1- Course Description

1112.101 is the second semester of General Chemistry Laboratory. It introduces experimental chemistry. The course covers principles and applications of chemical laboratory techniques including preparation and analysis of chemical materials, study of equilibrium, determination of thermodynamic data, study of oxidation-reduction reactions, data analysis and elementary synthesis. 12 reports will be due.

The heuristics calls for a strong student involvement and creativity instead of the more traditional cookbook approach. The laboratory is a complement to the lectures and plays an important role in the learning of fundamental concepts.

2- Student Learning Outcome

- Develop manual dexterity in manipulating apparatus
- Apply mathematics to the study of chemical systems
- Develop ability to solve scientific problems with critical thinking
- Perform volumetric studies
- Understand the relation between reactivity and oxidation-reduction reactions
- Report the experimental process and data in a lab notebook
- Write comprehensive lab reports

3- Graded Activity. There will be twelve sessions. Each session (lab or exam) will be graded over 100 points along the following guidelines. Absence to a session without a valid excuse will be graded zero.

3a- Presentation of the work (Pre-lab Write-up) (25 points/lab):

Each lab must be prepared by reading the specific instructions given by the instructor. Additional reading is optional but recommended. Each student will write in the notebook a presentation of the work containing the title, the objectives, the procedure, the concepts behind the experiment and the references. The presentation of the work will be shown to the instructor for grading at the beginning of each lab session.

3b- Conducting the experiment (25 points/lab):

Once the Presentation of the work has been approved students will start the experiment.
   a) Setup the work station including the equipment installation and glassware labeling to be recorded in the notebook
   b) Conduct the experiment carefully recording all steps and all data in the notebook on a structured manner
   c) Dispose of the chemicals following the safety guidelines, clean, dry and store the equipment

3c- Calculations, problem solving and quiz (25 points/lab):

All calculations must be performed in the lab. The layout and labeling with the proper units will indicate the level of understanding of the students. A simple error analysis based on the proper significant figures must be included. Additional problems related to the experiment will be worked on. A quiz will be given at the beginning of the lab.

3d- Report (25 points/lab):

Each student will prepare a report to be handed in to the instructor (in case of absence, e-mail it to berna.karayaka@tamucc.edu) before the beginning of the following lab. The report will include the Presentation of the work, the experiment journal and data, an error analysis, and a conclusion. 10 points deduction will be applied to the late work.

3e- Notebook (200 points/semester)
The notebook will be graded at the end of the semester for a total of 200 points.
3e- Final grade
The final grade will be obtained from the sum of each session grade (1200 points) plus the notebook (200 points).

Letter grades will be based on the following letter equivalence with the grade average.
A above 90%, B between 80% and 90%, C between 70% and 80%, D between 60% and 70% and F below 60%.

4- Safety Rules

A complete presentation of the chemical safety issues at Texas A&M Corpus Christi (points a, b, c, d and e) can be consulted at http://safety.tamu.edu/

a- Wear ANSI Z-87.1, 1989 goggles at all time in the laboratory. Do not use contact lenses. Be aware of the eyewash station place and use.
b- Do not ingest any food or drink
c) Wear clothing providing maximum body coverage including close shoes and gloves. Long hair must be tied. In case of large spill remove the contaminated clothing and use the safety shower.
d) Never touch nor taste chemicals
e) Use the hood for any reaction involving gas phase dangerous chemicals
f) Beware of the breakability of glass
g) Do not use any electronic device other than required for the experiment
h) Stow your personal belonging in the designated storage area
i) In case of an accident, even minor, notify immediately your instructor

LAB CONDUCT: All students are 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.

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.

5- Laboratory Rules of Conduct
a) Your work station and the laboratory equipment must be clean and operational. If such is not the case inform the instructor immediately. After the lab is finished clean off your work station and equipment so that it is in good shape for the next student.
b) Reagent dispensers must be kept in their original location. Excess reagent should not be put back in the dispensers but treated as waste.
c) All material must be weighted on weighting paper or in a container.
d) Spills must be cleaned after notification of the instructor
e) Stoppers must be kept in your hand while pouring reagent.

6- NFPA 704
The National Fire Protection Agency (NFPA), in section 704 of the National Fire Code, specifies a colored diamond system for identifying the hazards associated with materials. The following ranking is used.

Blue – Health
0 No hazard other than an ordinary combustible material (peanut butter)
1 Only short term irritation and minor residual injury (turpentine)
2 Intense exposure can cause temporary incapacitation or residual injury (ammonia)
3 Short exposure can cause temporary incapacitation or residual injury (chlorine gas)
4 Very short exposure can cause death or major residual injury (hydrogen cyanide)

Red – Flammability
0 Will not burn (water)
1 Will burn if preheated (olive oil)
2 Will burn if moderately preheated or exposed to relatively high temperature (diesel)
3 Can be ignited at ambient temperature (gasoline)
4 Volatile material burning easily

Yellow – Reactivity
0 Stable under fire and not reacting with water (liquid nitrogen)
1 Stable unless elevated temperature and pressure (phosphorus)
2 Violent chemical change at high temperature and pressure or reacting violently with water (calcium metal)
3 Explosive upon contact with an initiating source or water (fluorine gas)
4 Can explode by itself at normal temperature and pressure

White – Other Hazards
W hazardous when in contact with water
OX Oxidizer
Non-standard symbols such as corrosive (CORR), acid (ACID), alkaline (ALK), biological hazard (BIOL), poison (POI), cryogenic (CRYO) and radioactive are also used

7 – Material Safety Data Sheet (MSDS)
The Occupational Safety and Health Administration (OSHA) requires that MSDS be available to employees for potentially harmful substances handled in the workplace.
Commonly used MSDS databases can be accessed through the Environment, Health and Safety homepage at TAMUCC (http://safety.tamucc.edu/)

8- Waste Management
The experimental design follows the principles of green chemistry which includes, if possible, the use of non-polluting chemicals, a minimization of waste and a secure treatment and disposal of the waste that cannot be avoided.

General guidelines and checklists are available on the Campus labs section of the E, H & S home page http://safety.tamucc.edu/index.php?n=Site

Furthermore technical information on types of hazardous waste, containers and chemical tables can be found in the Texas A&M University Safety Manual http://ehsd-online.tamu.edu/documents/TAMUSafetyManual/14-WAST1.HTM

Chemical wastes are defined as

- Chemical components listed in the Texas A&M document
- Mixtures containing a listed hazardous waste
- Material meeting the definition of one of the following:
  - Ignitability (flashpoint < 60°C or supports combustion)
  - Reactivity (e.g., water reactives, cyanides, explosives, unstable chemicals)
  - Corrosivity (pH < 4 or > 10)
  - Toxicity (ex. Pesticides, heavy metals, poisons)

Specific waste disposal instructions will be included in the student documentation.

9- Policies

9a- 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 class, please see me as soon as possible.

9b- 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.

9c- 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.

10- Supplies:

Coat, goggles, marker, ruler, notebook (any bounded notebook with numbered pages and carbon copy pages). You may use the notebook that you used for Gen Chem I Lab.

11- Communication:

Students can stop by the instructor’s office during scheduled hours or request an appointment via e-mail. The course is using Blackboard for lab instructions and grades. All communication with the instructor, including lab report submission in case of absence, must be addressed to berna.karayaka@tamucc.edu

12 - Guidelines for writing the laboratory notebook

The notebook is the central piece of your laboratory experience. It is an extensive record of your activities in the lab describing the experiments as you do them, the observations as you make them. You will record all your data, their analysis, and the calculations leading to the results to be presented in your laboratory report.

The guidelines are as follows.

- The notebook must be bound with numbered pages
- All entries should be recorded in ink and in real time (directly) as you perform the experiment and the calculations. Errors should be crossed and not erased. You will use the information in the notebook to write your report and need to reconstruct accurately the experiment.
- Each page must be signed and dated

The notebook will be checked by your instructor and graded. The main criterion for grading will be the ability for someone else to repeat your work by reading your account.
13 - Guidelines for writing the laboratory report

You will be asked for most experiments to write a lab report. The objective is to learn how to write a scientific paper. A report, like a scientific paper, formulates hypotheses, observes processes, records data, analyzes data, calculates or deduct results and states conclusions. It will include the following fields.

- **Title**: The title might be the name of the experiment or a more elaborate statement. The front page must include your name, the name of the course and the date the report is due. There should be a statement indicating what is your own work in compliance with academic integrity and the shared work authorized by your instructor.

- **Objective**: State the objective in your own words, what scientific principles are being tested, what are the learning objectives.

- **Procedure**: This is where you describe what you have actually done and how you did it. A procedure is a specification of series of actions, acts or operations which have to be executed in the same manner in order to always obtain the same result in the same circumstances.

- **Data collection**: This is one of the most critical portions of the lab report. Without good data recording in the laboratory notebook, completion of the lab write up beyond this point becomes futile. Presentation of data in tables allows easy following of the coming data manipulations. Tables should be clearly labeled as to their content and numbered for ease of referral in the discussion section.

Part of the data may involve making observations (color changes, temperature changes, melting point, boiling point, the physical appearance of a chemical substance, etc.). Sometimes extra observations you make may provide extra clues. Keep your eyes open.

- **Calculation**: One clear example of each different type of calculation should be presented as a check of your work. Do not include pages full of each and every calculation; it just wastes your time and paper. Who wants to read 3 pages of the same calculations with different numbers?

- **Error analysis**: Some estimation of the experimental uncertainty is necessary to help explain the results and to verify if the scientific principle tested holds.

- **Conclusion**: It requires looking at the experimental title, the purpose, the data and calculation sections of the lab report and bringing them all together. Sometimes it involves the comparison of the student's experimentally derived answer to a known literature value. Other times, it requires the student to stress the main point of the experiment.

14- Data and results reporting
Measured numbers are reported with their range of uncertainty or with the last digit as the first doubtful digit. It is important to take account of the instrumental precision and use the appropriate number of digits. A smaller number does not take advantage of the precision of the measurement. Reporting with too many digits is an aberration.

Furthermore when you carry out calculations based on measurements it is important to remember that the results cannot be more precise than the initial data.

The number of significant figures of the initial data depends on the precision of the instrument and the skill of the observer. The rules for significant figures resulting from calculations have been explained in your lecture and textbooks. Scientific measurements are often done repetitively to eliminate the impact of random error. The more measurements, the higher the precision. Uncertainty calculations are performed with statistical methods such as the Gaussian analysis with means and standard deviation.

It is important to understand the difference between precision (the agreement between two readings) and accuracy (closeness to the actual value) and the type of error responsible for lack of precision versus lack of accuracy.

Graphing is also an important experimental tool and can be used for different purpose: data visualization, quantity calculation and extrapolation. You will need to practice graphing taking the following into consideration.

- Use graph paper or a correctly prepared computer graph
- Label axes properly
- Dimension the size of the graph to fit the data
- Use the abscissa for the independent variable and the ordinate for the dependent variable
- Use a pencil on graph paper and indicate the points with a cross (not a bubble).

It is sometime useful to calculate the best fit to a curve. Regression techniques such as the least square for fitting a straight line can be used.

15- Tentative Schedule:

The Summer curriculum of General Chemistry II laboratory will be built around 12 sessions. The first two sessions will be dedicated to a review of the basic concepts learned in General Chemistry I. The last session is a practical examination.

Each experiment will be introduced with the following specific information.

1- Title: the topic and the objective of the experiment
2- Tangible deliverables: a description of what is required from the students
3- Background: the scientific knowledge and concepts required to understand the experiment
4- The experiment: a general description of what needs to be done and the main steps
5- The procedure: an outline to be completed by the students in preparation for the lab
6- The chemical and equipments: the list of chemicals and special equipments
7- Waste management: specific instruction about discarding wastes

The following is a proposed schedule for twelve sessions

Session 1: Review of the basic concepts in Chemistry (dry lab)
Session 2: Chemical reaction (dry lab)
Session 3: Gas Law relation between volume and temperature
Session 4: Gas law determination of a molar mass
Session 5: Solutions, solubility, molecular interactions
Session 6: Solutions, concentration, titration
Session 7: Acid-Base chemistry analysis of a titration curve
Session 8: Chemical equilibrium
Session 9: First law of thermodynamics – enthalpy of a reaction
Session 10: Second law of thermodynamics – standard state functions
Session 11: Oxidation-Reduction
Session 12: Final examination

*First two labs will be graded based on the presentation and solution of the in-class problems.