I. This syllabus covers the General Chemistry 1 Lab.
This lab is a standalone lab and does not have to be taken concurrently with Gen Chem 1311 (lecture). As such the course material between lecture and lab may not be related.

CHEM 1111- (101-116) General Chemistry I Laboratory Prerequisite: None

II. STUDENT LEARNING OUTCOMES

This course is designed to give students hands on experience in dealing with chemical concepts. It will introduce the student to the techniques and procedures that are important to the successful practice of experimental general chemistry. At the end of the course the student should understand the technical aspect of chemistry, including developing a proper scientific approach to the performance and interpretation of experiments and experimental data.

III. INSTRUCTOR INFORMATION

<table>
<thead>
<tr>
<th>Instructors</th>
<th>Office</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Philip Egan</td>
<td>CS 206</td>
<td><a href="mailto:philip.egan@tamucc.edu">philip.egan@tamucc.edu</a></td>
</tr>
<tr>
<td>Dr. Narendra Narayana</td>
<td>CS 208</td>
<td><a href="mailto:narendra.narayana@tamucc.edu">narendra.narayana@tamucc.edu</a></td>
</tr>
<tr>
<td>Dr. Valeriu Murgulet</td>
<td>none</td>
<td><a href="mailto:valeriu.murgulet@tamucc.edu">valeriu.murgulet@tamucc.edu</a></td>
</tr>
<tr>
<td>Dr. Ioan Nicolau</td>
<td>none</td>
<td><a href="mailto:ioan.nicolau@tamucc.edu">ioan.nicolau@tamucc.edu</a></td>
</tr>
<tr>
<td>Mr. Arnold Mendez</td>
<td>none</td>
<td><a href="mailto:arnold.mendez@tamucc.edu">arnold.mendez@tamucc.edu</a></td>
</tr>
</tbody>
</table>

IV. TEXTBOOK AND OTHER MATERIALS:

Text: none required

Gen Chem Lab-Blackboard Website: Important information is posted regularly on Blackboard. The website has important information on: schedules, instructor contact information, safety, lab supplementary material, and lab announcements. Students are responsible for the information on Blackboard-visit it often.

Materials Needed:

- A bound pre-numbered notebook is required.
- A white lab coat and spill proof safety goggles are required.
- A scientific calculator: Quizzes will be given every day and will often require calculations. Therefore you must come to lab every time with a working calculator. Note that you will not be allowed to use your phone as the calculator so come prepared otherwise you may not be able to do the required calculations and therefore perform poorly on the quiz.
V. COURSE GRADE:

Lab Grade: The laboratory grade will be based upon lab technique/notebook grade, lab reports, quizzes and final exam. A list and description of the possible graded assignments is given in Section X of this syllabus. Final letter grades for the lab will be as follows: A = ≥90%, B = 89-80%, C = 79-70%, D = 69-60%, F = <60%.

Lab Notebook/ Lab Technique: At the end of the semester, your Instructor/Teaching Assistant will assign you up to 100 points based on your lab technique during the term. Important criteria include being well-prepared, arriving on time, being punctual in starting and finishing experiments on time, neatness in carrying out and cleaning up experiments, being safety conscious and being organized in your work. Since the lecture portion of the lab is extremely important points may be deducted, at the discretion of the instructor, from the lab technique grade for every lab lecture missed. Also any student, who misses the first introductory/safety lab at the start of the semester, may at the discretion of the instructor have points deducted from their lab technique grade. Your lab notebook will be reviewed and graded for specific content at the end of each class. As discussed later in this document, the laboratory instructor must sign your notebook before you leave each session. Know also that your lab notebook will be collected at the end of the semester to be graded for completeness and proper use.

Quizzes: The questions will cover your understanding of the experiment to be covered that day as well as your understanding of the experiment performed the previous week or weeks when pertinent.

Final Exam: The final exam is cumulative and will cover all relevant information covered during the semester including but not limited to background material, techniques, reactions, chemicals, safety information, and chemical concepts.

NOTE: Quizzes and tests will often require calculations so you must come to lab every time with a calculator. Phones can NOT be used instead of calculators. If you are seen using a phone during a quiz/test you will be given a zero for that quiz/test.

VI. THE RULES

LAB ATTIRE:
Upon entering the lab, you are required to wear:

- Safety goggles (not to be confused with safety glasses - goggles have a seal around the eyes and can protect you from a chemical splash)
- Lab coat
- Long pants
- Sturdy closed-toe closed-heel shoes
- Shoes should cover your feet as much as possible.
- Leather top & slip-resistant sole are also recommended.
- Without proper attire, you will be asked to leave.

Eye Safety: When in lab, always wear your safety goggles. A first violation will result in a verbal notification. A second violation will result in a reduction in your "lab technique" grade. A third violation of the safety goggle rule will result in your removal from lab for that day, which will result in a
zero for that lab. If you need a break from wearing the goggles, step out into the hallway and remove them for a few minutes.

**Clothing:** No open toe shoes, shorts (or short dresses), or mid-drefs (short tops) are allowed in the lab. Please keep your skin covered as protection against chemical spills.

**Cleaning and Waste Disposal:** Please be neat to avoid spreading chemicals. Always wash your hands just before leaving the lab. Never take samples or glassware out of the lab. Do not place your coats, backpacks and other personal items on the bench tops or floor in the lab to avoid contamination with chemicals. They should be placed in the cabinets under the benches. During the experiments, you will generate several types of waste, which need to be handled properly. Chemical wastes should be placed in an appropriately marked waste bottle. Do not pour liquid waste down the drain unless instructed by your Instructor. Broken glassware should be placed in the broken glassware box. Never put glass into the trashcans.

**Ask for Assistance:** If you have any questions about the safety of any procedure, please ask your Instructor/Teaching Assistant before proceeding.

**Academic Misconduct:** All students are expected to conform to college-level standards of ethics, academic integrity, and academic honesty. By enrolling in this course, you agree to be bound by the Regulations and Procedures published in the TAMU-CC STUDENT HANDBOOK. Honesty in reporting results is one of the essential characteristics of your laboratory work. Relatively little of your grade depends on getting "good" quantitative results and you will be more severely penalized for misrepresenting results than for honestly reporting "poor" results. Copying lab reports, receiving any type of help on an exam or quiz from another person or any source (notes, calculator-memory, etc.) not authorized by the instructors shall be considered academic misconduct and as a result will be penalized to the fullest extent possible.

**Electronic Devices:** Chemistry labs require your full attention at all times. Therefore the use of cell phones (including texting), ipods, pagers, earphones, and other similar equipment is prohibited. Please make sure that your cell phones are turned off or inactivated.

**LAB CONDUCT:** All students should be on time and prepared for each lab session. Note that the quizzes will be given at the beginning of each lab period (and sometimes at the end) and only a certain amount of time will be allotted for each quiz. Therefore if you are late you will not be given any extra time to finish your quiz and no makeup quizzes will be given. Furthermore, late arriving students at the discretion of the instructor may not receive credit for the Pre-lab (see following section) and since much of the material about safety and lab set-up is covered during the lecture any student that misses the lecture will not be allowed to complete the experiment. All students are also expected to follow proper laboratory conduct and behavior and treat the other students and the instructor with respect. If a student’s actions or behavior is deemed disruptive to the class by the instructor, the student will be asked to leave the class for that day. If the behavior persists, further disciplinary action may be taken, such as expulsion from the class. Absolutely no food or drink is allowed in the laboratory. **Students that find it necessary to eat or drink in the lab or behave in some fashion that is deemed by the instructor to be unsafe to themselves or others will be asked to leave lab for that day and will be given a grade of zero for that assignment.**
VII. UNIVERSITY POLICIES

Notice to Students with Disabilities: Texas A&M University-Corpus Christi complies with the Americans with Disabilities Act in making reasonable accommodations for qualified students with disabilities. If you suspect that you may have a disability (physical impairment, learning disability, psychiatric disability, etc.), please contact the Services for Students with Disabilities Office, located in Driftwood 101, at 825-5816. If you need disability accommodations in this lab please see me as soon as possible.

Grade Appeal Process: As stated in University Rule 13.02.99.C2, Student Grade Appeals, a student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is upon the student to demonstrate the appropriateness of the appeal. A student with a complaint about a grade is encouraged to first discuss the matter with the instructor. For complete details, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, see University Rule 13.02.99.C2, Student Grade Appeals, and University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures.

These documents are accessible through the University Rules Web site at: http://www.tamucc.edu/provost/university_rules/index.html. For assistance and/or guidance in the grade appeal process, students may contact the Office of Student Affairs.

Academic Advising: The College of Science and Technology requires that students meet with an Academic Advisor as soon as they are ready to declare a major. The Academic Advisor will set up a degree plan, which must be signed by the student, a faculty mentor, and the department chair. The College's Academic Advising Center is located in Faculty Center 178, and can be reached at 825-6094.

VIII. GENERAL GUIDELINES FOR LAB REPORTS

Pre-lab: As part of each experiment, you are required to prepare a typed pre-lab report to be turned in at the beginning of the lab period. If you come to lab without the typed prelab report that is an indication that you have come unprepared and you will not be allowed to stay. The pre-lab should provide enough specific information on the procedure (e.g., identity and quantity of materials, reaction times, temperatures, etc.) to enable you to perform the experiment. The summary should provide an overview of the experiment showing your understanding of the techniques and concepts being studied.

NOTE: It is advisable to print a second copy of the prelab so that you will have it available to you while you are conducting the experiment.

Pre-lab Summary: Summarize on one or two pages: Title of the experiment, purpose of the experiment, technique(s) or reactions(s) being used, and a brief chronological listing of the procedure you will follow in the experiment. In other words, write up step-by-step procedures for conducting the experiment.

More specific detailed information about lab reports and notebooks can be found in Appendix I and II of this document.
IX. GEN CHEM I LAB SCHEDULE—Spring 2013

Below is a VERY tentative schedule. The schedule is subject to change at short notice. As mentioned elsewhere in this document, information about upcoming labs will be given to the student in lab, by email and/or on blackboard. **It is the student's responsibility to keep up with any changes announced during the lab, posted on Blackboard, or emailed.**

<table>
<thead>
<tr>
<th>Week of</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-28</td>
<td>Introduction to General Chemistry Laboratory (equipment, procedures, rules, syllabi, safety etc.)</td>
</tr>
<tr>
<td>2-4</td>
<td>Precision and Accuracy of Scientific Glassware</td>
</tr>
<tr>
<td>2-11</td>
<td>Determining the Density of Various Liquids and Solids</td>
</tr>
<tr>
<td>2-18</td>
<td>Determining the Percent Copper and Zinc in Pennies from Density</td>
</tr>
<tr>
<td>2-25</td>
<td>An Introduction to Stoichiometry – <strong>Dry Lab</strong></td>
</tr>
<tr>
<td>3-4</td>
<td>An Introduction to Titration: Standardization of HCl, and NaOH</td>
</tr>
<tr>
<td>3-11</td>
<td><strong>Spring Break</strong></td>
</tr>
<tr>
<td>3-18</td>
<td>Investigating Stoichiometry with Sodium Salts of Carbonic Acid</td>
</tr>
<tr>
<td>3-25</td>
<td>An Introduction to Oxidation Reduction Reactions – <strong>Dry Lab</strong></td>
</tr>
<tr>
<td>4-1</td>
<td>Determination of % Composition of Pennies Using Oxidation-Reduction and Double Displacement (Precipitation) Reactions</td>
</tr>
<tr>
<td>4-8</td>
<td>Determination of % Composition of Pennies Using Spectroscopy</td>
</tr>
<tr>
<td>4-15</td>
<td>Behavior of Gases - Charles’s Law and the Determination of Absolute Zero</td>
</tr>
<tr>
<td>4-22</td>
<td>Behavior of Gases - Determining the Molar Mass of a Volatile Liquid</td>
</tr>
<tr>
<td>4-29</td>
<td>Thermochemistry - Heat of Solvation and Neutralization</td>
</tr>
<tr>
<td></td>
<td><strong>Final Exam - See Final Exam Schedule for Time and Date</strong></td>
</tr>
</tbody>
</table>

X. Description of Inquiry Based Learning

Two different types of labs will be conducted during the semester, dry labs and wet labs.

- **Dry labs** are typically problem based where the student is expected to work in groups to answer worksheet handouts designed to help reinforce concepts the students will be using both in the lecture and the lab. At the end of each dry lab a quiz will be given to test the students understanding of the concepts/problem solving ability based on the dry lab conducted that day. Note that a quiz may also be given at the beginning of the lab to test the student’s understanding of the experiment performed the previous week or weeks when pertinent and and/or to test the student’s understanding of the material to be covered in the dry lab exercise as well.

- **Wet labs** to be conducted will be “**Inquiry-based**” labs not **cookbook based**. Below is a description taken in part from Wikipedia on “Inquiry-based learning”.

**Generic Description of Inquiry Based Learning**

**Inquiry-based learning** or **inquiry-based science** describes a range of philosophical, curricular and pedagogical approaches to teaching.

Inquiry-based learning was developed in response to a perceived failure of more traditional forms of instruction, where students were required simply to memorize fact-laden instructional materials.
An important aspect of inquiry-based science is the use of open learning. There is an emphasis on the individual manipulating information and creating meaning from a set of given materials or circumstances. In many conventional traditional science experiments, students are told what the outcome of an experiment will be, or is expected to be, and the student is simply expected to 'confirm' this.

In open teaching, on the other hand, the students are either left to discover for themselves what the result of the experiment is, or the teacher guides them to the desired learning goal but without making it explicit what this is. Another approach is to give the students a “problem” to solve or a question to answer and allow the student to devise a method (set of procedures) to solve the problem or answer the question. For instance, in one of the first experiments the student will be told to determine the percent composition of zinc and copper in a penny based on the density of the penny. The student will have to search the literature and devise a method to answer this question. Some guidance will be provided by the instructor but it is the student’s responsibility individually and collectively (working in groups) to read the literature and devise a method.

**Description of Wet Lab Format and Expectations**

Information about upcoming labs will be given to the student in lab and on blackboard. It is the student's responsibility to keep up with any changes announced during the lab, posted on Blackboard, or emailed.

1. Each week the student is expected to have read the experiment to be performed and be prepared to conduct those experiments. Below is a description of two different types of reports that reports the student is expected to turn in. *(See Appendix I and II for more information about lab report format and guidelines)*
   a. Prelab Report – The prelab report should contain the following
      i. The pre-lab report should provide enough specific information on the procedure (e.g., identity and quantity of materials, reaction times, temperatures, etc.) to enable you to perform the experiment. The summary should provide an overview of the experiment showing your understanding of the techniques and concepts being studied.
      ii. Detailed set of procedures describing how you would expect to accomplish the goals of the experiment to be conducted. In other words, write up a cookbook set of instructions for the experiment to be performed that day.
   b. Formal Lab Report
      i. See Appendix II for instructions on what to include in the formal lab report.

2. At the beginning of each Wet Lab, a quiz will be given based on the experiment performed the previous week and on basic ideas and concepts of the experiment to be performed that day. The quiz should take no longer than 30 minutes. Note that the quiz will be given at beginning of the lab period. So get there on time because you will not be given extra time if you come in late.

3. After the quiz, the instructor may give a brief (~10-15 minutes) lecture discussing important concepts, procedures, etc. pertinent to the experiment to be performed that day.

4. After the instructor’s presentation, the students will break into groups to share their experimental procedures and write up a new set of procedures based on group feedback. This should take no longer than 10 minutes. After the 10 minutes is up, one member of the group will come and write up the procedures the group developed.
5. After each group has presented their procedures, the instructor will lead the guided inquiry discussion the pros and cons of each of the procedures presented. After which time the students will break into their respective groups (usually groups of two) and perform the experiment.

**Description of Dry Lab Format and Expectations**

When dry labs are performed the student will turn in the formal lab report from the previous week’s experiment but will not have a pre-lab assignment due. An additional difference is that there may be two quizzes that day. The first quiz, if there is one, will be on the experiment performed the previous week(s) and and/or to test the student’s understanding of the material to be covered in the dry lab exercise. The second quiz will be administered near the end of the lab period and will be based on the dry lab exercise content. If a quiz is not given at the beginning of the lab period, the quiz at the end of the lab period will likely include information on the experiment(s) performed the previous week(s). Dry labs will consist of students being given worksheets/problem sets to answer during the lab period. The dry labs are meant to be peer-lead learning assignments and so the students will be expected to work in groups. All students are expected to participate in the peer-lead learning exercises and if any student or group of students chooses to waste their time or other lab members time by not participating or being disruptive or distractive that student or group of students will be asked to leave and will receive a zero on the quiz that will be given at the end of the lab period.

<table>
<thead>
<tr>
<th>Lab Exercise / Experiment</th>
<th>Graded Assignments for Respective Lab/Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to General Chemistry Laboratory (equipment, procedures, rules, syllabi, safety etc.)</td>
<td>Quiz</td>
</tr>
<tr>
<td>Precision and Accuracy of Scientific Glassware</td>
<td>Lab Report</td>
</tr>
<tr>
<td>Determining the Density of Various Liquids and Solids</td>
<td>Lab Report</td>
</tr>
<tr>
<td>Determining the Percent Copper and Zinc in Pennies from Density</td>
<td>Lab Report</td>
</tr>
<tr>
<td>An Introduction to Stoichiometry – Dry Lab</td>
<td>Quiz 1 (maybe)</td>
</tr>
<tr>
<td>An Introduction to Titration: Standardization of HCl, and NaOH</td>
<td>Lab Report</td>
</tr>
<tr>
<td>Investigating Stoichiometry with Sodium Salts of Carbonic Acid</td>
<td>Lab Report</td>
</tr>
<tr>
<td>Spring Break</td>
<td></td>
</tr>
<tr>
<td>An Introduction to Oxidation Reduction Reactions – Dry Lab</td>
<td>Quiz 1 (maybe)</td>
</tr>
<tr>
<td>Determination of % Composition of Pennies Using Oxidation-Reduction and Double Displacement (Precipitation) Reactions</td>
<td>Lab Report</td>
</tr>
<tr>
<td>Determination of % Composition of Pennies Using Spectroscopy</td>
<td>Lab Report</td>
</tr>
<tr>
<td>Behavior of Gases - Charles’s Law and the Determination of Absolute Zero</td>
<td>Lab Report</td>
</tr>
<tr>
<td>Behavior of Gases - Determining the Molar Mass of a Volatile Liquid</td>
<td>Lab Report</td>
</tr>
<tr>
<td>Thermochemistry - Heat of Solvation and Neutralization</td>
<td>Lab Report</td>
</tr>
<tr>
<td>Final Exam</td>
<td>Exam</td>
</tr>
</tbody>
</table>

**Graded Assignments** – Below is a tentative list of graded assignments. All graded assignments will be worth 100 points each, except the final exam which will be worth 200 points. In addition to the graded assignments listed below, the student will be assigned a laboratory techniques/notebook grade also worth 100 points.
Appendix I: Chemistry Laboratory Notebook – Format and Procedures/Policies

All students are required to maintain a chemistry laboratory notebook during the semester. The notebook must be a bound (not spiral) composition book. All data are recorded in the notebook and checked by the laboratory instructor. The following must be followed in order to receive credit for the notebook:

- The notebook must be brought to each lab session.
- All observations, calculations, and data should be recorded into the notebook using blue or black ink. **No pencil! No white out!** All markings are permanent. If you need to correct a mistake, simply draw a single line through the word or phrase in error.
- No pages may be torn or removed from the notebook.
- All pages must be numbered.
- **Prior to arrival in Lab**, you must read the lab and record the experiment title, date, purpose, and procedure in your notebook. The procedure should include enough detail that you could complete the experiment with your notebook alone without the aid of your lab manual. Since you will be expected to turn in a typed pre-lab report at the beginning of each lab period it is recommended that you print two copies, one to be turned in and the other can be stapled into the lab notebook.

The Laboratory Notebook Format is as Follows:

**Page One** - Title page includes course title, section number, instructor, semester, date, and your name. It is also recommended that you include your email or other contact information so that in case you lose it the person finding it knows how to get in touch with you and return it.

**Page Two** - Table of Contents should indicate each experiment title, date performed, and the beginning page number.

**Overall Format for Writing Up Each Experiment:**

1. **Experiment Title and date performed**
2. **Purpose:** Write two or three sentences in your own words to explain what you are attempting to determine and the method used.
3. **Procedure:** Write a concise step by step outline of exactly what you must do to perform the experiment.
4. **Data/Observations:** Record all measurements you make (time, length, volume) and description of what you see (color, texture, precipitation, gas evolution).
5. **Calculations:** Show **ALL** calculations required to determine the results.

Each session must be clearly labeled. Leave appropriate space between sections to make notes and observations.

Your lab notebook will be reviewed and graded for specific content at the end of each class. **The laboratory instructor must sign your notebook before you leave each session.** Be prepared to turn over your lab notebook at any time. **Your lab notebook will also be collected at the end of the semester to be graded for completeness and proper use.**
The following is a list of **guidelines** for preparing the lab notebook.

- Write directly in the notebook
- Write in ink.
- No white-out
- No pencil.
- Do not tear pages out.
- Write on the right page only.
- Notes and personal scribbling may be written on the left side of the page. They will not be graded.
- Leave a few pages in the front for the title page and table of contents.
- Table of contents – use the page numbers that are in the NOTEBOOK, not the assigned experiment page numbers.
- The notebook must be checked and signed at the end of each lab session.
- Purpose & Procedure must be done prior to entering the lab. DO NOT copy directly from the lab manual or handout. Use your own words.
Appendix II: Lab Report Guidelines

Each lab must be typed or computer generated.

Hand written reports will not be accepted!!!!!!!!!!

Any copying or plagiarism from a text or a person will result in a Zero for that lab report. Text must be double spaced!

At the top any report should be the date, section number and your name. Your lab partner and the unknown number (if there is one). The experiment name and number; i.e.

Student: Joe Bob Whissletip
Partner: Monica Clinton
Unknown number: X-69

Date: April 15, 1998
Section: 1
Group #: 6

Experiment 22
Determination of Biomolecule Unknown

These formal reports should contain the following information.

Purpose- composed of two or three sentences summarizing the experiment to be performed.

Example:
The purpose of this experiment is to determine the concentration of the protein using a standard curve derived from the UV/VIS spectrophotometer. Its molecular weight is determined using size exclusion chromatography.

Theory- the length is not the most important consideration, but must contain:

1) A description of the theory which is being used in the experiment
2) Application of the theory to your system
3) Include all chemical equations
4) Description of the equipment/instrument(s) used, if relevant
5) Type of information obtained from instrument
6) Brief description of the data analysis or processing of the data
7) Expected results

Procedure and Observations:

Procedures: Tell how and what steps you followed as if you were the first one to ever do them. Write a concise step by step outline of exactly what you must do to perform the experiment. The procedure should include enough detail that you could complete the experiment with your notebook alone without the aid of your lab manual.

Observations: Record all measurements you make (time, length, volume) and description of what you see (color, texture, precipitation, gas evolution, etc).
i.e. ---- 5.023 g of unknown 12 was put into a 250 mL beaker and ~ 100 mL of water was added. The solution was stirred for 10 min and decanted the liquid through a Whatman # 23 filter to remove any undissolved impurities. Next, the solution was heated to boiling and 5 mL of 0.102 M NaOH was added slowly to the solution. The solution was allowed to boil gently for another 10 minutes. After the boiling period, the solution was placed in an ice bath allowed to cool and the temperature of the solution monitored with a digital thermometer. After about 20 seconds crystal were observed forming on the sides of the beaker. The solution was allowed to cool until the temperature of the solution reached 10 °C. etc. ------

Results- composed of:

1) Data in tables and instrumental data output should be attached permanently to a sheet of paper.

2) Graphs and tables must be properly labeled with figure or table numbers, with proper descriptive titles and axis labeled. In addition, all figures or tables should be computer generated. There will be no hand drawn graphs. It is also very important to note that while you may be working with a partner or a group in conducting the experiment, lab reports are supposed to be done separately. So DO NOT use any one else’s figures or tables. This will be considered plagiarism and will result in a grade of zero for that lab report both for you and the person you copied from. So do not be “nice” and share your reports with others because they may use your report improperly casing you to get a zero on that report.

3) Calculations: **GIVE AT LEAST ONE EXAMPLE!!!!!**. This should be well documented with a description of how you did these at each step and why you did what you did.

4) If experiments were done in triplicates be sure to include mean, average, and precision and accuracy measurements when appropriate.

5) Final answers should be well labeled with the appropriate units and with correct significant figures. (Yes these count here in the lab).

Discussion and Conclusion:

Intelligibly communicate a subjective evaluation of:

- Your own execution of the experiment,
- The performance of the instruments and materials used
- The validity of the data collected and the phenomena observed; this means compare it to the literature values.
- Clearly state your results,
  i.e. The unknown copper solution, sample 5A, was found to be 5 ppm copper.

On the procedure you have either made a measurement or manipulated the data mathematically or observed a physical property or a combination of the above,

*therefore* ---- Ask yourself ----- ?
• Is this reasonable?
• Does it coincide with theory?
• Can I justify it?
• For unreasonable data ask WHY?
  Did the apparatus \ instrument fail?
  Did I ......
  • make a mistake?
  • misread the procedure?
  • perform the experiment improperly?
Were chemicals contaminated?
Are the instructions incomplete?

Suggest improvements that could address the short comings ascertained from your evaluations.

Be sure to write in complete sentences and in scientific language, be concise.

**IMPORTANT:** Be sure that you include in your conclusions a section that summarizes all of your data and conclusions. Remember the old saying, “A picture pants a thousand words”, this is often best done by summarizing all of your data and conclusions in charts or tables. Remember also that all graphs and tables must be properly labeled with figure or table numbers, with proper descriptive titles and axis labeled. Be sure that if you have a table or graph in a report it MUST be referenced and discussed at least once. If it is not discussed then why is it included?

If still unsure about how to write the report, then read any scientific research journal such as *Analytical Chemistry*, Use it as a guide.

**References:**
Give and note in your report's text!

**Questions:**
Answer them if they are given in the lab handouts.