General Information
for Quantitative Analysis Laboratory

The principle task of a quantitative analysis laboratory is to determine the amounts of chemical substances that may be contained in a wide variety of samples. This class focuses on the manipulative skills, techniques, and problem solving processes required to perform an accurate and precise chemical analysis. These activities may be undertaken by chemists (analytical, organic, inorganic, or physical), biochemists, biologists, chemical engineers, medical technologists, or agricultural scientists. In each of these professions, as well as many other scientific endeavors, the skills and thought processes that you will develop while making analytical measurements will be invaluable to yourself and your future employer. It is therefore important that you, as a student, understand the importance of learning the skills required to perform an accurate analysis, the proper record keeping techniques and the importance of correct data evaluation. You may find that these abilities will be your most important allies once you become employed as a scientific professional.

The analyses that you perform in this laboratory are different in many ways than those you will encounter in industry, hospitals, or research. The samples you will receive will often be less complex than many "real-world" ones you will see. The procedures you use are generally well documented, the sampling and sample reduction will have already been performed for you in most of your experiments, and the stress on time-efficiency will be less than you would normally encounter in a job. In the future you will find that samples must be analyzed quickly, with cost and time-effectiveness, with limited amounts of sample, in very complex matrices, and sometimes without destroying the sample. These problems will not be strongly emphasized in this class but can never be overlooked nor ignored in normal sample analyses. However, the skills you should gain will position yourself to more competently perform these tasks.

Quantitative analysis laboratory classes often have the reputation for being difficult and tedious. In part, the rumors you have heard are true. Some of the procedures are time-consuming, and, in theory, difficult. But, in most cases, the difficulty and tedium are the result of a number of common errors made by the novice analytical chemist. Carelessness, sloppiness, and forgetfulness are the worst enemies of the beginning quantitative analysis student. If you properly plan your work before you come to lab class, label all appropriate lab equipment, keep adequate records, and exercise care and thought in all your operations, the problems you encounter in quantitative analysis laboratory will be minimal. In addition, the accuracy of your results will be as good as may be obtained by the beginning student.

BEST WISHES FOR A SUCCESSFUL SEMESTER.

Quantitative Chemical Analysis: The Student Perspective

A number of helpful hints have been compiled by former Quantitative Analysis students for your benefit. These have been attributed as the major reasons for their success in the laboratory. It would be advantageous for you to review these items and capitalize on their hindsight.

Preparation for Lab Class:

- You can never be overly careful in planning the analysis. The time spent reading and preparing the laboratory notebook prior to entering the lab will save a multitude of headaches and much time.
- A working knowledge of the calculations for the lab will save even more time.
- A list of the necessary equipment used will be very helpful.

While Working in Lab:

- Working at a **steady** pace throughout the semester will minimize errors and allow plenty of time to finish. At times you will be tempted to leave early when you reach a stopping point. It is urged that you use this time to ask questions, perform calculations, or prepare for the next lab experiment.
- When repeating a lab, keep in mind that the points gained for the second round may not off-set the loss of points if there is not enough time to finish a lab at the end of the semester. There is not a lot of time for mistakes; come into class prepared.
- Pay particular attention to the techniques that the instructor demonstrates. Many mistakes made by the novice are because of errors introduced by the use of the instruments. A small deviation in a method can be amplified throughout the remainder of the lab, creating a significant error in the results.
- Make sure the glassware is clean before using it however don't spend large amounts of time in the cleaning process.
- Always **keep solutions, solids, and unknowns** until you are sure that you will **never** use them again.
- Write down everything, even the things that might be viewed as unimportant. Something that is clear while working in the lab may become unclear later when trying to interpret your results. Sometimes even the smallest things have a large impact on your analysis or data interpretation.

Analysis of Results:

- Be sure to report your results with the correct units! If you are asked to report a concentration in % w/v and you report moles/L, your unknown score will suffer significantly.

- Go over all calculations at least twice prior to turning in your unknown results and lab notebooks. This will save time and headaches, not to mention improve your unknown scores.
- If the lab results come out poorly, first review your calculations and data interpretation carefully. Many errors are a result of these sources. A well-written error analysis can often partially compensate for poor results.

Final Words of Advice:

- Your instructor's time is valuable, therefore, when you want to ask questions be sure you know what you want to ask. Don't waste time asking about something that should have been read before entering the lab or that can be answered from the text in your lab manual.
- The techniques that you learn in this class will follow you throughout you career.

General Laboratory Information

1. The lab sections will meet at the designated times only. Plan your work carefully enough to finish when the class is scheduled to finish.

2. There will rarely be sufficient time to repeat experiments if your results do not turn out well. This speaks very strongly for advance planning and thought in preparation.

3. All experiments should be repeated in triplicate unless you are told otherwise before the experiment begins. When reporting your unknown results, a minimum of 2 values are required. A maximum of 4 values will be accepted.

4. Improper identification of unknown numbers or other samples in the laboratory notebook will result in substantial penalties.

5. Do not use distilled water for washing glassware. It should only be used for rinsing out previously soap washed and tap water rinsed items.

6. Label everything that you use to prevent mix-ups.

7. Never assume any glassware is clean unless it is properly labeled

8. Requests for unknown samples must be turned in at least one period in advance of need.

9. Concentrated acids and bases are kept in and under the fume hood. Please use them only in the fume hood to minimize potential harm to yourself, the other students in the class, and the lab instrumentation.

10. Much of the equipment that you use during the semester is expensive and/or fragile. Treat it with care. If you borrow any glassware, clean it and return it to the place you found it. You will be charged for broken items.

11. One of the most important considerations in the laboratory is cleanliness. Keep all of your work areas clean and neat. Plan time to clean up before you leave the laboratory each day.

12. *SOME HELPFUL SUGGESTIONS FOR BETTER RESULTS*:
    a. Be thoroughly familiar with the procedure and techniques required before beginning the experiment.
    b. Plan your lab work efficiently.
    c. Develop habits of neatness and orderliness.
    d. Consider yours and your neighbor's safety BEFORE performing any operation.
    e. Determine what data you will be collecting prior to lab and prepare a data table in your notebook prior to the laboratory. If properly considered, it will save you time, keep your data in an organized and readable fashion. This sort of consideration will also help prompt you to write down all important information.

CHEM 222 Equipment Breakage Policy

You will be issued a glassware drawer. After checking into the drawer, you will be responsible for ALL of the contents of the drawer. At the end of the semester, the drawer will be checked out by your instructor and any breakage or missing items will be charged to you. If you drop the class, you must come to the instructor and be checked out or you will be charged a $25.00 check-out fee. NO CHECK-OUTS WILL BE DONE AFTER FINALS START. You should replace glassware as it is broken during the semester, obtain a replacement and sign a breakage slip at the chemical stockroom or from your instructor. You will need to take it to the cashier in McClain Hall, pay the amount owed, and RETURN THE SIGNED SLIP TO YOUR INSTRUCTOR before the last day of finals. It is YOUR responsibility to return the slip to the stockroom. If the fee is not paid by the end of finals, it will automatically become a $25 fine and failure to pay will result in a hold placed on your account (no grades or registration).

Safety in the Laboratory

1. Approved safety glasses must be worn at all times while in the laboratory.
2. Never work in the laboratory alone and during times not approved by your instructor.
3. You must wear shoes and long pants while in the laboratory. Sandals, shorts, and other similar apparel will not be allowed.
4. Know where all the safety equipment is located and how to use it in case it is needed.
5. No eating, drinking, or smoking will be allowed in the laboratory.
6. No unauthorized experimentation will be allowed.
7. Avoid sitting on the lab benches. Quite often they contain residues from spills which may have happened earlier. These spills can and do result in serious burns or damage to clothing.
8. Do not fill pipets by using your mouth for suction.
9. One of the best ways to avoid accidents is to keep the lab clean. All spills and broken glassware should be cleaned up immediately.
10. If it is at all possible, tie back long hair. Remember that hair is extremely flammable.
11. Never heat a closed system.
12. Flammable solvents should not be heated with a flame.
13. Do not heat or mix anything near the face.
14. Review all reagents used in an experiment before using to note their hazards and the precautions needed when working with them.
15. Hands should be washed before leaving the laboratory to remove potentially hazardous chemicals.
16. It is recommended that protective clothing such as a lab coat or apron be worn in the lab.
17. Avoid rubbing your eyes in the laboratory.
18. Never directly smell any substance. Waft your hands over the container, fanning the vapors toward your nose.
19. Before performing any work in the laboratory, a Chemistry Department safety contract form and emergency medical agreement form must be read, understood, completed, signed, and returned to your instructor.

Grading Policies

Your laboratory grade will be derived from two main sources. These are: 1) your results on the unknown samples, and 2) the laboratory notebook.

I. Unknown Samples

Report Format and Rules

For nearly every experiment performed in the laboratory, you will be given an unknown sample that you will be required to analyze. The goal of these experiments is to obtain an accurate and precise quantitative analysis of a component contained in your sample.

The unknown you obtain, will be identified by a unique number. For liquid unknowns you may be asked to submit a clean, 100 mL volumetric flask. It should be labeled with your name, the experiment number and title, and your unknown identity number (typically your lab drawer number). The container should be submitted at least 1 period in advance of its planned use. Solid unknowns will be issued to you with your unknown number written upon it.

Make certain that you record the unknown number in your notebook immediately upon obtaining the unknown. The unknown number will be used in the grading process and your instructor will not have a record of the unknown numbers each student has obtained. Failure to record an unknown number or the recording of an incorrect unknown number will lead to poor unknown scores.

Once you have completed the experiment, the results of your unknown determination and calculations must be reported as required by your instructor. Follow the instructions your professor provides. At a minimum, your instructor will ask for the information shown below, which may be reported on instructor-provided forms or on a 3" X 5" note card. Some experiments may have more than one constituent or component to report. For these experiments, report each separate constituent on a different note card.

Name **Date**
Experiment #
Unknown #
Title of Experiment

Substance Analyzed
1. Result #1
2. Result #2
3. Result #3
4. Result #4
Average

Initials

Be sure to present your answer with the correct units and all measured values clearly shown. You must report a minimum of 2 values with no more than 4 values allowed. All reports should be submitted within ***one week*** of completion of the experimental procedure.

Grading of the unknown reports will be done on a percentage basis of the total points possible for the experiment. A grade of no lower than 30% will be issued for any unknown report turned in (provided the experiment was actually performed). If you have turned in a report and a grade of 0 still shows on the posted summary score sheet, please resubmit your results. It probably means that your card was either submitted incorrectly or was misplaced. Make every effort to perform your calculations correctly the first time, as a penalty of 10% of the total worth of the experiment will be assessed for every unknown card that has been resubmitted due to incorrect calculations or units. More than one resubmission will result in incrementally increasing the penalty. A second resubmission will result in a 20% penalty. At most three cards may be submitted per unknown.

If you find it necessary to repeat an experiment and a new sample is required, a 10% penalty will be deducted from the maximum score possible for the experiment. New unknowns must be requested 1 period in advance.

Criteria for Unknown Grading

The grade on any experiment will be awarded on the basis of the following basic criteria. The results are graded on the percent relative error of your unknown determination results compared to the "true" value for the unknown. The expected level of accuracy is established on the basis of either actual experimental data, past history, or calculated uncertainties for each individual experiment performed.

II. Laboratory Record Books

Notebook Format and Rules

The laboratory notebook is an extremely useful tool for keeping good records and is essential to proper and accurate performance in the laboratory. In many cases, poor record keeping has resulted in the failure to obtain a good result on an experiment and has wasted much student time unnecessarily repeating experiments. In industry, inadequate lab records can ultimately cost a company money (probably costing the employee responsible their job and possible future employment), or result in serious legal action against either the employee or company. Thus, the quantitative analysis laboratory is the ideal place to begin the habit of adequate record keeping.

The laboratory notebook must be a permanently bound record book (spiral bound notebooks will not be accepted) capable of creating duplicate pages. All records must be recorded in ***permanent ink*** of either blue or black color. The notebook should be organized and neat. It is critical that the notebook be prepared in such a way that it be intelligible to the notebook author. It should also be easily understandable by any trained analyst who reads the records, attempts to reproduce these results, or endeavors to finish an incomplete analysis. This concept is often termed as "**traceable**" in the industrial world.

A number of important pieces of information must be considered in the development of your laboratory notebook. They are:

- The laboratory notebook must contain a table of contents referring to each experiment by page number. This also means that each page must be numbered.
- As you are completing your records, each data page should have your initials and the date recorded clearly on them.
- You should record observations that you make within the notebook during the course of the experiment. These observations will serve as valuable evidence when evaluating the results of your work.
- No erasure or white out may be used in the laboratory notebook. To correct errors, you should draw a single, bold line through the incorrect information. To allow proper interpretation of this as an error, the line should be initialed, dated, and have a short accompanying explanation of the reason for exclusion. Often, after several days the reason for exclusion of the data may be forgotten if this is not done.
- You should include in the data section the identity of any chemicals that you use in the experiment, including the lot number of a chemical, the manufacturer, the purity, and, if possible, the molecular weight and formula of the substance involved.
- The identity of all instruments used must be recorded in the data section, preferably including serial number, model, manufacturer, and information on the calibration or settings used.
- There should be no loose scraps of paper in the notebook. Graphs, charts, spectra, or spreadsheet results should be affixed to the pages of the notebook with tape or glue.
- When recording experimental measurements or performing calculations, one should be very attentive to labeling units on all numbers.
- When possible, set up data collection by the use of tables. Consideration in preparation of lab should allow you to predict a data table. Although difficult to accomplish initially, you will find that data tables can actually save time and space in your lab notebook. In addition, they are definitely easier to read for the trained analyst, too.
- Don't forget. Once you have finished the experiment, calculations, data analysis and discussion you must sign and date the experiment!

Notebook Format:

During the course of this semester, it will be expected that you follow the following format in preparing and using your lab notebook. Parts i, ii, and iii should be prepared prior to starting work on the experiment. You should also review the proper techniques you feel will be used during the lab experiment to help you perform these experiments safely and accurately. Some

idea of the expected data you will collect is also important as it allows you greater ease in organizing the data tables.

Please organize each experiment's records to include the following sections. Each section should be clearly labeled with the Underlined words. *Sign and date each page as it is completed.*

i. **Title**: This should include the experiment's title, your name, any partner's names, and the date the experiment was begun.

ii. **Statement of Purpose**: Clearly and concisely describe the purpose of the experiment, including the general method that will be used and anticipated results. This should be *brief*, two or three sentences maximum. Use complete sentences.

iii. **Procedural Outline**: Your notebook should contain a working OUTLINE of the procedure for the experiment. These should be written so that you can follow the entire experiment without using your lab manual (i.e. only use of the lab notebook). You may consult your lab manual during lab time, but it must be done outside of the lab room. It is wise to use the following approach to allow for modifications to the procedure, as occasionally is necessary. You should divide the procedural page into two parts by the use of a vertical line drawn down the page, approximately 3/5 of the way across the page from the left-hand margin. Record the procedure on the left-hand side. Any modifications or procedural notes that are needed can be penned in on the right-hand side. Experimental data should NOT be recorded in this section.

iv. **Data**: All data should be recorded in this section in chronological order. Included should be all measurements made (with proper units), information on the chemicals and instruments used, methods of calibration, and any important observations noted when performing the work. It is important to clearly document you data and observations. Be thorough and meticulous here. Once again, use a tabular approach when possible for repetitive data. It is appropriate to include a listing of the reduced data, all graphs, spreadsheet results, and spectra in this section. Unlike the procedural outline, this and all following sections may use the entire right-hand page. You need not divide each page to account for modifications or notes.

v. **Calculations**: An example of each calculation performed to reach the final reported answers should be shown. One need include only one example of each different calculation. Remember to label units and clearly illustrate them.

vi. **Error Propagation:** One common approach to estimate the expected precision in a method is to propagate the uncertainties for each component of the measurement. Uncertainties (sometimes called *errors*) are often estimated using the tolerance for a particular piece of glassware or tabulated precision for an instrument. Your textbook provides a discussion of approaches to error propagation. You must provide an error propagation calculation for one of the samples run in your analysis.

vii. **Discussion of Conclusions and Error Analysis**: A thorough analysis of results and

discussion of error sources should be performed for each experiment. The analysis best includes a statistical treatment of the experimentally propagated uncertainty (determined in part vi) compared to your actual standard deviation for the experiment. It should also present the confidence limit for these data. You discussion should try to pinpoint various specific sources of error encountered from the standpoint of the most likely determinate and indeterminate errors in the procedure. Do not use phrases like "I liked this lab" or "This lab sucked". Keep things pertinent to the experiment and use complete sentences.

viii. **Summary of Results**: A final table summarizing the results of your experiment, including each individual value used in the establishment of the mean, the standard deviation, the percent relative standard deviation, and the confidence limit should all be presented in a tabular fashion. Once recorded, sign and date the experiment.

One additional point needs to be mentioned. The manner in which the laboratory must be run to make the best use of equipment and space makes it difficult for the instructor to set up regular due dates for the experimental results. This does not mean the experiments won't be collected, it simply means there may be some delay between the time that you finish the experiment before it is collected. DO NOT delay completing the experiment just because a due date has not been assigned. This will be a mistake in several different ways. First, attempting to complete 2-3 write-ups a few days in advance allows minimal thought about the work, usually results in mathematical errors, causes a sleepless night or two, and generally makes the instructor very grouchy when 25 people attempt to ask questions about calculations and interpretations the day they are due. If this occurs around the week of finals (when typically you could try to tie up around 4 experiments) you will not be happy about it. Secondly, what may have been clear at the time you performed the experiment (an observation or knowledge of the correct approach of the calculation) may suddenly no longer be remembered. These can cause an incorrect interpretation of the results. Finally, if work has been performed in groups, a group member holding the data may be hard to find, a computer may crash, losing some long-sought calculations/graphs, or other similar difficulties may be encountered. This will do nothing but increase your stress levels and quite possibly negatively affect your other classes.

Finally, you should refer to your instructor’s syllabus for details on grading the laboratory notebook.

Handling Unknown Samples

Reliable analytical results depend upon the sample supplied for the determination and how representative it is of the total material being evaluated. The proper collection and handling of samples is a topic of concern for all analytical chemists. The problems associated with non-representative samples are numerous. As a simple example, a manufacturing plant might emit wastewater from a specific process once every three days. Measurements of pollutants taken on a nearby stream might be very different if they are taken either immediately before or after the release from the plant and neither measurement would be a good determination of the average output of the plant.

The samples provided for your investigation have been carefully prepared so that they are homogeneous or very nearly so. In the case of solid samples, this is the result of elaborate grinding procedures so that the particle sizes are very uniform and quite small.

Real world samples are for the most part heterogeneous. The only exceptions are thoroughly mixed solutions, and samples of substances totally free of contaminants. You should avoid operations that destroy the homogeneity of your samples.

Sample Handling--Solids

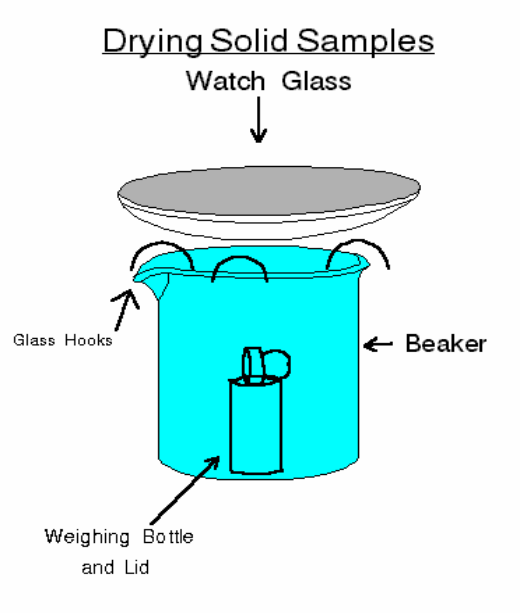
a. Avoid contact of your sample with moisture from wet containers, spatulas, weighing bottles, or droplets of water. A sample that is dissolved, and subsequently dried, forms crystals that are heterogeneous. This is a problem even in the case of small localized regions.

b. Samples adsorb moisture when exposed to the atmosphere. Unless otherwise noted, analysis of the sample is to be based upon the "dry weight". Note the sample drying instructions with each determination. Special considerations are necessary when samples have low melting points (less than 100 °C) or form very stable hydrates.

c. Properly dried samples are normally kept in that condition by storage in the "dry" atmosphere of a desiccator.

d. When a heterogeneous sample is supplied, special techniques are required. Grinding to increase uniformity, or dissolution followed by analysis of aliquots of the solution are often used.

e. Unless otherwise informed, assume that the sample should be dried for a period of time to remove excess adsorbed moisture before performing an experiment. Caution should be shown to keep the temperature low enough to prevent the sample from melting or decomposing. The proper approach for drying solids is shown in the following figure.



Sample Handling--Liquids

a. Samples that are to be provided to you as a liquid require that a clean container be submitted for the sample. The cleanliness of the container is your responsibility.

b. Liquid samples are normally issued in small amounts that are then to be diluted to a specified final volume. The container you submit should be a volumetric flask. The flask may be wet with traces of distilled water in those cases where water is to be used as a diluent.

c. Two manipulations of your unknown, dilution to volume and mixing, must be done with extreme care if aliquots of the solution are to represent the original sample.

d. Liquid mixtures that are provided for analysis without further dilution should be handled so that loss by vaporization is avoided. Mixtures for analysis by gas chromatography or infrared spectrophotometry change in composition as the sample vaporizes. Special sample handling instructions are usually provided.

Common Student Errors

This is probably the first laboratory in which a substantial portion of your grade is based on the accuracy of results you obtain. That means that you must perform every step of your experiment with care and forethought. A mistake at any step will result in a poorer grade.

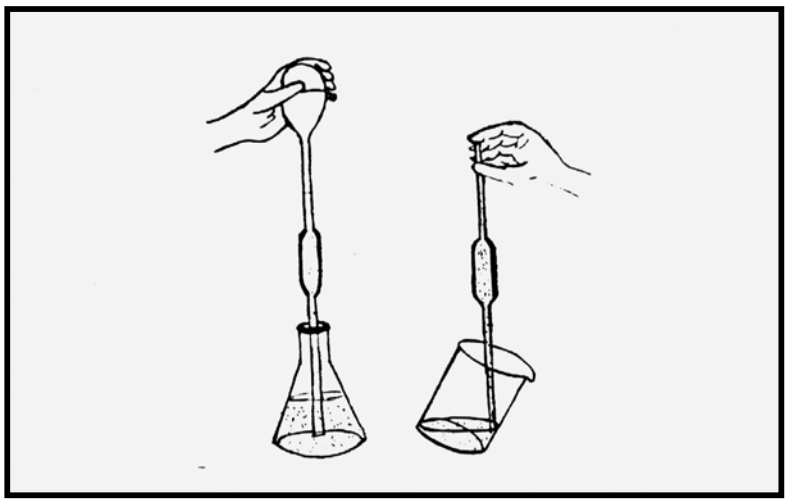
1. Incorrect use of balances. One incorrect massing operation is enough to ruin your results. So you must learn to use the balances correctly. It is important to follow the correct procedure. Your first laboratory exercise is designed to permit you to learn to use the balance. Do not leave until you are confident that you can use them correctly. The phrases "weigh accurately to about 0.98g", "weigh to nearest 0.1mg about 0.98g" or "weigh approximately 0.98 to 0.1mg" etc., all mean the same thing. Weigh all dry unknowns and primary standards to four decimal places, i.e. to 0.0001g. However, the exact weight must be within ± 10% of the weight 0.98g, i.e., between 0.8800 and 1.0800g. Never attempt to weigh a particular weight of any material, e.g., 0.9800g. **All weighing on these analytical balances is by difference, weighing the bottle and its contents before and after the contents are added to the appropriate container**. Another consideration is that your fingerprints can be weighed by these balances. Avoid getting them on the things you weigh.

2. Inadequate dissolution and mixing**.** It is important to ensure that your chemicals are dissolved completely. Otherwise, an incorrect value will be obtained. It is also essential to make sure that your solutions are well mixed. You must invert a volumetric flask about twenty times while rotating the flask one-quarter turn with each inversion to ensure sufficient mixing. An unmixed solution will yield poor results and hence poor grades.

3. Reading labels incorrectly. Many chemicals have similar names but react quite differently. For example, if your experiment calls for potassium iodide and you use potassium iodate, you can not get good results. *Always read labels carefully*.

4. Reading instruments and burets incorrectly. You will be instructed on the procedures for reading the various instruments. The burets should always be read to the nearest 0.01 mL. In addition, an initial and final reading are required to determine the volume delivered. A big waste of time in buret usage is to try to set the beginning meniscus exactly on 0.00 mL. Bring the meniscus below this mark and read the initial volume. Be sure that you know the correct manner for reading volume measurements on the buret.

5. Incorrect use of volumetric flasks and pipets. It is important that solutions prepared in volumetric flasks be made up exactly to the scored mark. An over- or under- filled volumetric flask will lead to inaccurate results. The same thing is true of pipets. Most pipets used in this course are designed "to deliver." That means that the liquid is allowed to drain out by touching the pipet tip against the receiving flask as shown here.



The material remaining in the pipet is not blown out. The pipet is calibrated to take into account the liquid that does not automatically drain out.

6. Retention or rejection of data. You may use the Q test at the 90% confidence level.

7. Significant Figures. Follow the rules of significant figures when performing calculations. In all measurements employed in this course you should use at least four significant figures. Examples are 0.9862 g., 46.02 mL, 0.1078 F and 294.2 g for weight, volume delivered by a buret, a concentration, and a molecular weight, respectively. Notice that to get a weight to four significant figures when weighing by difference, you will probably need six significant figures. For example:

Initial weight bottle + unknown	28.1987 g
Final weight after removing some unknown	27.2133 g
Mass of unknown removed	0.9854 g

8. Graphs. All graphs/plots should be appropriately labeled with a title, date, and labels and units for the axes.

Recommendations for the Treatment of Lab Data

These recommendations apply to laboratory data in which you generate a small set of results (considered to be small if there are less than 20 data points in the set). Generally, if you have a suspect point in the group, you should consider the following means for evaluation of that suspect result.

1. Carefully reexamine all data and results for the suspect result. The possibility of an error being introduced during your calculations is perhaps the most real of all common lab errors. A proper lab notebook containing carefully recorded notations of all observations is critical for review of your data (remember that observations are a good subjective means of dealing with bad data, especially in the treatment of outliers).

2. Estimate the precision that can be reasonably expected from the procedure that you used. Propagation of error, as illustrated in your text allows this estimate. Often times the outlying result is not at all out-of-line when compared to the expected precision of the procedure you are following.

3. Repeat the analysis if you have sufficient time and sample available. Agreement between the repeat sample and those of the original data set that appear to be valid will lend weight to the rejection or retention of the outlying number.

4. If you cannot obtain more data, apply the Q-test or the T-test to the existing data to see if the outlying number should be kept or rejected on the basis of statistics and probability.

5. If the statistical test indicates that you retain the number, consider reporting the median rather than the mean. The median includes all data in a small sample set without undue influence from an outlying value.

For additional information, please refer to your textbook.