1), the students are encouraged to independently read and follow the directions, and to obtain their own equipment and chemicals; later, they are prompted to draw their own conclusions. The group leaders' obvious enthusiasm for students' observations, results, and conclusions really make the students feel their results are indeed important. Independent thinking is promoted by asking questions throughout the experiment—"How did you do that?", "What do you think causes that to happen?", "What if you did this…?"

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Although some of the students are able to work quite independently, others need considerable direction. They are encouraged to follow the written instructions, but group leaders are ready to help before a student becomes frustrated. Good laboratory techniques and observational skills, sorting out relevant from irrelevant data, are part of the learning objectives. Questions are encouraged. Students are told not to worry about finishing; it is far better to have a quality experience than to simply "finish" a large number of activities. If a group is anticipated not to finish, the group leader may choose to leave a few activities out. Cleaning up the laboratory helps to teach the students the important lesson of responsibility. Students need to be supervised while they clean equipment and discard waste in the proper containers.

If a student or group finishes the activities early, they are encouraged to undertake other experimental measurements. For instance, they can estimate the mass of objects. The students pick up an object, estimate its mass, and then weigh it. Of course, other possibilities which might lead into the post-laboratory discussion abound. Some suggestions are made in this booklet.

Post-Laboratory Discussion

The post-laboratory discussion uses many of the same techniques of student involvement as the pre-lab discussion, but also serves to summarize and tie together the concepts addressed during the day. Students answer questions about laboratory experiments and results in an effort to reinforce learning. The post-lab instructor should perform demonstrations that extend the concepts behind laboratory activities. The post-laboratory session may also be used to do other fun and interesting demonstrations that introduce and create anticipation for the topic of the following day.

Getting Started

Running the Fun with Chemistry program each summer requires the work of many people. At UW–Madison, we have found that we require at least one person for each of the following tasks.

Program coordination and managing
Secretarial assistance for preparation of announcements, processing of applications, etc.
Lab technician to procure and prepare all necessary equipment and supplies
Instructor to test and perform all demonstrations and to prepare the group leaders
Printing services to provide publicity announcements, notices to parents and handouts for students
Laboratory group leaders (one for every four to six students is recommended)

Program Time Line

The pre-program organization of arranging laboratory space, staff, announcements and completing other tasks possibly requires even more effort than the program itself. To simplify your job somewhat, an advertisement, information sheet, and permission slip form used at UW–Madison are included in an Appendix F. The time line given in Figure 1 should also be a helpful tool preparing for a camp.

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Figure 1: Program Time Line

The following is the time line followed by the staff at ICE–Madison in organizing a Chem Camp. The numbers refer to the sample documents in Appendix F (which you are free to reproduce as you see appropriate). In the left-most column we have left space for you to fill in the actual dates for your own time line.

Week of:		
_____	**Five Months Before and Continuing**	❑ Announce program to public (Sample 1). At Madison, this form is distributed along with *Hands–On Activities* packets at SPICE (Student–Presented Interactive Chemistry Experiences) presentations held in local schools and at science fairs.
_____	**Twelve Weeks Before**	❑ Recruit laboratory personnel and secretarial staff. ❑ Order chemicals and equipment.
_____	**Eight Weeks Before**	❑ Recruit group leaders. ❑ Laboratory room reservations, if necessary. ❑ Order T-shirts to be printed.
_____	**Four Weeks Before**	❑ Obtain *Hands–On Activities* packets from ICE, if desired. ❑ Send Sample 2: letters to parents. ❑ Organize honoraria/salary paperwork.
_____	**One Week Before**	❑ Send out Samples 3 and 4: letters to participants and permission forms. ❑ Assign students to groups, assign group leaders to groups, prepare group lists and duplicate. ❑ Conduct a group leader orientation session. ❑ Duplicate Student Safety Instructions and Workbooks and Group Leader Notes. ❑ Print certificates (Sample 5). ❑ Prepare name tags.
_____	**Program Days 1— 5**	❑ Conduct daily group leader orientation and problem solving sessions. Hand out Group Leader Notes. ❑ Laboratory preparation and cleanup. ❑ Purchase refreshments. ❑ Distribute certificates and T-shirts. ❑ Remind students to take all their possessions home.

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When *Fun with Chemistry* was started, it was publicized by sending announcements to area schools; it is now advertised through handouts distributed by our outreach demonstration teams (Student-Presented Interactive Chemistry Experiences — SPICE) and by word of mouth. Contact with the parents of students participating in a summer program is ideally made in mid to late spring.

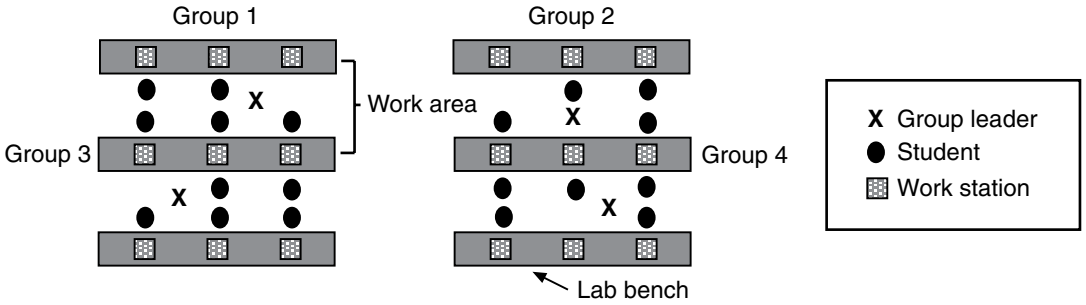
Reservations and program fees ($85) are collected up until one week prior to each session. The fees help to cover group leader salaries and costs of chemicals and equipment. Scholarship students are also accepted if they are unable to pay this amount. We estimate that the actual cost of the program, including instructor and group leader salaries, is about $150 per student. [Refer to Appendix B for more information about costs.] As applications arrive, the students are placed in groups of 4–6, sorted by age and sex, that is, no group contains a single girl or a single boy. The students remain in the same group, with the same group leader, for the duration of the program. A list of these groups and group leaders is prepared and printed, and distributed to the students at the end of the pre-laboratory discussion on Day 1. Information sheets and permission slips that are mailed to the accepted applicants are collected the first day of the program.

The staff of laboratory group leaders is arranged 2–4 weeks prior to the program. They are chosen from a pool of graduate students, medical students, and undergraduate science education students who respond to departmental announcements issued late in the spring semester. Group leaders at Madison have all been through at least six semesters of college-level chemistry. The current wage for the group leaders is $200 for each 1-week session. The group leaders meet with the program instructor prior to Day 1 for an orientation session and pep talk (see the section on Group Leader Notes).

Laboratory booklets used by the students are sent to be printed at least one week prior to the start of each program; additional printing jobs such as group leader handouts, name tags, and group lists are also completed the week prior to each program. Certificates are printed for each student and these are handed out on the last day. T-shirts are also given to each student, so arrangements need to be made for T-shirt printing six weeks prior to the program. Many of the chemical and equipment items used in the student laboratory activities are not common supplies and are ordered six weeks prior to the program. Lastly, refreshments for the breaks, such as juice and cookies, must be purchased. (You may wish to ask your students to provide their own beverage holders in the interest of environmental friendliness and cost reduction.) It is not recommended to eat in laboratories; therefore, a separate, chemical-free room must be made available.

Preparation of Laboratory Classrooms

At UW–Madison, the freshman chemistry laboratories are used for Chem Camp. Before the camp starts, the labs are divided into designated work areas for each group. Signs showing the number of the group that will occupy a given work area are placed on the lab benches, in order to avoid first–day confusion. In our lab rooms, six stations are available in each work area. We allow the students to choose a work station within the group's work area. Below is a floor plan of the laboratory classroom.



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Each work area ideally will have one top–loading (cg or mg accuracy) balance. Also, a combination hot plate/stirrer should be available for every two students. Below is a list of general equipment required per student. It may be conveniently stored at each student's work station. A more detailed list is provided in the Laboratory Support Guide section.

- ❑ Safety goggles
- ❑ Stirring rod
- ❑ Ringstand clamps
- ❑ Tongs
- ❑ Bunsen burner
- ❑ Forceps
- ❑ Spot plate
- ❑ Glassware
- ❑ Pencil
- ❑ Hot Plate/stirrer (per 2 students)
- ❑ Top loading balance (per 4–6 students)

Certainly the program can be run with less equipment, but sometimes at the expense of the number of activities that can be done. It may be necessary to substitute different sizes of glassware and to have more than two students share a single hot plate/stirrer or graduated cylinder. The chemicals and supplies that are shared by all groups are placed centrally on a lab cart from which the students can serve themselves. Dispensing solutions requires a supply of bottles; sometimes a single large bottle with a valve at the bottom may be more convenient than a large number of small bottles.

Specific materials are given in the daily guides. In the lists of materials, generally the quantities are calculated per student; however, occasionally they may be specified for a group of not more than five students. A few activities, because of safety considerations, are designed to be done only by the instructor, with the students observing. Major changes such as the substitution of chemicals or quantities used in the experiments should be carefully tested before used with students.

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