SYLLABUS

Name of instructor: Dr. Yves Coeckelenbergh
Course title: General Chemistry II
Course number: 1412.002
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Office hours: TR 10H45 – 12H30

Course Description:

General Chemistry is the foundation course in chemistry for all science majors. Chemistry deals with the properties of matter, the transformations of matter and the interactions of matter with other matter and with energy. The course will study atoms and collections of atoms that make up matter. Chemistry is a branch of the physical sciences.

As the follow-up to General Chemistry I this course assumes a good knowledge of the basic tools of chemistry such as measurement, unit management, elementary mathematics and stoichiometry. Students must be familiar with the properties and structures of atoms and molecules including electron configuration, periodicity and atomic associations. The concept of energy applied to reactivity must be understood qualitatively and quantitatively. The course applies a rigorous, quantitative approach to chemistry and emphasizes rational thinking and analysis rather than memory and number crunching. It follows a logical approach. The lectures, assignments and examinations will stress both concepts and context.

The laboratory brings the experimental component to the course along with extensive review and problem solving.

The core of the course will be the study of chemical thermodynamics leading to the understanding of free energy and chemical equilibrium. Two major types of reactions, acid-base and oxidation-reduction, will be extensively studied in that context. The time dependence of chemical reactions will be studied through chemical kinetics.

At the end of the course the student should know the “fundamentals” and be prepared to follow more advanced courses such as analytical chemistry, inorganic and organic chemistry, biochemistry or physical chemistry.
Student Learning Outcomes (SLO’s):

SLO 1: Apply a quantitative approach to solve simple chemical problems.

SLO1 will be tested by the ability to:

a) Express experimental and calculated results with the proper units and level of uncertainty.

b) Explain the concept of mole and calculate the Avogadro number.

c) Calculate the molar mass of a molecule from the isotopic composition of the constituting elements.

d) Describe a chemical reaction with the appropriate equation.

e) Apply the reaction table to the solution of stoichiometric problems.

f) Determine concentrations through several methods (volumetric, gravimetric, colligative properties and spectrometric) and convert various units of concentrations.

SLO2: Describe a chemical system with a macroscopic approach and quantize its parameters.

SLO2 will be tested by the ability to:

a) Map the behavior of matter in terms of intermolecular interactions

b) Calculate macroscopic variables and state functions in standard and non-standard conditions

c) Compare reversibility and irreversibility

d) Apply the law of conservation of energy $\Delta U = q + w$

e) Calculate entropy with the Clausius inequality and the Boltzmann equation

f) Define temperature

g) Calculate chemical free energy and characterize a chemical reaction in term of spontaneity and product orientation.

SLO3: Identify a chemical equilibrium and calculate its parameters.

SLO3 will be tested by the ability to:

a) Determine the components of a chemical equilibrium

b) Calculate the reaction quotient from approximated activities

c) Calculate the equilibrium constant from thermodynamic functions

d) Explain the behavior of a system away from equilibrium

e) Solve equilibrium problems with the reaction table.

SLO 4: Specify acids, bases and buffers, explain their reactivity and calculate pH.

SLO4 will be tested by the ability to

a) Define acid and base and describe their mechanism of action

b) Describe the acid-base behavior of water and calculate its equilibrium functions

c) Identify strong acid, strong base, weak acid, weak base and buffer

d) Calculate concentrations of acid-base systems and convert to p-scale

e) Describe the titration of various species qualitatively and quantitatively
f) Calculate the result of adding a strong acid or a strong base to a buffer.

SLO5: Identify oxidating and reducing agent, explain their reactivity and calculate the potential of a RedOx reaction.

SLO5 will be tested by the ability to:

a) Define oxidation, reduction and determine the oxidation state
b) Find the direction of the electron flow from the half-cell reduction potential
c) Calculate a cell potential in non-standard condition using the Nernst equation
d) Balance a RedOx equation in acidic and basic environment.

SLO6: Analyze the kinetics of a chemical reaction.

SLO6 will be tested by the ability to:

a) Calculate the rate and rate constant of a reaction from experimental data
b) Calculate the concentration of reactants and products at a given time
c) Determine the rate law
d) Calculate half-times.

SLO7: Design and run chemical experiments.

SLO7 will be tested by the ability to:

a) Manipulate chemical apparatus with dexterity
b) Apply mathematics to the study of chemical systems
c) Design an experiment following a system solving heuristics
d) Report the experimental process and data in a notebook
e) Write a comprehensive laboratory report.
Graded activities:

Final grade will be calculated as follows:

Midterm exam: 100 points
Final exam: 200 points
Quizzes, homework and class participation: 100 points
Laboratory 100 points

Final letter grading for the course will be: A> 90%, B>80%, C>70%, D>60 %, F < 60%.

Exams:

There will be one midterm examination and one final examination.

For the midterm exam students are allowed to bring a pen or pencil, a non-communicating calculation device, the data table previously distributed in class and a maximum of 10 pages of handwritten notes. No communication between students is allowed.

The final exam is a comprehensive exam where no notes are allowed.

The presentation is important. The answers must follow a self-explanatory logic. The reading must be clear. All calculations must be presented in detail and absolutely with the proper units. This is of course especially relevant to the “take-home” exam.

Missed exams without a valid excuse will be graded zero. Most of the questions of the exams will consist in problems similar to those seen in class or homework assignments.

Students must be seated no later than 5 min before the start of the exam. There should be as much distance between each student as the classroom configuration allows and the desk must be empty with the exception of specifically authorized items.

Students are not allowed in the classroom after the start of the exam without the permission of the instructor. In any case no student will be admitted after the first exam-taker has left. Student leaving the room will not be allowed to return unless authorized by the instructor. All material including intermediate calculations will be given to the instructor at the end of the exam. A picture ID is required.

There are no make-up exams. All excuses must be requested in advance with the obvious exception of emergencies. Students with a university approved scheduled absence (athletics, military duty, etc.) should contact the instructor well in advance of the scheduled absence to request an exception. Exams may be taken early in those specific cases. Students who do not arrange to take exams ahead of time will not be eligible for this special consideration. A written excuse from the university department involved or the Office of the Dean of Students may be requested.
**Homework and quizzes:**

Homework assignments will be posted on Blackboard.

Homework must be completed by the due date. They will be kept by the student unless instructed otherwise. A quiz to be graded will be held either on the due day or on the next lecture day. It will cover part of the homework. After completion of the quiz each exercise will be corrected in class and there will be time for Q&A. At the end of the semester the homework grades might be updated to take account of effort, regularity and progress.

There are at least three reasons to do the homework assignments.

First to understand the course, the course cannot be understood without such a minimal amount of individual work.
Second to prepare for the exams, most of the exam questions will be similar to the homework problems.
Third to receive credit to be included in the point average.

Students must fully understand the logic behind each assignment or repeat them until all uncertainties are waived. *We learn more by trying to find an answer, even unsuccessfully, than by studying the answer.*
Policies and guidelines:

This is a classroom course. Technology, web assisted learning, textbooks are useful complement but cannot replace attendance to the lecture. **Attendance is therefore mandatory.**

The course is built in a coherent manner and missing lectures will create knowledge gaps making further learning extremely difficult. If a class is missed, it is the responsibility of the student to obtain all needed information from a classmate. Missed information includes not only lecture notes and handouts, but also any possible information regarding homework, syllabus changes, exam dates, etc.

Students must be seated in the classroom **before** the start of the lecture and **sit in the front rows**. Students entering the classroom after the start of the lecture or leaving before the end will be required to enter their name on the class logbook. There will be neither eating nor chatting. **Use of communication devices such as cell-phones and computers is not allowed during the lecture.** Students failing to observe these rules will be asked to leave and be graded zero for attendance.

**Students must attend the lecture and take notes. PowerPoint presentations will be posted on BlackBoard and do not need to be copied in class. After each lecture the notes should be reviewed and the assignments completed.**
The following guidelines are recommended:

1- Attend the lectures

2- Review all the slides and if you have difficulties with anyone of them be tenacious until you grasp the concepts

3- Repeat the exercises done in class

3- Do the homework. Be tenacious. Don’t worry so much about the answer than the problem solving strategy. All problems are corrected anyway. After correction do them again.

4- Reading the handouts posted on BlackBoard is mandatory. Reading a textbook is optional and a complement, not a substitute to the lecture

5- When available use the Special Instruction sessions if needed as an important resource, also a complement, not a substitute

6- If you use other resources such as CASA, friends, online chat, etc…. be careful and wise. Do not accept alternate explanations unless checked with your instructor. There is a lot of material to be learned in a very short semester and a third person, if not a chemist, might not have learned all the concepts taught in the course.

7- If you don’t do well in the first exam catch up the missing lectures, slides and homework and keep working hard.

8- if you have difficulties with the course speak to the Professor.

Students not planning regular class attendance, daily review of the lectures, reading, completion of the assignments and study should consider another learning option.

Student should not try to “outsmart the system”. Your Professor organizes the course for maximum learning. Short cuts, better ways to explain things, tricks to answer questions are only deceptive. If you know a faster way to find the answer to a problem (like short cutting the reaction table) think that your instructor might have taken the long way to illustrate an important concept or a method to be used later in the course.
Disabilities Accommodations

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call or visit Disability Services at (361) 825-5816 in Corpus Christi Hall 116.

If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816.

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 Center for Instruction 350, and can be reached at 825-3928.

Grade Appeal Process:

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 on 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 on the process, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, consult Texas A&M University-Corpus Christi University Procedure 13.02.99.C2.01 Student Grade Appeal Procedures (http://www.tamucc.edu/provost/university_rules/index.html), and the College of Science and Engineering Grade Appeals webpage (http://sci.tamucc.edu/students/GradeAppeal.html). For assistance and/or guidance in the grade appeal process, students may contact the chair or director of the appropriate department or school or the College of Science and Engineering Dean’s Office.
**BlackBoard, Textbook, and supplies:**

The textbook contains handouts, slides and exercises for each chapter. It is written by your teacher and available free of charge on BlackBoard. The course shell includes also the course syllabus, useful links, grades and other information.

There is no specifically required commercial textbook but students might want to purchase a good General Chemistry reference such as *Chemistry, Silberberg, McGraw-Hill* and keep it as a future reference. Students intending to follow a serious curriculum in the physical sciences might prefer *University Chemistry, Laird, McGraw-Hill* presenting a rational rather than historical approach. The use of any other textbook should be submitted to approval of the Professor.

There are plenty of resources available online such as tutorial and recorded lectures. Some are textbook extensions and require a purchase like Connect from McGraw-Hill while others are free. Their quality varies from excellent to despicable and in case of doubt you should ask the advice of your instructor. Keep in mind however that the exams are exclusively based on the content of the lecture and the homework and that dispersed information might reduce your ability to concentrate on the important concepts of the course.

A calculator is optional. Students are encouraged to minimize the use of their calculator in order to focus on the problem solving rather than a plug-in formula based approach.

**Non-classroom communication:**

Students can stop by the instructor’s office during scheduled hours or request an appointment. E-mails must be addressed to yves.coeckelenbergh@tamucc.edu.

**SI instruction**

When available a SI instructor will attend the lectures and hold sessions where concepts and problems can be reviewed.

The SI instructor will never do the homework before the due date. All problems will be done in class after the due date and, if needed, reviewed again during the SI session.

Students are strongly discouraged to request CASA or internet search tools/blogs to do their homework before the due date. By doing so they miss the opportunity to practice problem solving and they risk exposure to errors bringing irreversible damage to the learning process.

**Tutoring:**

The Tutoring and Learning Center (CASA) provides tutoring, test-taking strategies, and extra help. Make sure that the tutor follows the same approach as presented in the course.
and in case of doubt discuss the matter with your instructor. A student having problems
with the lecture or the homework should consult with the instructor before seeking
outside help. **TLC is not a substitute for the lecture.**

**Anxiety and Stress:**

The University Counseling Center (Driftwood: 825-2703) provides help for test anxiety,
stress and study skills.

**Conflicting schedules:**

All students with conflicting schedules, including athletes, should ask an appointment
with the instructor in order to evaluate the possibility to complete the course

**Class Conduct:** All students are expected to follow proper classroom 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 students will be asked to leave the
class until proper sanction is applied.

**Academic Integrity/Plagiarism**

University students are expected to conduct themselves in accordance with the
highest standards of academic honesty. Academic misconduct for which a student is
subject to penalty includes all forms of cheating, such as illicit possession of
examinations or examination materials, falsification, forgery, complicity or
plagiarism. (Plagiarism is the presentation of the work of another as one’s own
work.) In this class, academic misconduct or complicity in an act of academic
misconduct on an assignment or test will result in a punishment.

**Dropping a Class**

I hope that you never find it necessary to drop this or any other class. However,
events can sometimes occur that make dropping a course necessary or wise. Please
consult with me before you decide to drop to be sure it is the best thing to do.
Should dropping the course be the best course of action, **you must initiate the
process to drop the course by going to the Student Services Center and filling
out a course drop form.** Just stopping attendance and participation WILL
NOT automatically result in your being dropped from the class. The last day to
drop a class with an automatic grade of “W” this term is indicated in the academic
calendar available on SAIL.
**Classroom/professional behavior**

Texas A&M University-Corpus Christi, as an academic community, requires that each individual respect the needs of others to study and learn in a peaceful atmosphere. Under Article III of the Student Code of Conduct, classroom behavior that interferes with either (a) the instructor’s ability to conduct the class or (b) the ability of other students to profit from the instructional program may be considered a breach of the peace and is subject to disciplinary sanction outlined in article VII of the Student Code of Conduct. Students engaging in unacceptable behavior may be instructed to leave the classroom. This prohibition applies to all instructional forums, including classrooms, electronic classrooms, labs, discussion groups, field trips, etc.

**Statement of Academic Continuity**

In the event of an unforeseen adverse event, such as a major hurricane and classes could not be held on the campus of Texas A&M University–Corpus Christi; this course would continue through the use of Blackboard and/or email. In addition, the syllabus and class activities may be modified to allow continuation of the course. Ideally, University facilities (i.e., emails, web sites, and Blackboard) will be operational within two days of the closing of the physical campus. However, students need to make certain that the course instructor has a primary and a secondary means of contacting each student.
Provisional course outline:

The weekly schedule below is a preliminary outline of the lectures susceptible to be modified. It is the student’s responsibility to keep up with changes to this schedule. The reading and problem assignments should be completed in due time. Failure to stay current will greatly affect your ability to keep up during the lecture and, therefore, will impact your grade in this course.

<table>
<thead>
<tr>
<th>Week</th>
<th>Activity</th>
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<tbody>
<tr>
<td>19JAN</td>
<td>Lesson 0 Introduction, syllabus, baseline quiz, lab safety</td>
</tr>
<tr>
<td>26JAN</td>
<td>Lesson 1 Mathematics for chemistry (review)</td>
</tr>
<tr>
<td>02FEB</td>
<td>Lesson 2 Fundamentals, the language of chemistry (review)</td>
</tr>
<tr>
<td>09FEB</td>
<td>Lesson 3 State of matter, intermolecular interactions</td>
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<tr>
<td>16FEB</td>
<td>Lesson 3 Gases, state functions, reversible processes</td>
</tr>
<tr>
<td>23FEB</td>
<td>Lesson 4 Aqueous solutions, concentration, colligative properties</td>
</tr>
<tr>
<td>02MAR</td>
<td>Lesson 5 Thermodynamics, energy, enthalpy, chemical reaction</td>
</tr>
<tr>
<td>09MAR</td>
<td>Lesson 5 Clausius inequality, Boltzmann equation, entropy, temperature</td>
</tr>
<tr>
<td>23MAR</td>
<td>Lesson 6 Free Energy, activity, chemical equilibrium</td>
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<tr>
<td>30MAR</td>
<td>Review and MIDTERM EXAMINATION</td>
</tr>
<tr>
<td>06APR</td>
<td>Lesson 7 Acid-Base Chemistry and Buffer</td>
</tr>
<tr>
<td>13APR</td>
<td>Lesson 7 Advance Titration and Take-Home Assignment (16APR)</td>
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<tr>
<td>20APR</td>
<td>Lesson 8 Electrochemistry</td>
</tr>
<tr>
<td>27APR</td>
<td>Lesson 9 Kinetics</td>
</tr>
<tr>
<td>04MAY</td>
<td>Review</td>
</tr>
<tr>
<td>07MAY</td>
<td>Final Examination</td>
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In choosing to take this course, you are agreeing to abide by the course rules. Should you have concerns or questions, you are to discuss them with the instructor as soon as possible. However, you are bound by these rules, regulations, and standards from the first day of the class throughout the duration of the course.

This is a course about learning chemistry with a strong emphasis on concepts. Problems are given to illustrate concepts. Solving a problem without the concept or trying to learn concepts without a quantitative problem solving approach are both meaningless.

There is no excuse to not learning.
Instructions for the lab

There will be 10 labs and one final exam. The exam will be graded over 200 points. Each lab will be graded over 100 points. At the end of the semester the notebook will be graded over 200 points. The total will be converted to 200 points for inclusion in the course final grade. The first two labs are graded by quiz. The grading of labs 3-10 is distributed between the following domains. The final lab grade will count for 200 pts. For the overall course.

Presentation of the work (25 points/lab):

Each lab must be prepared in accordance with the specific instructions posted by the instructor on Blackboard and the required material from lectures and textbooks. 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.

Conducting the experiment (25 points/lab):

Once the Presentation of the work has been approved students will start the experiment as follows:

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

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 can be worked on and the session might be concluded by a graded quiz.

Report (25 points/lab):

Each student will prepare a typed report to be handed in paper format to the instructor at 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.

Grading of the notebook (200 points/semester)

The notebook will be graded at the end of the semester for a total of 200 points. Emphasis will be put on the reproducibility of the experiment from the information available in the notebook.

Grading of the final exam

The final lab will consist in an experiment similar to one previously performed. The report will be written in the lab after completion of the experiment and graded over 200 points.

Final grade

The final grade will be obtained from the sum of each lab grade (1000 points) plus the notebook (200 points) and the final exam (200 points).

The final lab grade (/1400) will be converted to a grade over 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%.
Safety Rules

A safety presentation will be given to all students on the first day of class. Any student who didn’t follow the lecture will report to Gaylen Nuckols, chemistry lab coordinator, in order receive instruction for lab clearance.

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.tamucc.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

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.
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

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/)
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.

Supplies:

Coat, goggles, marker, ruler, notebook (any bounded notebook with numbered pages).

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.
Guidelines for writing the laboratory report

You will be asked for some 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.

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 or 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.

**Tentative Schedule:**

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<th>Session 1</th>
<th>Atomic Chemistry and Gas Law</th>
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<td>Session 2</td>
<td>Chemical Reactions</td>
</tr>
<tr>
<td>Session 3</td>
<td>Molar Mass Determination</td>
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<tr>
<td>Session 4</td>
<td>Solutions, Solubility and Molecular Interactions</td>
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<td>Titration Part I</td>
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<td>Thermodynamics and Van ’t Hoff Plot</td>
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<td>Chemical Equilibrium</td>
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<td>Titration Part III</td>
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