CHEE 4550

Chemical and Environmental Engineering Laboratory II



University of Toledo
Department of Chemical and Environmental Engineering

Chemical & Environmental Engineering Laboratory Guidelines

General Class Information

Staff

Instructor: See Syllabus
TAs: See Syllabus
Technician: See Syllabus

Time

See Syllabus

Textbook

None

Introduction

The class aims are to develop:

1. The ability to apply the mathematical, scientific, and engineering principles discussed in the lecture courses in a chemical plant.
2. The ability to design and conduct experiments, as well as to analyze and interpret data.
3. The ability to identify, formulate and solve problems that might be encountered in a chemical plant.
4. An understanding of professional and ethical responsibility.
5. Skills in report writing and oral presentations.
6. The ability to use the techniques, skills, and modern engineering tools in chemical and environmental engineering practice.

The laboratory procedures and experiments are undergoing continuous improvement efforts. Student feedback plays an important role in the development of the laboratory. The instructors and their assistants welcome any constructive comments/suggestions during the course.

Experiments

See Instruction manuals in WebCT

Organization of the Laboratory

You will be working in teams of three or four - the members selected by mutual consent.

Experimental results will be presented in a written report for each experiment. An oral presentation may be required as well. Guidelines for preparation of the reports and presentations are given the *Written Reports and Oral Presentations* section of this handout.

One student will be the team leader for each experiment. Expectations of the leader are outlined in the *Leader Responsibilities* section of this handout. The leader for each experiment will be graded for their leadership based on the observations of the instructor and fellow group members.

Safety and Procedures

Safety

Safety is an important part of any laboratory or engineering enterprise. All students, staff, and others must wear hard hats and either goggles or safety glasses with side shields during laboratory periods and any other time when experiments are in progress. A laboratory technician, teaching assistant, or instructor must supervise all work during the scheduled laboratory period or at any other time. A set of safety guidelines, "Basic Safety Guidelines for the Chemical and Environmental Engineering Laboratory," is provided in Appendix D of this handout. Each student should be familiar with all of its provisions and practice them.

Conduct of the Experiments

Students should follow the procedure below to conduct experiments.

1. Before starting any experimental work, thoroughly read the safety and experimental guidelines provided. The instructions for each project must be studied carefully and each person should be familiar with the theory, procedures, data analysis and interpretation as described in the instructions or as covered in relevant previous courses, BEFORE coming to the pre-lab. A few questions will be asked by TA and Instructor to check the understanding level of the students, which will be reflected in the pre-lab evaluation.
2. For each experiment, the group must meet with the appropriate TA, departmental technician, or instructor who will explain important aspects of the experiment. You must use this time to familiarize yourself with the equipment, to plan the experiments to be done, and to plan the safety precautions to be taken.
3. You should perform the experimental work in a thorough and careful manner. Thought should be given to ways of improving the accuracy and precision of the results and the ease of doing the work. Sources of error, anomalous results, experimental difficulties, and methods for improved operation should be considered and recorded in the laboratory notebook.
4. The laboratory notebook should be inspected and initialed by the professor after each laboratory period.
5. *Eye protection (safety glasses or goggles) and hard hats are required on both laboratory levels. The first violation results in a verbal warning. Subsequent violations lower the experiment grade by 10% per violation. Your safety is our paramount concern.*

Preliminary Work (Pre-Lab)

Prior to your laboratory day, your group must perform some preliminary work. The objective of this work is to familiarize students with the equipment for the experiment and ensure they have planned out how it will be conducted. The leader is responsible for making sure this preliminary work is completed. The preliminary work should include:

1. A detailed experimental plan. For some experiments you will be provided with a fairly detailed plan and you may use this, suitably rephrased. For the remaining experiments you should devise a plan.

2. A detailed flow sheet for the experiment. In addition to the major pieces of equipment, also show the peripheral ones such as valves and measuring devices.
3. A plan of the safety precautions taken. For example, MSDS sheets should be obtained for the chemicals to be used. These sheets should be pasted in the laboratory notebook.
4. A discussion of all the environmental implications of the experiment. For example, you can discuss how the chemicals can be safely disposed of at the end of the experiment. Will there be any significant gas, liquid or solid emissions due to the experiment?
5. Sample calculations for each of the calculations you will perform. You do not have to obtain experimental data to do this. Instead, make up data and use it to demonstrate how you would perform the calculations.
6. Identification of required flow meter calibration. Flow meters may require calibration and each group should determine an appropriate calibration procedure. It is recommended that calibration data be taken on the pre-lab day.
7. Data tables prepared in the notebook for use on lab day. All tables should be laid out cleanly with a straight edge and ready to use. These tables should be placed after any tables required for calibration data.

Each of these items should be included in your laboratory notebook. Each group will be graded on the thoroughness and accuracy of their pre-lab preparations based on the form given in Appendix A.

The Laboratory Notebook

The laboratory notebook is a log of what you did, when you did it, and who did it, written so others can understand it. *It must be a bound notebook with data entered at the time it is taken.*

1. All data, observations, steps in the procedure, alterations in the procedure, comments, calculations done during the laboratory session, and rough plots are to be entered into the laboratory notebook. *Use a ball-point pen.*
2. The notebook is to be maintained carefully and neatly. All sketching and layout of tables is to be done with a straightedge. Errors in recording data must be crossed out neatly and re-recorded. *Never write over numbers, erase, or "scribble" over errors. Preserve the legibility of errors by drawing a straight line through them; place your initials and date by the error.*
3. Work out, in advance, how tables will be organized for recording data. Remember that, along the way, other observations, quantities, and remarks may also have to be recorded. Leave room for columns of data that may not have been originally anticipated. Give each table and figure a title.
4. Record data as observed. Never perform any calculations prior to recording values as read from some instrument, scale, etc. In particular, if a *difference* between two values is a relevant quantity, record *both values* and then take the difference later.
5. Identify all variables by name, symbol and units. Record the units (in the column heading) of all quantities recorded in a table.
6. Prior to recording the data, state briefly all steps that were performed, so that a reader could repeat the experiment in exactly the same way.
7. It is important to be able to trace each data point from the experiment through the calculations to the final report, and in reverse. Identify all "runs" in a project by consecutive

Arabic numerals, e.g. Run 7. Separate measurements within a "run" may be, but usually are not numbered, and are called points. Repeated or very similar runs may be numbered as follows: 7.1, 7.2, etc. Do not refer to "Session 1" or "Day 1", etc., use run numbers only.

8. Record the names of the investigators and the date on each page of the notebook record. Record the beginning and ending times of the experiment. Number the pages and indicate the total number of pages by "p.2/5" (the second of five pages, for example).
9. The instructor will inspect, discuss and initial the data recorded in your notebook. It is recommended that copies of the original data pages be made for use by each student in the group as soon as possible after the laboratory period.
10. Data recorded automatically by a printer or recorder are part of the notebook record. They may be photocopied and taped into the notebook.

Team Leader Responsibilities

Each student will act as a team leader for at least one experiment, the other members serving as assistants. The leader will be "in charge" of the entire experiment, from the start to submission of the final report. The team leader's responsibilities are to organize the project from the first meeting with the TA or instructor through submission of the final report. He/she is responsible to:

1. Complete the review of the preliminary work with the appropriate laboratory TA or instructor.
2. Ensure that safety guidelines are followed.
3. Ensure a fair division of effort among the team members.
4. Review the laboratory notebook for completeness and adherence to laboratory notebook standards, before submitting the book to the instructor or TA for initialing at the end of each laboratory period.
5. Ensure that the experimental area is clean, equipment has been properly stored, all apparatus has been properly shut down, and any broken equipment has been reported to the technician before leaving.
6. Resolve scheduling problems for data analysis and report writing.
7. *Have final authority for the report. He/she should ensure the completeness, adherence to format, etc. If necessary, he/she may request others to redraw, rewrite, edit, etc. various parts of the reports.*
8. *Have final authority for the quantity, accuracy and adequacy of the data. He/she may require the group to conduct more or repeat runs*.

Written Reports and Oral Presentations

Written Reports

Reports are to be prepared according to the following format, and are due after 2 weeks from the experiment. Late reports will be penalized 10% per day. Initially, the instructor will check the report to determine if it generally conforms to the required format: if the report is unacceptable, the report may be resubmitted within 48 hours. Points will be deducted from the final report score for each unsuccessful resubmission. Upon successful submission, the report will be passed on for grading.

The report must be based solely on the work of members of your group, and written solely by members of the group. Plagiarism is a form of academic dishonesty and will not be tolerated. The reports should be typewritten/word processed on 8½×11 inch paper. Use a 12-point font, double space the text, leave 1-inch margins, and number each page (except the title page). Submit the report in a 3-ring binder. Usually the reports are 20-30 pages long including figures and tables. The sections of the report are:

1. ***Letter of Transmittal:*** The letter of transmittal is not part of the report, and has no page number, but is attached to the front of the report. It tells briefly what the report is, who did it and why it was done.
2. ***Title Page:*** The title page includes the team members' names, the date, experiment name, number and week, team leader, and identification as to whether a preliminary, final or rewritten report.
3. ***Abstract:*** The abstract seldom has more than 200 words, outlining the equipment, the purpose of the experiment, how you conducted it, and your main conclusions and recommendations. The abstract must stand by itself, as if it were in a card catalog, and *not* refer to the body of the report. *The abstract must contain quantitative numbers regarding the scope and results of the investigation.*
4. ***Table of Contents:*** The table of contents includes all sections, list of tables and figures, plus appendices.
5. ***Introduction:*** The introduction explains what the problem is, as well as your approach in solving it. Sometimes this section includes a brief discussion of the theory.
6. ***Theory***: The theory section describes the basic theory underlying the experiment. Relevant equations are presented here (in the proper format, each numbered at the right hand margin).
7. ***Procedure:*** The procedure section is expected to have approximately 2-3 double-spaced pages, plus a *neatly prepared figure of the apparatus* (do not copy figures from the literature or handouts). Outline both the experimental work performed and any special data processing techniques used. The description and/or figure should give the reader an idea of the scale of the experiment.
8. ***Results:*** In this section you should provide tables and/or figures (graphs), as appropriate, and a written discussion that guides the reader through the data. In these experiments, where you are comparing experimental data with theory and/or other data, the best way is a comparative figure - that is, a scatter diagram with all your data and any comparative data/theory on the chart. Any modifications of the theory appearing in the handout (if applicable) should also be given here. Large amounts of tabulated or graphical data, such

as might be collected on a diskette, should not be included in this section. It should be put in an appendix and summarized graphically for this section.

9. ***Discussion of Results:*** Give a critical appraisal of your results in this section. Include comments on the major sources of error, and the testing or analysis you did to determine the accuracy of your results. It is appropriate to discuss the importance or implications of the experimental results and make statements regarding the meaning of these results in a more global context in this section.
10. ***Conclusions:*** Include your conclusions and recommendations from the experimental results here. Include any suggestions for improvements.
11. ***Notation:*** Include all symbols, their definitions, and units. Follow the format used in the *AIChE Journal*. The symbols must be in alphabetical order, with English notation first, followed by Greek.
12. ***References:*** Follow the format used in the *AIChE Journal*. The references should be in alphabetical order, but do not number them. Refer to them by author(s) and year, as in Nadarajah (1998). Refer to equations in a text using the reference, page number and equation number. Do not use footnotes or ibid. If you use library references or unusual references, photocopy the relevant pages and include them in Appendix C. Unpublished class notes are never used as references, but should be traced to the original reference or derivation. Likewise, web pages are generally not considered as an appropriate reference, unless they refer to a specific report, document, or collection of data that is made available through electronic means.
13. ***Appendices (in the following order)***

    A. Sample calculations - Do these calculations in a manner such that any technical person can follow them, even if unfamiliar with the technology. Refer the reader to a specific run or data point, in such a way that one can start with the raw data and check the calculation of all intermediate points to the final data. Refer to tables, figures, equations, etc. by number. Include units and conversion factors. *Record all sample calculations by hand, in black ink unless you can make them look like a textbook example with word processing. Very important: take one data set and perform the sample calculations using it from beginning to end (raw data to final result) in a clear way that the reader can easily follow. Include <u>all</u> calculations, no matter how trivial, and be sure to include units on all numbers.*

    B. Copies of the laboratory data sheets. It may be necessary to rewrite them to make them presentable in the report, but you must include the original signed data sheets as well. Include a summary table: a table which presents each run or datum point number on the left, followed by results of intermediate calculations to the right, all the way to the final results.

    C. Other material of importance such as handouts, journal articles, etc.

Grading

Each 100 points of an experiment will be divided as indicated below. Reports with grades below 70% must be rewritten in order to receive credit. They will be re-graded on a basis of 70% maximum.

Adherence to Format	10
Sentence Clarity/Grammar	10
Technical Content	50
Sample Calculations	30
Total	100

Appendix B contains the form that will be used to evaluate and grade written reports.

Oral Presentations

The oral presentations must use presentation software (e.g. Microsoft PowerPoint). Oral presentations are an integral part of a professional's job whether it is in industry or academia. When preparing a presentation, remember that oral presentations are different than written reports. The reader of a written report has time to look carefully at tables or figures, can reread a passage to clarify its meaning, and can ponder details. The audience for an oral presentation cannot do these things. The presenter must use graphics that are legible from a great distance, speak slow enough to be understood, and limit the information presented to an amount that can be readily comprehended.

Good presenters typically tell the audience what they will hear, let the audience listen to what they have to say, and finally tell the audience what they heard. This repetition increases retention by the audience of the information presented to them. Since the audience cannot reread or replay your presentation you must do it for them.

The amount of material (detail) covered in a presentation will be less than that in a written report. This is due to time limitations. Therefore, the presenter must pick out the most important parts to present. Additionally, the presenter must present the material using fonts that are big enough to read from a distance and a combination of colors that provides good contract between the background and foreground. Use text only to paraphrase what you will say: you should provide a grammatically correct voice-over that corresponds to the text.

Oral presentations should contain the following slides:

1. Title Slide: presentation title, names of presenters, affiliations, date
2. Outline: a list of the major sections of the presentation
3. Introduction: describe problem, terms used, procedure followed, and results obtained
4. Results: present major results that support conclusions
5. Conclusions: highlight most important results and their implications
6. Acknowledgements: acknowledge people that made project possible

Some additional suggestions for developing and giving your oral presentations follow.

Organizing the talk.

1. Plan your presentation carefully
2. Prepare an agenda and control the time
3. Ensure that your talk answers:
   - What was (is to be) done?
   - How was (will be) it done?
   - What was (will be) the significance?
4. Ensure that your talk answers:
5. Compose an outline
   - Think of your talk as a summary
   - Start with big picture, then proceed to details
   - Make sure the talk is self-contained and doesn't refer to itself
6. Target and involve your audience
   - Things obvious to you may not be to the audience
   - Think about the audience's background
   - Make sure audio-visual aids are engaging
7. Give extra thought to openings and closings
8. State conclusions and action items explicitly
9. Remember your purpose is to inform - not just to impress

*Presenting your talk (*Suggestions for Oral Presentation)

1. Proper attire.
2. Clearly state the objectives.
3. Good eye contact.
4. Be confident.
5. Reduce amount of text, use bullets.
6. Use more figures and plots.
7. Avoid fuzzy colors such as yellow, pink, or gray in the figures.
8. Use legends in your plots.
9. Proper font size for text (> 18) and axis's titles (>16).
10. Explain the experimental procedure along with the experimental set-up figure.
11. Need to cite the source of references.
12. Don't just read the equations. Explain them. (physical meanings, for example)
13. Do not read the text off the screen.
14. The group members who are not presenting stand straight and be attentive (no chatting).
15. Use the laser pointer more.
16. Answer questions honestly; say "I don't know but will try to find an answer" when you really don't know.
17. SMILE!

Preparing visual aids (PowerPoint)

1. Plan on using graphics
2. Never photocopy books or typewritten material
3. Plan on a maximum of 6-10 lines per a slide (use no smaller than 18 point font)

4. Plan your graphics as a harmonious suite
5. Use numbers (tables) sparingly; if used, align decimal points and use an appropriate number of significant figures

The presentations, excluding the question and answer period, should last no more than 15 minutes. Appendix C contains the form that will be used to evaluate and grade oral presentations.

Preparation of Engineering Plots

Engineering figures are the primary means for presenting experimental results in a written report or oral presentation. Thus, it is vital that these be prepared in a manner that is readily comprehensible. A figure should contain enough information that its content is clear without having to read the report or listen to the presentation. Furthermore, it should be an honest representation of actual data. Suggested guidelines for figure preparation are:

1. The figure must have a caption. This caption should contain the information necessary for the figure to stand on its own. All plots are "Figures" and should be labeled as such. For example: Figure 1. Calibration of Shell-Side Rotameter.
2. The caption should be placed at the bottom of the figure in written reports. For oral presentations, the caption may be at the top.
3. All axes should be labeled and scaled appropriately. These labels must include the name of the variable and its units. Use appropriate significant figures and use division corresponding to round numbers (e.g., a division of 12.5 is not appropriate – use a division of 5.0 or 10.0)
4. The independent variable should be plotted on the abscissa.
5. Extrapolations beyond the range of the data are to be avoided. If absolutely necessary, extrapolations are shown as dotted lines.
6. If a family of curves is shown, a keying method should be employed since the possibility exists that the graphs will be photocopied and lose any colors you might have selected. You may use colors if you wish, but you must also vary line styles and types of data points to key-code the curves. Also do not use fuzzy colors like gray, yellow, or pink.
7. Do not force too much data onto one plot. The intention in preparing these figures is to provide data in a readily understandable form – not to confuse the reader.
8. Avoid three-dimensional plots. They are difficult to read.
9. Most engineering plots are *scatter* plots. Use line plots only when the independent variable can take on a small, finite set of values.
10. Use bar or pie charts only when the independent variable is not quantitative (e.g., run number). When using pie charts, each slice should contain the percentage of the total and the total amount should be indicated in the figure caption or outside the pie.
11. Figures printed in landscape mode should be included in a report with the top of the figure closest to the binding.
12. Figures and Tables must be cited in the body of text close to them.

Appendix A – Pre-lab Grade Form

Pre-Lab Grade Form. Team: Date:

Item	*Complete*	*Comments*
Experimental Plan	☐	
Detailed Flow Sheet	☐	
Safety Precautions	☐	
Environmental Implications	☐	
Sample Calculations	☐	
Flow Meter Calibration	☐	
Data Tables	☐	

Grade: /100

Appendix B – Written Report Grade Form

Written Report Grade Form. Team: Date:

Item	*Present*	*Comments*
Letter of Transmittal	☐	
Title Page	☐	
Abstract	☐	
Table of Contents	☐	
Introduction	☐	
Theory	☐	
Procedure	☐	
Results	☐	
Discussion of Results	☐	
Conclusions	☐	
Notation	☐	
References	☐	
Appendices	☐	

Format: /10 English & Grammar: /10 Technical Content: /50 Sample Calcs: /30
Total: /100

Appendix C – Oral Presentation Evaluation Sample

Oral Presentation Grade Form. Team: Group #1 Date: 00/00/04

Names: Mr. Actual Factual (group leader) and Mr. Know All

Content & Organization	Comments
Clear objectives, logic and structure	Well-organized. Objectives were not clear.
Targeted for audience	Good
Cover necessary topics	Good Presentation was a little mono-tone.
Presentation	
Controlled pace	Good
Voice quality and delivery: clear, confident, enthusiastic, proper language and grammar (no slang)	Good: some group members need a bit more enthusiasm.
Frequent eye contact Good use of laser pointer; Gestures: natural, relaxed	Good. The group "talked" to the audience and didn't just "read" the presentation.
Visual Aids	
Relevant, informative	Very good.
Easy to read (Proper font size, bullets, colors)	Very good.
Good use of tables, figures and graphs, clearly labeled	Very good.
Other	
Ability to field questions	No.
Sources of information properly cited	No.
Finished on time (< 15 min)	Achieved

Total Score: 91/100

Appendix D - Basic Safety Guidelines for the Chemical & Environmental Engineering Laboratory

Safety and health in the laboratory can be achieved only through the full participation and cooperation of all students. The following guidelines must be practiced in order to protect you and your classmates from injury. This list is not inclusive nor a substitute for prudent caution and common sense.

1. Determine the potential physical and chemical hazards, and the safety precautions that apply to your experiment before beginning.
2. No laboratory work should be carried out in the absence of your instructor.
3. Do not perform unauthorized experiments.
4. Never begin an experiment unless you are confident you can finish or arrive at a safe endpoint before the end of the laboratory period.
5. Be alert to unsafe conditions and actions and call them to the attention of the instructor immediately.
6. Never leave unattended an experiment that is in progress.
7. Allow yourself sufficient time for clean-up at the end of the laboratory period.
8. Safety glasses or goggles must be worn at all times in the laboratory.
9. Contact lenses may be a hazard in the laboratory, even with safety glasses or goggles. Chemicals can be concentrated under such lenses and cause permanent eye damage.
10. Safety hats must be worn when working on pilot-scale equipment, when others are working above you, or when objects may fall from above.
11. Proper protective gloves should be worn whenever the potential for contact with corrosive or toxic materials of unknown toxicity exists.
12. Laboratory coats should be worn to prevent contact with chemical splashes and spills.
13. The appropriate respiratory protection must be worn whenever you are exposed to toxic airborne contaminants (gases, vapors, dusts, mists, or fumes).
14. Horseplay and other acts of carelessness are prohibited.
15. Avoid distracting or startling any other worker.
16. Never wear sandals or shorts. Exposure of legs and feet to spilled chemicals is a main cause of chemical burns.
17. Confine long hair and loose clothing when in the laboratory.
18. No eating, drinking, smoking, or chewing of gum is permitted in the work area. Contamination of food, drink, and smoking materials is a potential for exposure to toxic substances.
19. Mouth pipetting is prohibited. A pipe bulb or aspirator should be used to provide vacuum.
20. Do not put your nose directly over a container to smell the contents; waft vapors toward the nose instead.
21. Learn the location and proper use of safety equipment: showers, eyewash, fire extinguishers, chemical spill kits, etc.
22. In the case of a fire, chemical spill, or other emergency, alert the instructor and all other students in the laboratory.
23. Perform operations with toxic or noxious agents in the laboratory hood.
24. Before opening a new container, check to be sure another container of the same chemical is not already opened.
25. Never return a reagent to the storage bottle. You may create an incompatible mixture by mistake or contaminate the chemical.
26. Keep reagent containers closed. With an open container, dust and vapors may escape and gaseous or suspended material may enter, changing the nature of the reagent.
27. Always pour acid into water. Never pour water into acid.

28. Spilled chemicals should be cleaned up immediately and disposed of properly. Ask your instructor for assistance in clean-up procedure.
29. Outdated chemicals must be discarded, especially ethers and peroxidizable materials.
30. *Hazardous, toxic, or undiluted* chemicals should not be poured down the drain.
31. Chemical wastes must be disposed of properly.
32. Do not pour your waste into a waste container that is unlabeled.
33. The compatibility of chemicals must be determined before combining them in the same waste container.

Ten Laboratory Safety Rules

1. Use personal protective equipment.
   a. Goggles preferred over safety glasses.
   b. Contact lenses not recommended in the lab.
   c. Gloves.
   d. Lab coats or aprons.
   e. Face shields.
   f. Properly selected and fitted respirators.
2. Do not eat, drink or smoke in the lab.
3. Maintain safety equipment.
   a. Safety shower. Test weekly.
   b. Eyewash station. Test weekly.
   c. Spill kits for flammable, corrosive and caustic liquids. (Should contain neutralizing and absorbent materials, gloves and goggles.)
   d. Mercury spill kit.
   e. Fire blanket.
   f. Fire extinguishers: Class A – Paper, wood; B – Oil, grease; C – Electrical; D – Metal fires.
   g. Acid carrier.
   h. Safety shield.
4. Know where to find and how to use Materials Safety Data Sheets.
5. Use fumehoods when working with volatile chemicals.
   a. Maintain correct sash height.
   b. Do not use fumehoods for storage of chemicals or apparatus.
   c. Do not use perchloric acid in a regular fumehood!
6. Establish emergency procedures for fire, accidents and spills.
   a. Post emergency telephone numbers.
   b. Know how and when to use a fire extinguisher.
   c. Be familiar with first aid procedures.
   d. Report all accidents and injuries.
7. Secure compressed gas cylinders to wall or bench.
   a. Close cylinder valves when not in use.
   b. Keep caps on cylinders without regulators.
   c. Never transport cylinders without a cylinder cap. Remove regulator if necessary before transporting cylinder.
8. Label all chemicals.
   a. Date all new chemicals when received.

b. Know the NFPA 704 labeling system.

9. Never store chemicals alphabetically.
   a. Use flammable and corrosive storage cabinets.
   b. Dispose of old or unlabeled chemicals. Never dispose of chemicals in the trash!
   c. Do not stockpile large quantities of chemicals.
   d. Be wary of organic peroxides!
10. Do not dispose of broken glass in the regular trash.
   a. Purchase and use a glass disposal box.
   b. Full boxes must be placed into the dumpster by the lab occupants, not the custodians.