New Mexico State University
Department of Chemistry and Biochemistry

TA TRAINING MANUAL

Fall 2013
FOREWORD

The purpose of this manual is to familiarize you, the teaching assistant for our department with the purpose that a teaching assistant serves in our department. I will try to explain what are your duties and responsibilities within the framework of our department, as well as the rights that you have as a teaching assistant at the Department of Chemistry and Biochemistry of New Mexico State University. In essence, this manual will serve as a reference guide. I will try to explain what is expected of you in this very important component of instruction in a major university. A do's and do not's set of rules that hopefully will guide you through the academic year that you will be serving as a teaching assistant in our department.

Becoming a teaching assistant can be an intimidating experience. This can arise from not knowing what to expect in this position, which is probably new for most of you. This manual will hopefully remove some of the mystery and ease your anxiety. Nevertheless, not all situations can be expected to be discussed in this manual, but that is what life is all about sometimes, new situations and how we respond to them allow us to grow as persons. Hopefully, this manual will be a practical guide to most of the common experiences that a TA encounters in his or her duties and can serve as a starting point in your graduate student life at NMSU.

Welcome to our department and hope that you enjoy your graduate student career with us and best of luck in your academic pursuits. Have a successful and enjoyable academic year.

Sincerely,

Dr. William Quintana
Professor and Department Head
CONDITIONS OF SERVICE
TEACHING ASSISTANT

WHAT IS A TEACHING ASSISTANT?

The teaching assistant is best defined as a full time graduate student registered at
New Mexico State University. Teaching assistants are chosen based on their potential for
elegant scholarship and future promise as teachers. Teaching assistants serve an
apprenticeship period under the supervision of a regular faculty member. A teaching
assistant is an important member of our university and helps fulfill our institutional
mission as a land grant university.

APPOINTMENT

Your appointment is made by our department and must be approved by the
Graduate Dean. Appointments are for one semester, two semesters, or an entire year. In
some cases, TA-ships may be awarded at less than 50% time with a proportionate
reduction in salary. Any teaching assistant that works more than 50% must be approved
in writing by the Department Head and the Graduate Dean.

The aggregate length of time of all appointments as a teaching assistant or
research assistant cannot exceed four years. A fifth year of support might be possible
(not automatic) if the graduate student petitions the Graduate Dean and has completed his
or her oral comprehensive exams. Under no circumstance can support be provided
beyond the fifth year limit.

WORKLOAD

Teaching Assistant workloads are intended to allow you to fulfill your own
academic obligations. Teaching assistants are employed half-time (.50 FTE). You are
expected to devote an average of 15 to 20 hours per week to TA duties during
instructional and examination periods, time not to exceed 220 hours per semester. These
hours include all time spent in preparation, classroom and laboratory teaching, office
consultation, and reading student papers. You should also be informed that " .50 FTE"
means a half-time job in University language, "FTE" = full-time equivalent.

RESPONSIBILITIES

The teaching assistant is responsible only for the conduct of recitation, laboratory
or duties assigned by the supervising faculty member. The teaching assistant is under the
active direction and supervision of a regular member of the faculty to whom final
responsibility for the course's entire instruction, including the performance of his [or her]
teaching assistants, has been assigned. A teaching assistant is not responsible for the
instructional content of a course, for selection of student assignments, for planning
of examinations, or for determining the term grade for students. Neither is the TA
to be assigned responsibility for instructing the entire enrollment of a course or
providing the entire instruction of a group of students enrolled in a course.
SUPERVISION AND REVIEW

The selection, supervision and training of all student teachers are an important responsibility of our department, and in particular of the Academic Department Head. All candidates for appointment and reappointment should be subjected to a careful review and recommendation. A person designated by the Department Head, the department as a whole or an appointed committee, can do this recommendation.

GUIDELINES TO BE APPOINTED AS A TEACHING ASSISTANT

Like any enterprise in life, a set of guidelines is needed to ensure quality. In order to be appointed as a teaching assistant in our department, the following rules must be followed.

1. You must be a student in good academic standing. For a student to be considered to be in good academic standing, the minimum GPA required is 3.0. Obviously, those of you that are first year graduate students, are in good academic standing since you were accepted into our academic program, but your grades from this point on must not fall below the minimum GPA. This can result in cancellation of your appointment. Any student that after his or her first semester at NMSU obtains a GPA below 3.0 will be placed in academic probation and as a result of this fact, might not be entitled to a teaching assistant position until his or her GPA increases to the minimum of 3.0 or above.

2. A teaching assistant must exhibit proficiency in the English language. The minimum TOEFL (Test of English as a Foreign Language) required by our department is 600. Any foreign student admitted into our program from non-English speaking country must also attend the ITAL course during the summer. Any student that does not meets the minimum English proficiency requirements must enroll in the required course to help you improve your communication skills and is not allowed to teach in a laboratory until proof of improvement is offered. Lack of improvement can result in the cancellation of your teaching assistantship.

3. You must be a full time student within our department. You must enroll into three chemistry courses a semester for a total on nine credit hours. Each division within our department has required courses that students must enroll and make appropriate progress. Any student wishing to take courses outside our department, either in excess of the minimum nine credit hours or in substitution of all or part of the minimum nine credit hours requirement must receive written permission from his or her graduate advisor(s) and the Chemistry and Biochemistry Academic Department Head.

4. Each teaching assistant must attend the safety orientation provided by the Department before working in any teaching laboratory. This will include the required Right-to-Know information. Failure to be certified in safety regulations will result in cancellation of your teaching assistant appointment.

5. Teaching assistants must attend the University sponsored graduate student orientation offered by the Graduate School prior to the start of the fall academic semester.
6. Finally, you must follow all instructions given to you by the instructor in charge of the course. The instructor in charge will set all policies dealing with the laboratory component of the course and is the only person that can make changes dealing with experiments, grading policies, and excusing students from a laboratory. The Teaching Assistant cannot make policy in any course that he or she is assisting the major instructor of the course.

7. Your appointment is for 20 hours a week. This includes the laboratory sessions that you will be responsible for teaching, grading reports and quizzes in a timely fashion, proctoring departmental exams and other duties that the instructor in charge of the course might assign to you as part of your appointment. You must be available to perform these duties when directed by the instructor in charge of the course. If for some reason you cannot perform these duties, it is your responsibility to inform the instructor in charge of the course as soon as possible.

**DUTIES AND RESPONSIBILITIES OF TEACHING ASSISTANTS**

Your duties depend on your background and experience in the field of Chemistry. They may include but are not limited to the following:

1. Assisting students and instructor during the laboratory session.
2. Preparation of materials for the laboratory session as directed by the instructor.
3. Checking equipment in and out of the chemistry stockroom.
4. Checking students in and out of the laboratory at the beginning and end of the semester.
5. Grading laboratory reports, quizzes or exams as requested by the instructor.
6. Other duties, such as taking inventory, putting chemicals back on the shelves, cleaning equipment and making sure that at the end of the period the laboratory is ready for the next group that needs to use it.
7. Some suggestions on how to conduct yourselves as teaching assistants:
8. You are probably the most important person in the academic life of your students. Your attitude will definitely have an impact on how the students perceive the course. Therefore you must treat all your students with respect and fairly. It is important that you show a genuine interest in their performance in the laboratory and assist them when they request help or when you see that help is required.
9. Arrive at the laboratory a few minutes before the scheduled start of the experiment. This shows dedication to your job and also allows for checking that the room is ready for the scheduled experiment of the day.
10. Attend all the meetings scheduled by your instructor that deals with the laboratory. You must be more knowledgeable of the experiment than the students, so you can explain it to them. It sets a good example when you can actually answer the questions that your students have concerning any experiment.
11. You are responsible for ensuring that all the chemicals needed for an experiment are actually in the laboratory and that the equipment needed for the experiment is in working order. Any problems have to be reported immediately to the stockroom, so they can assist you in correcting the problem prior to the start of the laboratory session.
12. Effective teaching means direct contact with the students in your laboratory session. Make sure that you visit each station at least once during the experiment and that the students are performing the experiment according to the instructions given in the laboratory manual.

13. Always be in the lookout to help students develop good laboratory techniques and safe practices. Remember that you are the expert in the laboratory and you are training students in a very important aspect of chemistry.

14. Your duty during the laboratory period is to be aware of what is going on in the session at all times. You must be attentive at all times. Therefore, grading papers, studying for a class, leaving the room are not allowed during the laboratory session. Neither is talking to students of other topics other than the experiment at hand.

15. Help students without doing their work.

16. Provide feedback to the instructor in charge of the course about course materials, student attitudes, typos or mistakes in the laboratory manual, etc. You can suggest changes or innovations to any of the laboratory experiments for consideration from the instructor in charge.

17. How to grade the report or quizzes should be worked out between the instructor and you. Make sure that you follow all the instructions given and if in doubt, ask for clarification.

18. Be prepared at all times. You must be familiar with the experiment that you are supervising. Students can sense lack of preparation on your part and they will be frustrated and dissatisfied. This in turn can discourage students to attend the laboratory, resulting in them failing the course and you are responsible.

19. Take this opportunity to learn how to teach. In the future, you will find that in any job there is always a “teaching opportunity” that will present itself. You are helping our department prepare the next generation of professionals and you must take this responsibility seriously.

20. Be friendly to the students, but never become too familiar or inquire into their personal lives. Never become involved romantically with any student under your supervision.

21. Any student that approaches you with a personal or health problem must be referred to the instructor in the course. The instructor will make the determination whether or not the student should be referred to a professional in the area of their problem.

22. There is always the possibility of conflict of interest.

23. You should not tutor any student in your laboratory for profit. Remember you do have a grading responsibility with that student; so it is inappropriate that you accept monetary compensation for helping a student in your laboratory session.

24. It is unwise to engage in a romantic relationship with a student under your supervision. If such involvement develops, the university rules state that you must inform your immediate supervisor and you will be probably transferred to another laboratory session.

25. Be very careful with remarks that you make to students of the opposite sex. You could be accused of sexual harassment because of an innocent comment.
26. Be accessible to your students outside the classroom. You are required to keep at least one hour of office hours per laboratory session that you teach. Therefore, if you teach two laboratory sessions a week, you are responsible for a total of two hours of office hours every week. Room 110 in the Old Chemistry Building is the designated room for all TA’s to hold their office hours. You must inform your students of your office hours, so they can reach you. If for some reason a student cannot attend your office hours, try to make a reasonable accommodation to that student.

27. Some students in your laboratory session might have special needs. The law states that students with documented disabilities must be given reasonable accommodations so they can successfully complete the laboratory experiment. If you have any questions regarding this issue seek advice with the Disable Student Programs coordinator at 646-1921 and/or the Americans with Disabilities Act Coordinator at 646-7795.

28. At the end of the semester, you are responsible for distribution student evaluations to your students enrolled in the laboratory session. A student in your laboratory must turn in the evaluations to Ms. Denise Pedraza, the secretary of the General Chemistry Program. You are not allowed to handle these evaluations once the students have filled them. A summary of your evaluations will be given to you in a timely fashion, once they have been tabulated and examined by the Department Head and the Coordinator of the General Chemistry Program. The evaluations will become part of your permanent academic record in our department.

29. Grading should be done fairly and in a timely fashion. Your students have the right to know how they are performing in the laboratory. This will reduce anxiety and give the student the opportunity to avoid repetitive mistakes and thus improve their score. A grade book must be maintained and all scores faithfully entered. You should post midterm grades for your students. This is important, since the students do have the right to withdraw from a course that they are not performing well. At the end of the semester, you are expected to have completed your grades and submit them to the instructor, so he or she can use them in calculating the student’s final grade in the course. The instructor needs this information since students sometimes ask for letters of reference and the laboratory grade is a good indicator of the capability of a student.

30. Any situations, in which you are not sure to proceed, consult with the instructor in charge of the course. Remember that you are part of a team and that the instructor in charge is the person responsible for the course, therefore it is important that the lines of communication between teaching assistant and instructor are kept open.

31. If you need photocopies for an experiment, make arrangements with the main office to have the copies done prior to the start of the laboratory session. DO NOT SEND A STUDENT FROM YOUR SESSION TO ASK FOR THE COPIES TO BE DONE.
CHEMISTRY DEPARTMENT LABORATORY RULES

I. No drinking, eating, or smoking is allowed in the laboratories. Any student that does not abide by this rule will be asked to exit the laboratory until the problem is corrected. Do not put any objects into your mouth in the laboratory room.

II. Unless official rules posted specifically for a course indicate otherwise, there is no work to be done by students alone in the laboratory room or outside the regularly scheduled laboratory hours.

III. Safety goggles or glasses must be worn at all times. It does not matter what you are doing in the laboratory or whether or not you are wearing prescription glasses. This includes the Teaching Assistant as well as the students. There are no exceptions to this rule. Anybody not following this rule will be asked to leave the laboratory room until the problem is corrected. The stockroom does rent out goggles to students that do not bring their own to the laboratory session. The charge is $1.00 per laboratory session, the safety goggles must be returned to the stockroom once the experiment is over.

IV. Only faculty-authorized experiments are permitted.

V. Bare feet, sandals, open-toed shoes are not allowed.

VI. Pants, shorts, skirts, dresses are to extend below the knee-cap, no bare midriffs or tank tops in the laboratory. Any student dressing inappropriately must go to the stockroom to rent appropriate dressing equipment for the laboratory.

VII. ALL incidents with suggest a potential of bodily harm (regardless of the presence or absence of an actual injury) or breakage of apparatus is to be reported to the instructor in charge of the course or to a qualified laboratory assistant or to the stockroom manager immediately. An incident report form must be filed with the stockroom (they keep copies in the stockroom), regardless of an injury or not. A sample of this document is found in this manual.

VIII. You must know all the safety related emergency equipment present in the laboratory and how to use the equipment. This includes:

1. eye wash stations
2. fire extinguishers
3. safety shower(s)
4. fire blanket(s)

IX. In case of a fire alarm or a hazardous fire taking place in your laboratory, evacuate the room immediately and notify the fire department as soon as possible. DO NOT ATTEMPT TO EXTINGUISH A FIRE THAT IS CLEARLY OUT OF CONTROL THAT IS THE DUTY OF THE FIRE DEPARTMENT. YOUR DUTY IS TO MAKE SURE THAT YOU AND YOUR STUDENTS ARE SAFELY OUT OF THE ROOM.

X. Know the locations of all exits from the laboratory room in case of an emergency and instruct your students on their locations and what to do in case of an emergency.

XI. Wipe off your work area thoroughly with a wet sponge before leaving the laboratory room. Rinse out the sponge thoroughly with cold water after using it.
All spills are to be wiped up immediately with cold water and a sponge. Additional details or rule modifications may apply for particular experiments.

XII. Form a cleaning detail among your students, making sure that all the stations are thoroughly clean before leaving the laboratory. Remember that other students will be using the same room later on the day or the week, so it is good manners to leave the laboratory room. This includes picking up trash and placing it in the appropriate containers. Also wipe clean the whiteboards on the room, the next teaching assistant will be using for his or her laboratory session.

XIII. Wash hands thoroughly with soap and water before leaving the laboratory.

CONDUCTING A LABORATORY

Chemistry is an empirical discipline; therefore the laboratory is an important component of the course. Through the laboratory experience, the students enrolled in your course will see the concepts explained in the lecture applied in real time. Students tend to learn and retain information in a more effective way after a hands-on experience. Therefore, your responsibility as the laboratory instructor is to assist students in achieving the following objectives:

1. Give the student the opportunity to carry out experiments.
2. Make careful observations and record information accurately.
3. Become proficient in laboratory techniques and in the use of instruments.
4. Collect and analyze data in a scientific manner.

A. Learn to interpret results and draw valid conclusions.
B. Provide applications of concepts and principles discussed in lecture.
C. Develop the ability to plan and carry out tests.
D. Learn to work independently and make decisions.
E. Cultivate a team spirit when experiments call for students to work in pairs or groups.
F. Gain respect for the difficulties involved in performing some types of experiments.
G. Acquire skills in using the scientific method.
H. Stimulate interest, enthusiasm and appreciation for science and its impact on everyday life and living.

I. Preparation

You must read the experiment prior to the start of the laboratory session. You also must be prepared to conduct a short recitation prior to the experiment. The recitation must include the outline of the experiment, sample calculations to be used in the experiment, changes in procedure, if any and stress the safety procedures for the particular experiment. It is your duty to help your students to complete the experiment in the allotted time. Provide guidelines on how to use time effectively and reduce errors in the experiment. It is a good policy to familiarize yourself with the experiment, so you can offer meaningful suggestions to your students.

When returning graded work to your students, make certain that you have recorded the scores in your gradebook or spreadsheet. Make sure that you take the graded work with you to the laboratory.
II. Laboratory Protocol

You must arrive early to your laboratory session and check the room for cleanliness, safety features and necessary chemicals and equipment needed for the experiment. In case that you find a problem, report it immediately to stockroom personnel or the instructor in charge of the course. Become familiar with how an instrument operates. If an instrument requires a warm up period, turn the instrument on as soon as you arrive in the laboratory, so that your students can use it for the experiment.

Discuss the experiment for the day during the first 15 minutes of the laboratory period. Ask students questions, to probe their understanding on the experiment. This will help them crystallize in their minds what they are supposed to do during the experiment. This is a good opportunity to emphasize the safety rules, use demonstrations if necessary and introduce techniques or how to set up an apparatus. You must start the class on time and take attendance. Punctuality is a fairly good indicator of the student’s attitude toward the course.

The rules of our department state that students at all times during an experiment must wear safety goggles. You are responsible for enforcing this rule. If you do not set the example by wearing safety goggles during the laboratory session, you cannot expect the students to follow this rule. If a student gets injured during an experiment, you might be liable if you did not enforce this rule.

Circulate among the students during the experiment. Interact with them and check that they are recording their data in their laboratory notebook, ask questions about the experiment and when necessary offer suggestions on how to perform a task, but do not perform the task yourself. Do not sit at your desk the entire period. You must go to the students, not the other way around. Remember that you are the supervisor for the experiment, so you are not supposed to be grading quizzes or reports or doing homework during the laboratory session. Some students are slow or insecure, be ready to assist them if necessary. Other students are anxious to leave the laboratory as soon as possible, be aware that they might make mistakes that can result in injury if they are hurrying and not following safety procedures. Make sure that each student performed the experiment, collected individual data and cleaned up its area once he or she finished the experiment. You must sign the laboratory notebook and the laboratory manual before the student leaves the room. All entries in the laboratory notebook and manual must be done in ink.

Returning graded laboratory reports is of paramount importance. You should offer suggestions that will help the students to improve their lab write-up and earn higher scores.

You should be ready to handle accidents. Knowledge is power in an emergency situation. You are not alone in this situation and the authorities in the department and outside the department will be ready to assist you. An incident report must be completed and submitted to the appropriate authorities. You must be familiar with the use of fire extinguishers, fire blankets, safety showers and emergency exits. If an emergency situation develops that you are not sure you can handle, evacuate the laboratory room as soon as possible. Your personal safety and that of your students is your first concern in any emergency situation. Be calm and levelheaded and help the students to exit the laboratory in an orderly fashion.
All students must be able to finish the experiment on time. Careful planning is important. Do not let students work overtime too often, since one bad habit is established it might very difficult to break.

At the end of the period, you and your students are responsible for the clean up of the room. Each student is responsible for cleaning up his or her immediate working area. Furthermore, common areas, like the hood, must be left clean before leaving the laboratory. Other groups will be using the same room, so it is important that the room is clean. Before leaving the room, you should check utilities such as gas, water and air outlets, electrical appliances and any other potential hazard sources.

III. \textbf{Special Situations}

The first and last periods are typically conducted differently depending on the nature of the course. The first meeting can be used as a get to know the student session. Introduce yourself to the students and give them useful information, such as your name, laboratory section number, office hours and location of your office, telephone number of your research laboratory (if you are working on one), your e-mail address. Collect information on 3 \textit{X} 5 cards, such as the student’s name, e-mail address, emergency phone numbers, etc. This will facilitate efficient and effective interaction between you and your students.

In some courses we require a formal check-in and checkout procedures. During the check-in, students are assigned lockers or drawers containing the necessary equipment to perform experiments during the semester. They must carefully check all items listed on the check-in list and inform you of missing items, so that they can be obtained from the stockroom. After they have make sure that they have all they required equipment in their drawer, they are required to sign the form in acknowledgment. During the semester, every student has to keep track of his/her supplies and replace any missing or broken items in keeping with departmental policy. Checkout is typically scheduled for the last week of classes. The students must make certain that they return all of their equipment in good condition and clean. Any missing item has to be reported to the stockroom and the student will be charged a fee for replacement. An inefficient checkout by the teaching assistant lead to financial losses for the department and with tight budgets this would affect the quality and successful operation of the laboratory program.

IV. \textbf{Laboratory notebooks, reports and grading policy}

The laboratory notebook is a valuable record of all work performed in the laboratory and as such every student is expected to keep and maintain an accurate laboratory notebook that reflects the work performed in an experiment. Students must use their laboratory notebook to record all data and procedures employed during an experiment. The purpose of this is two-fold. First, in case of a discrepancy, the laboratory notebook can be used to reconstruct an experiment that a student has performed and to which no report is found. Second, it will teach students that in chemistry, as well as in other disciplines, recording the data is an important component of science.
Students are also required to have the Prelab questions of their laboratory manual answered prior to the start of the experiment. Answering these questions ensure that the student has read the experiment, improves efficiency in time management, increases safety awareness and reduces the potential for accidents. The Prelab questions are part of the final report that the student must submit for every experiment, so they must be graded and its score added to the report that the student submits after finishing the experiment.

All information obtained in the laboratory has to be entered in the laboratory notebook and not on scraps of paper. It is the teaching assistant responsibility to see that students develop good skills in documenting their observations and data. You must sign the student’s notebook and laboratory manual before he/she leaves the laboratory.

Additionally, students are required to submit a written report upon completion of an experiment. You must emphasize that students turn in their written reports in a timely fashion. Do not accept late reports unless a well-documented excuse is presented. Valid excuses are: illness, death in the family or participation in an University sponsored event. The instructor prior to acceptance of a late report must clear any other excuses. The reason for not accepting late reports is simple; students develop bad habits and get the wrong impression that reports can be turned in at any time during the semester, which is not acceptable under most circumstances.

Some instructors will provide you with a grading key to maintain some uniformity in grading. You also must be prepared to explain your grading scheme to your students. Students do compare grades and you should always be aware of this and ready to explain it to the students. If a dissatisfied student approaches you and there is an inadvertent error in grading, you must correct the situation immediately. Any controversy or problem that you do not feel sure that you can solve, consult with the instructor in charge of the course, remember that is the ultimate responsibility of the instructor to set up the grading policies of the course.

It is your responsibility to keep a gradebook and to enter all scores faithfully in the gradebook. You will be required to turn in all scores obtained by the students to the instructor in charge of the course. In certain instances you might be required to assign points for subjective evaluation of each student. Some examples are: how prepared is the student in the laboratory, correct use of laboratory techniques, cleanliness in the laboratory, efficiency in completing experiments, quality of laboratory notebook and reports, interest and attitude and experimental attitude.

V. Conclusion

The experience in the laboratory is a learning opportunity for the student and the teaching assistant. The fact is that as everything in life, the unexpected can happen, but do not be discouraged, you will learn from the experience. Encountering difficult situations is part of the process of learning. If you confront a problem with patience and perseverance, you will succeed even under difficult circumstances. Remember that your instructor is always available for help and will provide advice any time that you request it.
TEACHING STRATEGIES

To become an accomplished teacher you need to practice and become proficient in different aspects of teaching. A teacher can change students' behavior. By improving in the different facets of teaching, you can make an impact in the life of your students. In this section we will present those aspects of teaching what most of the time are taken for granted, but if they are taken seriously can make a huge difference on your success as an effective teacher.

I. Use of the Blackboard

It might seem a trivial task, but an effective use of the blackboard is one of the most important skills that a teacher can develop. You must for a moment look at this skill from the point of view of your students. Look at your writing as though you were a student in your own class. Your students depend on you in this respect. It might seem to you that everything that you write on the blackboard is probably clear to you, the test that you must pass is to make your blackboard presentation clear to a student seeing it for the first time.

The principles that you must follow are:

A. Students must be able to see and read what you have written. Illegible or obscured work is worthless.
B. Students must be given time to copy what you have written. They cannot think analytically very well while they are writing.
C. Your board work must be organized so those students later will be able to interpret their notes. You must be organized in your use of board space as well as in your method of presenting material.

Let us look at each of these points individually.

1) Seeing and reading: Even in an average sized room, students in the back rows may have trouble reading words in a small handwriting and they may not be able to read even large words if they are scrawled or written too lightly. Unless the floor of the classroom is sloped, students of average height sitting behind the two rows will not be able to see the bottom of the board. To find the effective bottom of the board, sit in the last row while your class is occupied with some task and note the line below which a student of average height would find it difficult to copy notes. You might want to mark this line with a piece of chalk. If there is a desk at the front of the class, keep it clear of objects that might obstruct their vision.

Try to keep your work visible for as long as possible. If you are right-handed, fill the right-hand panel first, then move to the panel on the left and continue your writing. In this way, you will not be blocking the view of students copying the writing that you have just completed. If you are using a sliding, three-layered blackboard, fill the middle board first, then push it up and pull the front board down. When the front board is full, push it up and use the back board.
2) Time to copy: Most students will copy everything that you write on the board. If you ask them to analyze and idea, they will not begin to think analytically until they have finished copying. When you want them to make a point, stop writing. Let people catch up to you. Then begin your discussion. Similarly, if you have engaged in a long discussion without writing very much on the board, allow them time to summarize the discussion in their own minds and to write their summary down in their notes before you again begin to use the board or to speak.

If a TA modifies part of the board work before they have a chance to copy it, it will result in frustration for the students. A good rule to follow is that you should only erase the board when you run out of space to write. If you find to make a mistake, do not erase them without an explanation, acknowledge that you made a mistake and correct them while explaining what the mistake was.

If you are modifying a drawing, use dotted lines or some other techniques to show changes. You must remember that a student cannot make the same erasures that you can in a blackboard, without losing his written record of intermediate steps; you can alter parts of a drawing much faster than he can reproduce the whole thing. Erase only the oldest or least important work. Erase the entire panel to avoid the implication of a connection between new work and any unerased work.

3) Organization: (a) First erase the board completely. This step is especially important when mathematical equations are written. Stray lines may be interpreted as symbols. (b) If you are to solve a problem, write a complete statement of the problem on the board, or write a precise reference. (c) Fill in one panel at a time, always starting at the top and moving down. (d) Make your notation consistent with that in the textbook or the professor’s lecture, so that students do not have to translate from one system of symbols into another. (e) Underline, or in some other way mark, the most important parts of your presentation. The major assumptions, or conclusions, or the intermediate steps that you plan to refer to later on. Colored chalk may help to clarify drawings. (f) At best, the blackboard is only a teaching aid. Break your presentation into manageable parts and give students a chance to deal with facts and concepts as you present each part, or just afterward. Then verbally outline the text part of your presentation. If you neglect to do this, your students may be copying blindly, without any idea of where your are going.

Evaluation of your use of the Blackboard

You can determine how effective your use of the board is in several ways: (a) After class, without prior notice, request one of your “A” and one of your “C” students to lend you their notes. If the notes seem incomplete, ask yourself, “What could I have done to help them catch the points that they missed?” (b) Stop yourself twenty minutes into your presentation and ask yourself, “If I were one of these students, would all of the major points written on the blackboard be clear and coherent?” If you are not sure of the answer, ask your students. (c) If possible, tape one of your presentations and viewed at a later time. This will place you in the position of your students. You might ask yourself
the following questions: Did I violate any guidelines suggested in this manual? What were your reasons for doing so?

This will hopefully help you to use the blackboard more effectively and learn how to look at your work from your students’ point of view.

QUESTIONING SKILLS

As a chemistry teaching assistant, you will ask questions for a variety of specific reasons. You may want to find out what your students have learned in lecture about a certain subject. You may want to find out how well your students have prepared a lecture or laboratory assignment. You may want to use questions to guide a student in solving a problem in a classroom or laboratory setting. In general, as a chemistry teaching assistant, you will frequently encounter teaching situations in which asking effective oral questions are your most important skill.

Level of questions

The kinds of intellectual skill of your students will develop vary in complexity. Sometimes you will be satisfied that a student simply know (i.e., have memorized) a fact. At other times, you will expect more sophisticated reasoning. For example, you may expect them to use evaluative criteria in selecting from among two or more synthetic routes to a compound.

A system of classifying educational goals according to a hierarchy of intellectual skills was developed in 1956 under the editorship of B. S. Bloom. In this hierarchy, six broad categories of educational goals are established. These are:

A. Knowledge: the simple recalling of facts.
B. Comprehension: the ability to translate into one’s own words; using a given equation to solve a problem; translating a literal statement into an equation.
C. Application: the ability to apply concepts to a specific situation; the recognition and ability to solve a problem in which equations are not provided.
D. Analysis: involves all that application does and also requires that students recognize component parts within material. Distinguish relevant from extraneous material as well as fact from hypothesis.
E. Synthesis: requires that students assemble components into a form, which is new to them; design a research plan; devise a synthetic scheme.
F. Evaluation: the ability to judge the value of materials in terms of internal and external criteria.

It is much easier to list these categories than to gain enough experience to use them effectively. As you question your students, you will want to keep in mind that there are different levels of questions. If most of your questions are at the knowledge level, many students quickly become bored and pay no attention. If most of your questions are at the synthesis or evaluation levels, many students will be unable to participate and will quickly become discouraged. Therefore it is important to use a questioning strategy that provides a balance.
Questioning Strategies

Two pairs of question types may be identified as particularly helpful in planning questioning strategies.

An initiating question begins consideration of a particular topic. Initiating questions can be planned in advance to make them suitably interesting. Initiating questions can be arranged in sequence from simple to complex (remember the six levels or categories) to fully develop the various aspects of a concept. Frequently, you will find it desirable to follow the initiating question with one or more probing questions. A probing question is asked of the responding student to bring out more of what he/she knows about the subject. Probing questions are not easily planned; the nature of the probing question depends upon the student’s initial response.

Convergent questions require students to solve problems, which have a single correct answer. Questions aimed at the first three categories of educational goals (knowledge, comprehension, application) tend to be convergent. Divergent questions require examination of problems for which may answers are plausible. The last three categories of educational goals (analysis, synthesis and evaluation) lend themselves to divergent questions. For example, a standard organic chemistry text may provide students with sufficient reactions such that one general synthesis may be approached through five routes. A teaching assistant may want to get students to first come up with several of these routes, and then to evaluate them so as to select one best available route.

Formulating Questions

How a question is stated often determines its effectiveness. You must consider the following:

A. Avoid questions that are ambiguous. Questions that are direct are better. The use of a measurable verb, such as name, write, balance, etc. gives a direction that the student can easily follow.

B. Avoid yes and no questions. For example, the question: “Is carbon monoxide considered a pollutant?” is almost certainly to be followed by “Why is carbon monoxide considered a pollutant?” so you might as well begin with the second question.

C. Avoid double-barreled questions. Questions, which pose two problems simultaneously, are confusing and are to be avoided. For example, the question “What is the difference between fission and fusion, and how is electrical power generated from these reactions?” is actually a three in one question.

Questioning and Responding Techniques

How a question asked and the manner that responses are treated is extremely important. We have talked about the levels of questions, strategies of selecting questions and how to phrase of questions. Even though these aspects of questioning are important, the efforts you expend on these tasks is lost without follow-through in managing the questions.
I. You must wait a prudent amount of time after you ask a question. Typically a pause of several seconds, except when asking a memory or recall question is appropriate before selecting a student to respond. This should be done even if volunteers appear immediately. Following a response from a student, wait several seconds before you provide the correct answer or validate the answer provided by the student. Waiting after a question gives every student in the class an opportunity to think about a response. Picking a respondent immediately allows other students not to think about a response. They will listen to the respondent but will pay little attention to the answer. The period of waiting gives the respondent an opportunity for the student to expand on the answer. Frequently, the student responders will self-initiate an extended response and thus you will not need to use a probing question to elicit the extended response.

II. Distribution of questions among students is important. You should try to bring as many students as possible to participate. You can choose from among volunteers, but also feel free to call upon students that are not volunteering.

III. You may reinforce responses with verbal praise and with non-verbal encouragement. By repeating a student's response also serves as positive reinforcement. Never ridicule an answer. Although it is tempting to do this when a response is foolish, it sends the wrong message. Students will feel threatened and will not participate any further.

IV. Use your students to reinforce one another and to help you eliminate erroneous responses. For example, ask the class to comment on respondent's answer both when they are correct and incorrect. This is a good way to allow a student's peers to deal with foolish responses.

V. When you are using divergent questions, it is particularly helpful to get students debating with one another. For example, when two students have each devised synthetic route to a compound, debate between the two as to which is a preferred route is going to be a valuable learning experience for both of them and the class. Such debate may be conducted at the evaluation of the goal hierarchy.

Tutoring

During the course of your academic career you might find an opportunity to tutor students enrolled in chemistry classes. It is important that you understand that the dynamic encountered when tutoring a student on a one to one situation is different than lecturing in a class. Likewise, tutoring often takes place on an impromptu fashion. Students typically ask questions prior to the start of the laboratory session or right afterwards. The ability to deal effectively with these tutorial situations is essential to your success as a teaching assistant.

A prime role of any teaching assistant role is to help insure that as many students as possible will attain the instructional objectives of the course. In another words, the teaching assistant must assume some of the responsibility for the success or failure of students. In order to know whether or not a given student is having difficulty in achieving instructional goals, a rapport must be established between student and teaching assistant whereby the student will feel comfortable about getting help. The quality of help you can provide to your students will be a function of the care that you take in
following a few steps designed to increase the likelihood of success of the tutoring experience.

Analysis of Tutoring Technique

Your first step toward effective tutoring is to become acquainted with each individual student in your class – the student’s name, ability, and feelings toward chemistry. Then, when an actual tutoring situation arises, you will be able to identify with the students’ feelings about difficulties encountered in mastering a particular problem or laboratory manipulation.

At the beginning of a tutoring session, you can best begin by determining what general educational objective the student needs to achieve. This might be obvious in some cases or quite difficult in other situations. This can be accomplished by asking the student to specifically identify the principle or concept giving the student problems. This way you can ascertain which educational objective must be met to allow the student to comprehend the problem. You may have the student attempt to work out a problem to demonstrate what specific skills are already mastered. While the student responds to questions, you should listen carefully, identifying what the student knows and what gaps presently exists in his/her understanding. Examples of this process are given below.

If the student requesting help is “having trouble with the chapter on Chemical Arithmetic”, a few questions may reveal that the general educational objective is for the student to be able to solve stoichiometric problems involving the masses of any or all reactants or products given the mass of one reactant or product. For you to be satisfied that the objective has been met, the following specific performances might be required.

1. Write the formulas for all compounds involved.
2. Write and balance the equation for the reaction.
3. Write conversion factors relating grams to moles.
4. Write conversion factors relating moles of one reactant or product to moles of another.
5. Write an equation using conversion factors to change from grams of the compound given to grams of the compound sought.
6. Perform the mathematical manipulations specified and obtain the correct answer.

Having the student attempt to work a specific stoichiometric problem will reveal which of the specific performances the student has already mastered as well as what skills yet need to be developed.

A similar process is recommended when assisting a student encountering difficulties in performing a particular laboratory manipulation. For example, consider the situation in which a student is attempting to separate a precipitate using a conical filtration apparatus, which is filtering at a very slow rate. A careful visual examination of the apparatus by the instructor and several questions about the procedure should identify the general nature of the problem. The specific performances that the instructor might require of the student could include one or more of the following:

A. Read the labels on filter paper boxes.
B. Digest the precipitate for a specified length of time.
C. Correctly fold a piece of filter paper for a conical filtration apparatus.
D. Place the folded filter paper in a funnel and form an airtight seal.
E. Decant 90% of the clear decantate into the filter paper before swirling to form slurry and decanting the solid into the filter paper.

After you have determined what specific skills or concepts the student needs to develop, you must assist the student in developing these. Having the student complete the original problem or beginning a new one often does this. Ask questions or give directions to allow the student to complete the task with minimal assistance provided only when needed to overcome obstacles.

Small steps taken one at a time will generally be more effective than a giant intellectual leap. You should not provide a prolonged lecture explaining the entire process followed by a statement like, “All right, now let me see you do it.” Consider tutoring a student who has a problem involving a concept. The student can be assisted in mastering the concept if you lead him/her through a series of small steps such as these:

A. Help the student state the concept in his/her own words.
B. Be sure the student understands the concept; ask for examples of application of the concept.
C. Help the student apply the concept to a specific problem.
D. Encourage the student to state in his/her own word how the concept provides the key to the problem.
E. Give the student a similar problem requiring the same concept for its solution.
F. Encourage the student to practice other similar problems.

To accomplish this you will need to arrange a series of cues, questions, and hints which, hopefully, will all be happening in an order, which encourages desired student responses. Throughout this process, keep in mind that positive reinforcement, in its many forms, is the desirable consequence for increasing response strength.

Provide verbal and non-verbal reinforcement all along the way as the student masters the individual steps. Provide opportunities during an instructional sequence for the student to behave in a fashion consistent with the objectives. Let the student practice what he/she will be called upon to do in displaying mastery of the instructional objectives. Try to provide practice that is exactly like the terminal behavior identified as the objective. This means that the instructional stimuli will be identical to those used, for example, on the final examination. Alternatively, let the student have an opportunity to practice behavior that is similar, but not identical, to the terminal behavior. In this practice situation, there may be modifications in the nature of the instructional stimuli or in the nature of the learner’s response. The student may be required to perform the same intellectual operations, but respond in somewhat different way.

Tutoring provides an effective opportunity to assist each student in the learning process. As you know, many students are unsure of themselves in their chemistry course work. When tutoring, we deal with people, whether justifiably or not, those people may lack confidence in their ability to “do chemistry”; that feeling of awe frequently does hamper their learning. Therefore, it is important to accept this feeling and to give each student who comes to you some feeling of mastery, however large or small. Tutoring is an open interaction. Students will reveal their sense of insecurity to you. When they do, help them overcome their anxiety. When a student does master a new concept or skill,
call this to his/her attention. That is, provide positive reinforcement. Help each student to recognize his/her achievement when it occurs.

Usually, the final step in a tutoring session is to allow the student to demonstrate that he/she has mastered the objective by providing and evaluative problem. This evaluative problem should require the same skills at the student's original problem.

Recitation

Some of you might be called upon to conduct recitation sessions. A recitation serves two important functions: to help students find solutions encountered in lecture and/or in understanding the subject material, and to improve student-teacher interactions and allow the teacher to closely monitor the progress of students as individuals. The responsibility of conducting a recitation is delegated to graduate teaching assistants who have most of the close contact with students and hence directly influence their performance in the course. You can really succeed as a teacher if you take the responsibility seriously and dedicate yourself to the assigned task.

Administrative details

Be punctual. Arriving five minutes early to each recitation sets a good example to your students and demonstrates a mature attitude toward your work. Start your recitation on time even if all your students are not present, as it will encourage them to come on time.

Dress may be casual but should be reasonably neat. Dress as if you care about the recitation session and have prepared for it. You must appear to be in charge of the class if you hope to maintain control in the classroom.

Learn the names of your students promptly so that you can address them by name in and out of class.

Accessibility to your students outside the classroom can be accomplished by arranging a time that is agreeable to as many students as possible. You must have scheduled weekly office hours. It is necessary that students be informed about how they can reach you outside of class.

Preparation

Students do know when an instructor is not prepared to conduct a lecture. This can greatly affect the morale of your students. Obviously, we all make mistakes every once in a while, but if we do not take time to adequately prepare for a lecture or recitation, the number of mistakes can increase significantly.

Be knowledgeable. You must know how the book treats a topic and how the professor presents the same material. Attendance at lectures is highly recommended and in certain instances it is mandatory. The benefits far outweigh any minor inconveniences. Some professors conduct weekly TA meetings and this is a great opportunity to keep up with activities in the course. You must be familiar with the problems assigned each week so that you can answer questions about them. Spend some time planning for your recitation, although your primary concern must be constructive handling of questions.
raised by the students, be prepared to give a mini lecture, ask questions, solve problems or initiate a discussion.

Prepare a clear outline of what you plan to accomplish during the recitation, but do not be disappointed if you cannot complete everything you had planned. Time is very limited, usually about an hour, and must be used effectively. If you are instructed to discuss a topic or elaborate on material not covered by the professor, then this should be the first item on your agenda.

Quizzes or tests are given during recitation in some courses and the recitation score contributes to the students' final grade. Questions should be well thought out and there should be no ambiguity. It is a challenge to write a good quiz. Check to make sure that all copies of the quiz are legible.

Conducting the Recitation

Start by outlining the activities that you have planned for the recitation session and invite suggestions from your students. This will enable you to use the time effectively to cover as much as possible during the period.

Be certain to show your enthusiasm. Studies do suggest that students tend to learn more when their instructor is enthusiastic. Be certain to project a positive attitude towards the student and the course material. Enthusiasm is contagious, so also a negative and cynical attitude will rub off on your students. First semester freshmen are quite impressionable and will take seriously almost everything you say. If you have any criticism of how the course is being run, talk to the instructor. NEVER GRIPE TO THE STUDENTS.

Speak slowly and distinctly. Try to maintain a good voice level. Use the blackboard, as necessary, to improve communication. Eye contact with students seated at different locations in the room will convey the idea that you are attempting to interact with all the students and not focusing on a small section of the class. Using gestures, while talking, is alright as long as they are not distracting.

When using the blackboard, write legibly and in areas that are visible to the whole class. It is not good practice to keep talking while writing on the blackboard and with your back to the class. Do not erase the blackboard too often or too quickly.

Problem solving is an important part of recitation. Try to be systematic and use the same problem solving technique as the professor. If alternate methods are possible, you may briefly refer to them and suggest that interested students contact you for more details. You could request a student to solve a problem at the blackboard and this approach often works well as students relate to each other and the class tend to be more alert.

Student participation is essential to keep the attention of the class at all times. Invite questions and encourage all students to participate in the discussion. Be prepared to ask questions to break the ice or keep the ball rolling. Some students have a tendency to dominate discussions, do not destroy their enthusiasm, but tactfully call upon another student, by name, to keep the class involved. Unusual situations may put your patience to the test. A distracting conversation, a snoring student, a busy body frantically completing some other course assignment, never lose your cool, but try to deal with the situation in the best way possible. An alternative is to ask the student to see you after class. If you
encounter an unpleasant or hostile situation, inform the professor in charge of the course at the earliest opportunity.

Questioning skills can have a great impact on the learning process. Skilful teachers do not "spoon-feed" their students but provide hints and ask questions that will help the student to find the answer. Students should feel free to ask questions and you should be sensitive to the needs of your students. Never embarrass or put down a student in class. Inevitably, there may be occasions when you do not know the answer to a question. Do not give a wrong answer. Simply state that you will find the answer and convey it at the next meeting. This is a promise and it is your responsibility to keep your word.

Stockroom policy

Our stockroom has a policy regarding laboratory practices in a learning environment. This policy is reproduced in its entirety below. Any questions, you should contact Mr. Tom Reichardt, our stockroom manager.

WELCOME GENERAL CHEMISTRY
TEACHING ASSISTANTS & STUDENTS

The following is the stockroom policy for the Chemistry and Biochemistry Stockroom in regards to general chemistry laboratories. Your knowledge of these guidelines will greatly assist you in creating a safer and smoother semester for everyone. A copy of the stockroom policies will be handed out and read to the students at the beginning of the semester.

STOCKROOM POLICY

LABORATORY CHECK-IN:

Every lab section is assigned a folder that contains a Drawer Assignment Sheet and Apparatus Sheets. The TA distributes the Apparatus Sheet and assigns drawers to each student pair. Normally, there are two students per drawer and each will sign one Apparatus Sheet. The students should inspect their drawer to verify the completeness of the glassware and to identify and replace missing or broken equipment, which the TA will indicate on the back of the Apparatus Sheet. Students requiring equipment may be sent to the stockroom with their Apparatus Sheet to get replacements for missing or broken equipment. Once the drawer is fully stocked, the students must sign and date the Apparatus Sheet. After the students check-in, anything missing or broken throughout the semester must be replaced by purchase in the stockroom. Prices of each item are on the apparatus sheet. The Drawer Assignment Sheet is a listing of all the drawers in a lab section. Once all drawers are assigned to the students, the TA must clearly print the student names on the Drawer Assignment Sheet next to the drawer number. The
Apparatus Sheets and the Drawer Assignment Sheet will be kept on file in the stockroom during the semester.

The TA will obtain copies of the Safety Quiz and Safety Agreement from the stockroom. These will be passed out and completed by each student following the reading of the safety instructions given in the lab book. These instructions must be read out loud by the TA. The TA will be prepared to answer any question that may arise. The TA grades the Safety Quizzes. The Safety Agreements will be placed in the stockroom folder and retained for the duration of the semester by the stockroom.

LABORATORY EQUIPMENT SECURITY:

It is important that the students be responsible in caring for their equipment during the semester. They need to be vigilant in checking that they have put all their equipment away and that their drawer is properly locked at the end of each lab period. If there is any possibility of a breach in the security of their equipment, the stockroom must be notified immediately. Each student and their TA will have both checked all the equipment in the drawer issued at the beginning of the semester. The student responsible for any missing or broken equipment must replace it before the end of the semester. In the case of a dispute, the replacement costs for missing equipment will be split between the lab drawer partners. If a student does not pay for missing or broken equipment at the stockroom window before the end of final exams week, the charges will be sent to the Student Accounts Office with an additional $5.00 charge.

LABORATORY CHECK-OUT:

At checkout each drawer must have a complete set of apparatus as it is listed on the “Apparatus Sheet” checked and signed by the student at the start of the semester. All other apparatus must be returned to the stockroom. The student responsible for it must replace any missing or broken equipment. Students must show up at their scheduled checkout time, unless prior arrangements have been made with the TA or instructor of charge of the course. If both lab partners do not show up to checkout the TA will checkout the drawer for them and they will be charged $5.00 along with charges for any missing or broken apparatus. The TA will sign and date at the bottom of the apparatus sheet only when the drawer equipment is COMPLETE. Afterward, the student will go to the stockroom with their apparatus sheet and their lock to be checked out by the stockroom and issued a new lock. The TA will collect the stockroom approved apparatus sheets from the students and lock the drawer with the new lock. After class the TA will return the apparatus sheets to the stockroom file cabinet.

Any student withdrawing or changing lab sections during the semester must come to the stockroom and account for all the equipment in their drawer. Students must buy missing or broken items at this time or make other arrangements with the stockroom personnel.
HOUSEKEEPING:

The lab should be clean and neat at all times. The cleanliness of the lab is the student’s and TA’s responsibility. Each lab room is used as many as 15 times during the week. The janitor only sweeps the floor and empties the garbage cans. It is mandatory to keep the lab room in a clean and safe condition. Make sure to enforce this housekeeping rule by having the students clean up the lab room (especially around the scale) before any students are dismissed at the end of each lab session. Remember, maintaining a clean and neat lab results in a safer working environment.

Frequently inform the students of the following: 1) Do not put waste chemicals down the sink drain or in the garbage cans. Put waste chemicals in approved waste containers only. 2) The sinks and the broken glass boxes are not to be used as a trash bucket. 3) Take special care not to spill or slop when getting chemicals or disposing of chemical waste. 4) Be careful not to spill chemicals on or around the scale. (This may affect your experimental results.) 5) Place used matches and used wood splints in the ceramic crocks only. Do not put waste paper in them. 6) Clean up after yourself.

UNATTENDED LAB SESSIONS:

Absolutely no students are ever to be in a lab room without a TA present. Each lab room is provided with a phone line directly connected to the stockroom facility. If any lab equipment or chemical solution is needed during a lab session, the TA should contact the stockroom using this telephone line. The storeroom will be there to assist you promptly.

Do not enter the lab room early without your TA. If a TA is late for the lab, do not start working. Notify the stockroom and substitute supervision will be provided.

A student who misses a lab session will need to make it up within one week or risk getting a zero for that lab. An excused absence may be obtained from the professor ahead of time.

LABORATORY ACCIDENTS:

All laboratory accidents, no matter how minor, should be reported to the TA and the stockroom immediately.

Clean up of spills (chemical spills, water leaks, mercury spills, etc.) that do not require stockroom personnel can generally handle immediate evacuation.

Students involved in a laboratory accident may choose to obtain or decline medical treatment. Regardless of this decision the TA must submit a written report of each accident to the stockroom personnel. Forms for this procedure are available in the stockroom.
Refer to the attached sheet "Outline for Accident Response" for more complete emergency information.

**LOST & FOUND**

Lost and found boxes are located in the stockrooms (room 103 and room 192) ask the stockroom personnel about lost calculators, books, keys, etc. Do not leave personnel items unattended in lab classes.

**SOME GENERAL SAFETY GUIDELINES**

**EYE PROTECTION:**

All people in the academic laboratory including the TA's must wear safety goggles at all times in the lab rooms, even if not performing any experimental work. Students must be informed of this on the first day of lab and any late addition must also be informed. Safety glasses and/or goggles can be purchased or rented at the stockroom. Goggles may be purchased from any store as long as the goggles are of the approved type. No one is allowed to participate in the lab without proper eye protection.

**APPROPRIATE LAB APPAREL:**

Proper body protection is required in the laboratory. Shorts, miniskirts, bare midriffs, sandals, or open toe shoes should not be worn. If a student is not dressed appropriately for the lab the TA should send them to the stockroom to rent or purchase a lab coat, apron, or shoe cover.

**TRASH DISPOSAL:**

Each lab has 3 trash containers for normal non-regulated waste such as paper towels, latex gloves, plastic, etc. Each lab also has a broken glass box for broken glass disposal. Regular trash should not be discarded in the broken glass box. Matches and other burnt items should be placed in the ceramic crocks designated for this purpose. These rules are a matter of safety and governmental regulation. The TA should instruct the students in the proper use of all waste receptacles.

**CHEMICAL WASTE DISPOSAL:**

The Resource Conservation and Recovery Act (RCRA) of 1976, the RCRA requirements regulate disposal of certain waste for waste disposal are administered and enforced by the Environmental Protection Agency (EPA). All university personnel must follow the waste disposal guidelines issued by the EPA. In the teaching laboratory, hazardous chemical waste must be stored in a chemical waste bottle properly labeled "WASTE". Each waste container also receives an NMSU Waste/Material Tracking Form and is filled out by the waste generator. Please contact the storeroom for any questions concerning the proper disposal of chemical wastes.
CLEANING UP:

It is a matter of personal safety to maintain a clean working area. Chemical residue left on bottles and counters may inadvertently contaminate the skin and/or clothing of other people. Therefore it is important to clean up your own workspace and common areas after each lab session.

Outline for Accident Response
Department of Chemistry and Biochemistry
New Mexico State University

Material Safety Data Sheets (MSDS) are available for all chemicals used in the department, and provide information to identify health hazards, and adequate treatment in case of contamination. Inform yourself before an accident occurs. MSDS’s are available in printed form and electronic versions at the Chemistry & Biochemistry Stockroom.

Severe Emergencies: Evacuate in case of fire or other immediate danger, move to a safe secure area. Provide aid to injured victims, designate an individual to call 911 or activate the fire alarm, NMSU Fire Department will respond and provide first aid.

Poison Control Center: 1-800-432-6866
Hospital Emergency Room: 521-2286

Accidents not requiring evacuation: The Teaching Assistant (TA) remains with the class, calls the stockroom and/or designates a student to contact the stockroom. Possible scenarios include: Chemical Spills, Contamination, Chemical Splashes, Inhalation, Ingestion, Cuts, Abrasions, and Burns.

Contact with Acid/Base: Remove contaminated clothing, flush area with large amounts of water, use eyewash or shower as appropriate. Do not attempt to neutralize chemicals on the body.

A. Minor Accidents, student requires medical attention:

The stockroom should be contacted, and will provide transportation to location for medical treatment. The treatment facility may require an MSDS for information on hazards and treatment, so be prepared to FAX this information. The TA completes an Accident Report Form, and gives this to the Stockroom. The Stockroom completes subsequent paperwork.

Injured Students: will be taken to the Student Health Center during the hours of 8:00-11:30 am & 1:00-4:30 PM. Phone: 646-1512
Fax: 646-6428
Injured Graduate Assistants, Faculty, Staff, and Hourly Employees: will be
taken to the Employee Health Center during the hours of 7:30-11:30 am.
Phone: 646-6600
Fax: 646-7865

Outside Office Hours: Injured personnel will be taken to the Memorial Hospital
Emergency Room. Phone: 521-2286

B. Minor Accidents, student refuses medical attention:
The Stockroom should be contracted to provide basic first aid supplies and treatment for
minor injuries. The injured party completes a release form-stating refusal to seek medical
treatment.

Chemical Accidents

Preventing Chemical Accidents
How You May Be Exposed to a Chemical
You may be exposed to a chemical in three ways:

1. Breathing the chemical
2. Swallowing contaminated food, water, or medication
3. Touching the chemical, or coming into contact with clothing or
   things that have touched the chemical.

Remember, you may be exposed to chemicals even though you may not be able to see or
smell anything unusual.

Chemical Accidents Can Be Prevented
Many people think of chemicals as only those substances used in manufacturing or
laboratories. But chemicals are found everywhere—in our kitchens, medicine cabinets,
basements, and garages. In fact, most chemical accidents occur in our own homes. In the
laboratory, however, chemicals are more numerous and often acutely hazardous. It is
important to always use protective measures when working with any laboratory chemical
especially one that is hazardous. Eye protection, lab coat and gloves are standard for
working with most chemicals.

Always read the directions and/or the MSDS prior to handling an unfamiliar chemical or
product. Some chemicals should not be used outside of a hood to avoid inhaling
dangerous vapors. Other chemicals should not be used without gloves and eye protection
to help prevent the chemical from touching your body.
Another effective way to protect yourself is to store chemical products properly. Always store chemicals tightly closed in their original containers so you can always identify the contents. In a laboratory all containers that contain a chemical must be labeled for contents. Not to do so is a serious safety violation. Store all incompatible chemicals on different shelves or in different cabinets.

One of the best ways to reduce the possible exposure to a chemical hazard is to keep your workspace clean. This takes watchfulness while working and involves the following:

- Don’t rush or take short cuts while working with chemicals.
- Triple rinse glassware immediately after use.
- Keep the scale free from any chemical residue.
- Clean up any spilled chemical immediately (even a single drop or grain).
- Make sure the outside of your glassware remains chemical free.
- Wipe down your bench space with a wet towel after you complete a task.
- Always wash your hands after working with chemicals.

**Chemical Spill Response**

Spill/Release Events are divided into three basic categories.

1. **Spills/Releases That Are Immediately Dangerous to Life or Health (IDLH):**
   A spill/release that, in the opinion of the lab supervisor or individual responsible for the chemical or area, poses an immediate health threat to the individual and/or other occupants in the building. In this case:

   - Sound the fire alarm, if appropriate.
   - Call 911 from a safe location and provide the following information to the dispatcher:
     - Nature of the emergency
     - Chemical involved
     - Building and room number
   - Remain on the scene to meet response personnel and provide additional information.

   An example would be a one-liter spill of benzene or an uncontrolled release of hazardous gas.

2. **Spills/Releases That Can Be Cleaned Up By Lab Personnel:**
   Attempt to clean up a spill/release if you and/or your supervisor feel that it is safe to do so. Guidelines include:
   - You are thoroughly familiar with the hazards of the material. (Reference MSDS)
   - You have been trained to deal with spills/releases of the size in question.
   - You have the proper Personal Protective Equipment (PPE), should it be necessary.
   - The appropriate absorbent/neutralizers are readily available.

   It is essential that you collect all spills clean up waste for proper disposal. DO NOT PLACE IN OR AROUND THE REGULAR TRASH. Place the spill clean up waste in a
closed container (like a zip-lock bag) and attach a NMSU Waste/Material Tracking Form or at a minimum label with contents. The safety office will properly dispose of the waste. An example would be a mercury thermometer that breaks but the mercury is contained.

3. Spills/Releases That Are Not IDLH But Require Technical Assistance:
If you or your supervisor feels that you do not have the proper training or equipment necessary to clean up a spill/release then call EH&S direct at 646-3327 or 646-3311 to page EH&S staff through the NMSU Police Department. An example would be a thermometer that breaks and scatters mercury across the floor.

A very large water spill may require the assistance of the janitorial service. Ask the secretary in the chemistry office to order an emergency work order. Smaller water leaks or puddles may be cleaned up with a mop and bucket. The mop is kept in room 103B.

Chemical Exposure First Aid Treatment

Stockroom personnel are not health providers and are not allowed to give medical attention or advice to other students or employees. When there is a medical question or an emergency an appropriate health service should be contacted. Instructions for doing so are posted in various locations including at the first aid station. The Student Health Center phone number is 646-1512. The following information is for the general knowledge of stockroom employees.

Chemical Burns

A chemical burn can be minor or life threatening, but prompt and proper treatment can reduce the chance of infection and the damage caused by contact with the chemical. Remove any affected clothing or jewelry from the injury. Use lots of cool running water to flush the chemical from the skin until emergency help arrives. The running water will dilute the chemical fast enough to prevent the injury from getting worse.

Use the same treatment for eye burns and remove any contact lenses. Be careful to flush the eye from the nose outward.

If no large amount of clean water is available, gently brush the chemical off the skin and away from the victim and you. If the chemical is on the face, neck or shoulders, ask the victim to close his or her eyes before brushing off the chemical. Do not expose yourself to the same chemical while assisting the victim.

Cover the wound very loosely with a dry, sterile or clean cloth so that the cloth will not stick to the wound. Do not put any medication on the wound. Seek medical attention immediately.

If you believe you have been contaminated with a chemical, call the Student Health Center, Employee Health Center, Poison Control Center or 911 immediately. If medical help is not immediately available, remove your clothing starting from the top and working your way down to your socks. Take care not to touch your contaminated
clothing to your bare skin. Place your clothing in a plastic bag so it cannot contaminate other people or things. Take a thorough shower to wash any chemical away. Re-dress in clean clothing and go for medical help at your first opportunity.

**Chemical Poisoning**

There are several symptoms of chemical poisoning whether by swallowing, touching, or breathing:

- Difficulty breathing
- Changes in skin color
- Headache or blurred vision
- Dizziness
- Irritated eyes, skin, throat
- Unusual behavior
- Clumsiness or lack of coordination
- Stomach cramps or diarrhea

If you think you have been exposed to a toxic chemical, call the poison control center or 911 immediately.

If you see or smell something that you think may be dangerous, or find someone who has been overcome with toxic vapors, your first job is to make sure that you don't become a victim. If you remain in a dangerous area and become injured or unconscious, you cannot help yourself or any victims. Because chemical poisoning can be a life-threatening emergency:

1. Send someone to call 911 immediately.
2. Tell the operator the location of the emergency and the phone number from where you are calling.
3. Describe what has happened, how many people are involved, and what is being done to help.
4. Stay on the phone until the operator tells you to hang up.

If you are trained in CPR or first aid, and feel confident that you are not in danger, check the person for life-threatening injuries. Administer appropriate treatment, and then deal with the chemical injuries.

If you have not recently taken a course in CPR or first aid, contact your local Red Cross or the NMSU EH&S office for course information and schedules.
GENERAL EMERGENCY RESPONSE

Call 911 in an Emergency for Police, Fire, or Medical attention

New Mexico State University has an "Enhanced 911 System." This means that all you have to do in an emergency is dial 911. This will put you in direct contact with a dispatcher who will send the appropriate help.

When you call 911, please provide as much of the following information as you can:

- Is this an Emergency?
- Exact Location of Emergency (Building and room number)
- Type of Emergency:
  1. Police
  2. Fire
  3. Medical
  4. Chemical, Biohazard or Radioactive Incident
- Brief Description of Emergency
- Your name and phone number (optional but helpful for response to incidents)

This information will help to ensure necessary help is sent promptly.

WHAT IS AN EMERGENCY?

Many people worry about calling 911 because they do not know if their situation is an emergency. An emergency exists any time there is a fire, someone needs immediate medical attention, a crime is in progress or if a chemical, and biohazard or radiological spill threatens safety and health.

If you are in doubt, go ahead and call 911.

Not every call to a police or fire department is an emergency. Any non-emergency calls should be placed to the regular telephone numbers in order to keep the 911 lines available for those needing them.

Non-emergency phone numbers at NMSU:
- Police Department—646-3311
- Fire Department—646-2519
- Student Health Center—646-1512
- Employee Health Services—646-6600
- Other Medical—646-3311
- Environmental Health and Safety—646-3327
- Poison Control Center—Thomason Hospital [www.poisoncenter.org](http://www.poisoncenter.org)
  Emergency:
  - 1-800-POISON1
  - Administrative: (915)534-3800
  - University Operator—On Campus "0" —Off Campus 646-0111
  - NMSU Escort Service 646-1111

If you are not sure which office to call, contact the NMSU Police Department, and they will assist you in contacting the appropriate office.
FIRST AID EMERGENCY PROCEDURES

The following emergency procedures are recommended in the event an injury occur from a fire, explosion, or other laboratory accident. These procedures are intended to limit injuries and minimize damage if an accident should occur.

In case of any emergency, laboratory personnel should remain calm and do only what is necessary to protect life (without jeopardizing their own safety).

1. Summon help immediately by calling 911.
2. Render assistance to persons involved. Do not move an injured person unless he or she is in danger of further harm.
3. Warn personnel in adjacent areas of any potential hazards to their safety.
4. Keep any injured person at body temperature. Remember if the injured person is laying down keep the underside at body temperature also. If feasible, designate one person to remain with the injured person. The injured person should be within sight, sound, or physical contact of that person at all times.
5. If clothing is on fire, knock the person to the floor and roll him or her around to smother the flames or, if a safety shower is immediately available, douse the person with water.
6. If chemicals have been spilled on the body, flood the exposed area for 15 minutes with sufficient running water from the safety shower and immediately remove any contaminated clothing.
7. If a chemical has entered the eye, immediately wash the eyeball and the inner surface of the eyelid with plenty of water for 15 min. An eyewash fountain should be used if available. Forcibly hold the eye open to wash thoroughly behind the eyelids.

MEDICAL FACILITIES

The emergency room, Memorial Medical Center, is the nearest full-care medical facility. In case of an emergency, call 911. An ambulance will be dispatched to render assistance and transport the victim. A person suffering from a medical emergency should be transported by an ambulance and not by a co-worker or friend. The Student Health Center (646-1612) and Employee Health Service (646-6600) will provide urgent medical care for minor injuries. Call the medical facility first to confirm hours of operation.

FIRES AND EXPLOSIONS

In case of fire and/or explosions activate the fire alarm system, and then call 911 from a safe location.

CHEMICAL SPILLS

Small-scale, large-scale and hazardous or toxic chemical spills may be possible in our laboratories. Spill-control methods are outlined in the policy “Chemical Accidents”. Do not attempt to clean up a spill unless you have been trained to do so and are confident in you ability to do it safely.
If a chemical or radiological spill threatens the safety and health of students, faculty or staff evacuate the area or building and call 911 from a safe location to report an emergency involving hazardous material.

“SMALL EMERGENCIES”

Emergencies that require one to summon emergency responders are not a frequent occurrence in the chemistry building, but one needs to be prepared. More frequently, you may be faced with what one might call a “small emergency” that requires your immediate attention but not the outside help of the police, fire or ambulance. These may include the following: small cuts, small chemical spills, power outages, etc. that do not threaten life or health. If an unusual or unfamiliar situation like this presents itself and you are not sure what to do ask the coordinator for help (you may call him at home).

Remember, you are not a medical provider and are not allowed to give medical treatment or advice. If a student with a small injury requests assistance you may offer a band aid or other supplies from the First Aid Box, and allow them to tend to their own wound. If the victim requests medical attention or advice you may offer to escort them to student health services or otherwise direct them to the facility. Call ahead to be sure that they are open and to let them know to expect the student. If it is a case of a chemical exposure they may ask you for an MSDS of the chemical involved. You may fax them a copy. Memorial Hospital is the alternate medical facility when the Student Health Center is closed. Students may receive free service from the Student Health Center when injured in class even if they have not paid their activity fee. Be sure to record all incidents by following the below procedures.

RECORD KEEPING

Whenever there is any kind of an accident, emergency or injury—large or small—the incident MUST be recorded. There are two forms that are attached together that need to be read, filled out and signed. Both blank and completed forms are kept in the stockroom file drawer labeled “Accident Reports”.

The first form is the “Student Accident Referral / Release Form”. The student MUST sign this and a witness whenever there is any kind of student injury. It asks the student to make a decision about medical assistance. Generally, the TA or stockroom personnel will act as the witness.

The second form is the “Laboratory Incident Report Form” and is a record of the who, what, where and when of any kind of an incident. It should be filled out as completely as possible by the TA or by stockroom personnel. The completed forms are kept on file in the stockroom for three years.
STUDENT ACCIDENT
REFERRAL/RELEASE FORM

To: Chemistry and Biochemistry Student

From: Tom Reichardt
Coordinator for Administrative & Academic Service

You have been involved in a laboratory accident. You may need to seek medical assistance. If you feel this is necessary, you may be escorted to the Student Health Center, or you may go on your own. If you have not paid the Health/Activity Fee, a Chemistry Department Employee can nevertheless, call the Health Center to inform them that you were in a laboratory accident and require care. The Health Center will then be required to treat you. If you decline treatment at this time, you may require it later. If so, please call the Chemistry Department, and the Health Center at that time so you can be admitted. The Main Chemistry Storeroom phone number is 646-4330 and the Student Health Center phone number is 646-1512.

You may wish to read the MSDS on the chemicals you may have encountered in your incident, they are available in the storeroom, and also in the front lobby near room 100. We will make copies for you to take to the Health Center, also.

I have read the above paragraphs and

I decline treatment ___________ Student’s name and date

I request treatment ___________ Student’s name and date

Witnessed ___________ Storeroom employee or teaching assistant and date

LABORATORY INCIDENT
REPORT FORM
DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY

DATE ___________ TIME ___________

STUDENT INVOLVED:
GENERAL SAFETY RULES IN A CHEMISTRY LABORATORY

1. Never engage in horseplay or other acts of mischief in lab.

2. Wear eye protective devices (goggles, face shield) at all times when work is being conducted in the lab. If anyone is working in the laboratory, all persons in the lab must be wearing approved goggles.

3. Wear clothes, which adequately protect the legs and feet (no sandals or shorts). A lab coat or a plastic apron will provide additional protection.

4. Learn the location and proper use of emergency equipment, shower/eye wash stations, fire extinguishers, laboratory exits, alarm stations and first aid kits.

5. Walk, do not run in the lab.
6. Keep aisles free of obstructions.

7. Store coats, packs, etc. in the areas provided, not on or around the lab bench.

8. It is forbidden to eat or drink in the laboratory or to use laboratory glassware for such purposes. All food and drink must be left outside the lab door; it is not to be brought into the lab at any time (this includes the coat rack areas).

9. Pay strict attention to all instructions before undertaking an experiment. If you do not understand, ask.

10. Performing unauthorized experiments is forbidden.


12. Report all accidents to your instructor or supervisor immediately.

13. Wipe up all spills and bottle rings immediately.

14. Avoid inhaling toxic vapors and gases and use fume hoods when using such reagents.

15. Set up apparatus as far back on the bench as possible so that it will not tip over onto the floor.

16. Never remove chemicals from the lab unless directed otherwise by the instructor.

17. Never sit on the lab bench. You never know what chemicals have been spilled on the benchtop.

18. Always clean your apparatus, benchtop, and sink area after finishing your experiment and before leaving the lab.

**EYE PROTECTION**

It is required by the state that every student, instructor and visitor in a chemistry lab where experiments or demonstrations are being performed must wear industrial quality eye protective devices.

Approved eye protection for people handling chemicals must prevent both chemical splashes and flying particles (e.g. from broken glass) from entering the eye. The minimum eye protective device that meets these requirements is goggles with hooded ventilation ports. This is the required eye protection in undergraduate chemistry labs. A face shield may be worn over goggles to further protect the face and neck areas. Protective eyewear other than standard goggles must be approved by the staff member(s) responsible for your course.
FIRE AND EXPLOSIONS

Fire is one of the major hazards in the chemistry laboratory. The vapor of nearly all organic solvents is flammable. To avoid igniting flammable vapors, keep all organic solvents covered and away from open flames, heating elements and electrical sparks.

For your own protection, avoid wearing loose clothing, jewelry and unrestrained long hair. Cotton clothes rather than synthetics are recommended since synthetic burn so rapidly and stick to the skin.

Always make a point of knowing where the fire extinguishers in a lab are and be sure you know how to use them.

Rules regarding fire safety

1. Smoking is forbidden in the laboratory.
2. Limit flammable liquids to the amount needed for immediate use.
3. Set up apparatus so that is not necessary to reach through the assembly to turn water, gas or electricity off.
4. Assemble apparatus so that control valves and switches will remain accessible if a fire should occur.
5. Be aware of what neighboring students are doing.
6. Know the location of nearest exit, fire extinguisher, safety shower and fire alarm pull station.
7. If clothing catches fire, use safety shore or roll on the floor to put out fire. DO NOT RUN. Know the location of the fire blanket.
8. Avoid inhaling smoke and gases resulting from a fire or explosion.

In the event of a fire or explosion follow these steps:

1. Sound the alarm to evacuate the building. If there is no alarm nearby, inform personnel in the vicinity to leave the building.
2. Leave the building or immediate area.
3. From the nearest phone in a safe area call 911 to report fire.
4. Arrange to meet emergency response personnel near entrance of building to direct them to location of fire.
5. Do no return to area until granted permission by fire department, safety department or chemistry department personnel. Be aware that it is considered a minor felony to disobey instructions from the fire department personnel and you might be charged with a crime.

NOTE: If the fire is small, the person in charge might designate a responsible person to report the fire while the area is being evacuated.
Handling glassware

Laboratory glassware is fragile and must be handled properly to avoid injury.

1. Tubing should be broken as follows:
   Scratch with a single stroke of a triangular file. Moisten scratch and wrap a towel around the glass to protect hands. Place thumbnails against tubing opposite scratch and press while pulling hands apart. Fire polish ends before using.

2. When fire polishing or bending glass tubing, place hot glass on wire gauze. Make sure glass is cool before touching or handing it to another person.

3. Tubing should be inserted into rubber stoppers as follows:
   Choose a stopper with whole size appropriate to the size of the tubing. Lubricate the tubing and hole with glycerin or water and wrap tubing in a towel to protect hands in case tubing should break. Grasp tubing close to point of insertion and apply force while slowly twisting tube. Hold stopper between thumb and forefinger and keep palm of hand away from area where glass will come through the stopper.

4. Tubing is very difficult to remove from stoppers if the two have been in contact for a while. Always protect hands with a towel if attempting to do this. It may be possible to separate the two by pushing the small end of a spatula or the handle of a file into the hole parallel with the tubing. As an opening is generated add water to it for lubrication. Avoid exerting pressure on the glass. A cork borer of the appropriate size may also be used to separate rubber and glass, but if you experience difficulty with the methods suggested seek the help of the instructor.

5. Apparatus that can roll, such as a thermometer or pipette, should be placed on the lab bench at right angles to the edge of the bench and braced against other objects, to keep it from rolling onto the floor.

6. Filter flasks used in vacuum filtration should be heavy walled and free of cracks or other imperfections. Vacuum must be released from all parts of apparatus before disconnecting.

7. Broken glass should be swept up with a brush and dustpan. Take care to get all the fragments. Discard all broken glass in a container designated for that purpose. If you are unsure, ask.

Handling chemicals

Before using a chemical, students should familiarize themselves with the properties of that chemical and hazards which may be associated with its use.

Nearly all chemicals are poisonous to the human body in some degree and can enter the body through various routes. Inhalation is the most common route. Evaporation of chemicals can cause health hazards over a period of time, even if the concentration in the air at any one time is low.

A second route of entry is through the skin. Chemicals may enter the body through an open wound or directly through the pores. A third route is through the eye. Chemicals splashed into the eye not only may injure the eye, but also may enter the body.
because the eyes are so vascular. Finally, chemicals may be inadvertently ingested if the mouth area is touched while chemicals are on one’s hand, or if one eats, drinks or smokes in the laboratory.

To avoid these hazards, observe the following rules.

1. Keep volatile chemicals covered whenever possible and work in the hood. Never put your nose directly over a container of volatile chemical. To sample a substance by odor, direct some of the vapor toward the nose with the hand after filling the lungs with air.

2. Dry ice is dangerous because of its low temperature and the possibility of suffocation. Handle dry ice and items stored in dry ice with tongs or leather or insulating gloves. Never put your head in a container of dry ice as it will be filled with carbon dioxide gas and sudden suffocation may result.

3. Always wear safety goggles when work is being conducted in the lab. Eyes must be washed for 15 minutes with running water, should a chemical splash occur. If the victim cannot be moved safely, call 911 for medical assistance. Otherwise, escort the victim to the Student Health Center.

4. Chemicals splashed on the skin should be rinsed off with plenty of fresh water. If irritation or pain develops, call for medical assistance or report to the Student Health Center.

5. If cuts or open wounds are present on the hands, wear gloves when handling chemicals.

6. Wash hands thoroughly before touching any area of the face in lab, and always wash hands before leaving the lab.

7. Never test chemicals by taste.

8. To dilute an acid, pour it slowly into water while stirring. NEVER POUR WATER INTO ACID. If water is poured into concentrated acid, the heat generated may boil the water and spatter the acid out of the container.

9. When transferring chemicals from one container to another, always label the new container.

10. When you are pouring from a bottle, hold the stopper out of contact with anything but air. This will avoid getting the chemical onto the bench top or transferring contaminants to the bottle. If any chemical gets on the outside of the bottle, rinse it off before returning the bottle to the shelf.

11. NEVER return unused chemicals to stock bottles.

12. Always dispose of chemical wastes properly. Follow the instructions posted so that all types of waste are disposed of in the appropriate containers.

13. Unlabeled chemicals must not be used. They should be given to a staff member for identification and proper disposal.

14. Chemicals, which react to give off dangerous gases, or to cause fire or explosion, should not be stored in proximity to each other.

15. All spills must be cleaned up immediately. Acid spills should be neutralized with sodium bicarbonate. Basic spills should be neutralized with boric acid or dilute acetic acid. Notify the instructor as soon as a spill occurs. If a volatile, flammable or toxic material is spilled, all flames should be extinguished and all spark-
producing equipment should be turned off. The instructor will designate the proper clean up procedure and may direct the students to vacate the lab.

16. Keep mercury out of sinks and sewer drains. Mercury spills must be reported and cleaned up immediately with a mercury sponge or pump. Then, to reduce vaporization of any, which may have been missed, cover the area with sulfur powder or an approved commercial product designed for that purpose.

17. Hydrofluoric acid must not be used except under direct supervision of the instructor. Immediate medical attention is necessary if this acid comes into contact with the body.

18. Perchlorates or perchloric acid must never be used except under direct supervision of the instructor because of the explosive nature of these substances.

19. Radioactive materials must only be handled under the direct supervision of the instructor.

Waste disposal

In general, no chemical wastes should be disposed of into the sink, sewer or regular trash containers. Chemical wastes should be collected, labeled, dated and disposed of through the Safety Office disposal service.

It is the responsibility of all working in a chemistry lab to see that wastes are disposed of properly. Toxic wastes must be disposed of in appropriate containers and removed from the facility for treatment to reclaim the materials or for burial in an approved wasted disposal site.

As a general rule in the lab, wastes should be disposed of as itemized below.

Check with instructor for deviations from these guidelines.

1. Dry chemicals should be disposed of in the designated waste container(s).
2. Paper should be disposed of in the trashcans.
3. Aqueous wastes containing heavy metals or other toxic substances should be disposed of in the bottles provided for aqueous wastes.
4. Organic solvents should generally be disposed of in the organic waste containers provided. Halogenated solvents should be disposed of separately from non halogenated in so far as possible.

Titrations – Use of a Buret

1. Wash buret and rinse with distilled water. Assemble according to instructions.
2. Place buret in buret clamp.
3. Pour 5 mL of titrant into buret so that it runs down the sides, rinsing the buret. Allow this liquid to run out of the tip and into a waste beaker.
4. Repeat step 3 twice more to completely rinse the buret. Now it is coated with the solution you will be titrating with.
5. Fill the buret with titrant. Drain the buret to the ‘0’ or below and allow the tip to fill completely with solution. If there are difficult bubbles in the buret tip, they may be removed by placing a gloved finger over the tip and top of the buret, opening it and inverting it. When it is returned quickly to the upright position, the tip must be over the waste beaker. A second method involves removing the buret from the
clamp, opening the stopcock and giving the buret a gentle downward shake. Close the stopcock and record the level of the bottom of the meniscus. If it is other than the “0”, subtract this reading from the final buret reading at the end of the titration.

6. Operate the buret with the non-dominant hand while swirling with the dominant hand. This allows the titration to go faster and, when the student has practiced a consistent method, to be more precise.

**Use of a volumetric pipet**

**WARNING: DO NOT MOUTH PIPET!**

1. Clean the pipet with soap and water until it drains properly. To test: fill the pipet to above the top calibration mark with distilled water and allow the liquid to run out. The water should drain out in sheets, leaving no drops. If you see drops on the surface, continue washing and rinsing.

2. Test again with distilled water. If pipet will not drain clean with distilled water obtain a different pipet.

3. Practice filling the pipet with the pipet bulb.
   a. The rubber bulb should be placed in contact with the end of the pipet (but not pushed over the end) and controlled using your non-dominant hand. This will keep the index finger of your dominant hand free to place immediately over the mouth of the pipet when the bulb is removed.
   b. Draw the solution into the pipet until the level is above the etched line of the pipet. If you run out of suction in the process, put your index finger over the top of the pipet, squeeze the bulb and replace it. Never allow the liquid to be drawn into the bulb itself.
   c. Place your finger index over the top of the pipet.
   d. Dry the outside of the pipet using a Kimwipe.
   e. Position the tip of the pipet against the side of a clean beaker or flask. Release your index finger slowly and allow the fluid level to drop until the bottom of the meniscus touches the etched line.
   f. NOTE: The pipet must always be rinsed with distilled water when changing from one solution to another, and then rinsed with a small quantity of the particular before pipetting the required volume.

**Meniscus**

Liquid in glass will adhere to the side of the vessel, so you will not see a straight line at the surface of the liquid. You will see a U-shaped line; this is called a meniscus. Take your readings from the bottom of this “U”.

g. Transfer your pipet to the vessel desired. Position the tip against the side and release your finger, allowing the liquid to flow out under the influence of gravity. After the main volume of the liquid has run out, hold the pipet in place for 30 seconds then incline the pipet such that the opening in the tip touches the side of the vessel. There will be one drop left in the pipet. **DO NOT BLOW OUT THE LAST DROP.** The pipet is calibrated to deliver the volume stated on the pipet.
4. After you have practiced with water, rinse the pipet twice with small portions of your sample solution to avoid dilution of your sample. Discard the rinses.
5. Fill your pipet as instructed and dispose of waste liquids in their proper receptacle.

Use of a measuring pipet

Use the pipetting devices provided. Never pipet directly from a supply bottle. Contamination ruins everyone’s results. Transfer the necessary amount to a beaker or test tube.

1. Always clean the pipet with soap and water. Rinse it with distilled water before you start.
2. Attach the pipetting device to the pipet and position the tip below the surface of the sample. Make sure the tip remains below the surface until you have collected the desired amount.
3. Draw the liquid up the pipet slowly and watch the liquid level rise.
4. Draw the liquid past the volume you need. Adjust the level of the liquid to the proper volume and deliver the desired amount into the receptacle.
5. The pipet need should be rinsed several times with distilled water when one needs to change solutions.

Care of the pH meters and electrodes

Please demonstrate to your students proper use of the pH meter and care of the probes. It is necessary that students treat them carefully. These electrodes are expensive, so students must take care of the electrodes and will be charged for careless breakage. Also bear in mind that static electricity can be a problem with electrodes. Nonylons, sweaters, etc. should be worn while working with the pH meters.

To use this electrode:

1. Connect the probe to a meter. The meter should be OFF at this time. Carefully take the probe out of the storage bottle; rinse with distilled water and blot with Kimwipes. When done, it must be returned to the storage bottle, taking care to save the washer inside the stopper which holds the electrode in position.
2. The meter should be turned to STANDBY when the probe is not submerged in a liquid to be measured. The meter should be turned to ON or pH only while measurements are being made.
3. Standard pH 4, 7 and 10 buffers will be used to calibrate the meter. The meters may be calibrated for the acid range by adjusting to pH 7 with the set or intercept knob on the front of the instrument and adjusting to pH 4 with the temperature control knob (on some of the meters, this is located on the back of the meter). The alkaline range may be set up using 7 and 10. Whenever the solution is acidic, the meter should be calibrated between pH 4 and 7, whenever it is basic, the meter should be calibrated between pH 7 and 10.
4. Each student should need only about 10 mL of each buffer in an 18 x 150 test tube.
NOTE: The pH of distilled water is not 7. It is between 4 and 5 due to dissolved gases, particularly carbon dioxide.

5. When you have completed the readings, turn OFF the meter.

PLEASE DO NOT USE THE PROBE AS A STIRRING ROD. IT IS VERY FRAGILE AND EXPENSIVE.

Use of the pH meter as a Voltmeter

You will be using a modified pH meter as a voltmeter. Prior to the beginning of the experiment you will need to “zero” the meter. The bottom scale on the meter is calibrated in millivolts (-700 to +700). Since some of the potentials that you will be measuring exceed 700 mV, you will zero the meter at the left-hand side of the scale. To do this, clip at two leads from the meter together to “short out” the meter, turn the control knob from “off” to “mV” and adjust the reading with the “SET” knob until the needle lines up with the last calibration line. Since the pH calibration lines are equivalent to the mV calibration lines, it is convenient to read the pH scale and multiply by 100 to read the potential between the two leads. You may wish to repeat this calibration procedure several times during the experiment.

With the voltmeter adjusted in the manner described above, one of the leads must always be connected to the positive electrode in the voltaic cell (cathode) and the other lead must be connected to the negative electrode (anode). In the first cell that you investigate, you will be told which electrode is the cathode and which is the anode. Connect the voltmeter leads to this cell using a red lead for the cathode (+) and a black lead for the anode (-). If the needle deflects slightly to the left, reverse the leads where they plug in the meter and the needle should then deflect to the right allowing you to measure the cell potential. In subsequent experiments, determine how to connect the leads to the electrodes so that the needle deflects to the right; this allows you to determine which electrode is the cathode and which is the anode.

Use of a spectrophotometer

Spectronic 20

1. Turn on the POWER switch to the on position. There will usually be a light to indicate the flow of current in the electronic components. Allow at least fifteen minutes for warm-up of the instrument.

2. Turn the WAVELENGTH control to the desired setting. Adjust the ZERO control so that the METER reads zero with the sample holder empty. Be certain that the sample compartment is closed during all measurements.

3. Take the tube you designated as your blank. It should be approximately half full. Carefully wipe off any moisture or marks on the lower three quarts of the tube with a soft, lintless wipe (Kimwipes). You should not handle the tube below the etched lettering and the vertical line. Any marking (e.g. fingerprints, water droplets) in the path of the light beam
affects the light transmission or absorbance and gives you incorrect results.

4. Insert the cuvette into the sample holder. Align the etched mark on the tube with the score mark of the same holder. Again, if the cuvette is not so situated, you will get incorrect results. Close the cover of the sample holder.

5. Adjust the LIGHT CONTROL knob until the METER reads 100% transmittance (zero absorbance). You will now have compensated for any absorption due to the solvent so that any absorption of light by your sample will be to solute absorption. This procedure must be repeated each time the wavelength is changed, and should be repeated before each test sample is read.

6. Your cuvette should be half full with your sample solution and the exterior surface clean. Insert the sample cuvette in place of the solvent cuvette in the sample holder, again aligning the direction marker. Close the cover and read the percent transmittance or absorbance of your sample on the METER.

7. When your measurements are completed, remove your cuvette from the sample holder and close the cover. Turn off the power to the instrument. Clean and rinse the cuvettes, taking care not to scratch them on any hard surface. NEVER use abrasive cleaners or test tube brushes to clean cuvettes.

Light may be regarded as waves of electromagnetic energy propagated through space, in waves which can be described in terms of their wavelength (λ), their frequency (v), and velocity (c). The wavelength (λ), may be defined as the distance between crests of the wave. The frequency (v), is the number of crests passing a given point in space each second. If the wavelength is specified in cm and the frequency in cycles per second (s⁻¹), the product of λ and v has the units of cm/sec and is equal to the speed of light, 3.00 X 10⁸ cm/sec. This is expressed in the following equation; v λ = c.

In the visible region, the wavelength of light is usually measured in terms of nanometers (10⁻⁹ m). The visible region is usually taken from the region between 380 to 750 nm, spanning the color spectrum from violet to red. Within this region light is composed of all the various spectral colors. When light of a particular wavelength, i.e. a particular color, is absorbed the solution will appear as the complementary color. White light, or sunlight, is composed of all these wavelengths and colors and is known as polychromatic light. Light of a single wavelength is known as monochromatic light.
Table 1. Correlation between wavelength, color, and complementary color in the visible region.

<table>
<thead>
<tr>
<th>Wavelength, nm of light absorbed</th>
<th>Color of light absorbed</th>
<th>Complementary Color color of solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>380 - 435</td>
<td>violet</td>
<td>yellow - green</td>
</tr>
<tr>
<td>435 - 480</td>
<td>blue</td>
<td>yellow</td>
</tr>
<tr>
<td>480 - 490</td>
<td>green - blue</td>
<td>orange</td>
</tr>
<tr>
<td>490 - 500</td>
<td>blue - green</td>
<td>red</td>
</tr>
<tr>
<td>500 - 560</td>
<td>green</td>
<td>purple</td>
</tr>
<tr>
<td>560 - 580</td>
<td>yellow - green</td>
<td>violet</td>
</tr>
<tr>
<td>580 - 595</td>
<td>yellow</td>
<td>blue</td>
</tr>
<tr>
<td>595 - 610</td>
<td>orange</td>
<td>green - blue</td>
</tr>
<tr>
<td>610 - 750</td>
<td>red</td>
<td>blue - green</td>
</tr>
</tbody>
</table>

Since many substances form colored solutions, a comparison of the intensity of the color of a known concentration with that of a solution of unknown concentration offers a convenient way for the quantitative estimation of the concentration of the colored substance in the unknown solution. If the comparison is done visually, the method is called colorimetry. If a photoelectric cell is used in place of the human eye, the method is called photometry. In the technique used in this experiment, when monochromatic light is used as the source and a photoelectric cell is used as the detector, the method is known as spectrophotometry. The white light emanating from the tungsten lamps passes through the entrance slit and is reflected by a diffraction grating. The grating is a dispersing element, acting like a prism to separate the white light into its component wavelengths. In setting the wavelength, the grating is rotated by means of a cam, so that the desired wavelength passes through the exit slit. The monochromatic light that passes through the exit slit goes on through the sample and finally strikes the measuring photoelectric cell, where the light energy is converted to an electric signal.