

Chemistry 214-001, Quantitative Analysis Laboratory

Spring 2017 Syllabus

Chem 214-001, Quantitative Analysis Laboratory (1 credit hour), January 17th through April 28th 2017
Tuesdays 2:30 – 6:30 pm, Flanner Hall 313 (FH-313)

Prerequisite: Chem 106/102 and 112, as well as active attendance or completion of lecture Chem 212.

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Office Hours: Wednesdays 11am - 12pm, OR by a
scheduled appointment.

Course Description:

This lab course emphasizes application of topics/theory covered in the lecture course (Chem 212). It introduces students to classical and modern methods of chemical analysis and teaches wet chemical laboratory techniques including quantifying analytes of interest via acid-base titration, EDTA complexometric titration, pH titration curves and corresponding derivative graphs, gravimetric analysis, spectrophotometry, and refractometry. Use of buffers, indicators, a variety of laboratory equipment/glassware, basic statistics, etc. Chemical knowledge spanning from general chemistry to new topics in Chem 212 lecture is vital. This list is not exhaustive but mentions the highlights.

Course Goals & Outcomes for Students:

- 1) Acquaint students with classical and modern techniques in analytical chemistry
- 2) Teach wet chemical lab skills, efficiency and planning of experiments, and importance of accuracy and precision of laboratory work. Build confidence in an individual's laboratory skill
- 3) Become familiar with conventional data collection in commercial and academic laboratories
- 4) Teach interpretation and critical evaluation of experimental results

By completing Chem 214 students will be able to:

- Apply knowledge to prepare, plan, and execute laboratory experiments
- Demonstrate proficiency in usage of laboratory equipment (analytical balances, burets, glassware, instrumentation) exposed to in this course
- Evaluate accuracy, precision, and validity of experimental data
- Articulate experimental results in concise, written format via lab reports

Policy for Staying in Lab Course If Dropping Lecture (212):

Students wanting to drop lecture after midterm may stay in the co-req lab only if midterm grade, posted in LOCUS, is a D or better. Students should continue to attend lecture until the week of the drop date to gain as much background knowledge as possible. For Spring 2017, students wishing to drop lecture, and have a midterm grade of D or better, can seek assistance from the Department of Chemistry and Biochemistry office beginning March 20th at 9:00 am through Friday March 27th at 4:00 pm. Students with a midterm grade of F must drop the co-req lab along with the lecture. No exceptions.

Attendance Policy: It is expected students attend every scheduled laboratory [i.e. lab] session/class. It is also expected students are *on time*. Additional time will not be provided to students who are absent from a lab session or who come late to lab. Students are allowed to attend only the section in which they are enrolled. You, the student, are enrolled in Chem 214-001 on Tuesdays and are NOT allowed to attend the Thursday or Friday labs under any circumstances. Students must have required materials and be properly dressed to perform experiments in the lab. Make-ups for the Exam are not given [conflict? You must take it early.] If a student misses an online pre-lab quiz, make-ups are not given. Stipulations are listed later on pages 4 and 5 of this syllabus. If you know you will be absent for a day of lab, contact the Instructor, but realize no time extensions are given for absent students for any of the course materials or experiments. Students are required to initial a sign-in sheet on each day of lab, documenting/verifying their attendance. If you are present in lab but forget to sign-in, safety points are deducted, as accountability is important for safety. The sign-in sheet serves as a formal record. If an absence occurs, it is the student's responsibility to contact the Instructor ASAP.

Required Materials:

- One bound (NOT SPIRAL) *laboratory notebook* such as a national-brand Composition book.
- An inexpensive *calculator* having logarithm (base 10 and e), exponential, and trig functions.
- A pair of *lab goggles* [safety glasses are NOT allowed] must be worn at all times in the laboratory.
- A *lab coat* must be worn at all times in the laboratory. It offers a layer of protection against hazards. Any color is ok, but it must be long sleeve & buttoned. Amazon or the Loyola bookstore sell them.
- Chem 214 lab manual and handouts, all handed out on 1st day of lab [always available in Sakai].
- Non-erasable pen [scientists do not write in pencil or erasable ink]. White out is not allowed.
- Use of Sakai (frequent access, pre-lab quizzes, submission of experimental results, etc.)

For one/two experiments it may be advantageous to bring a laptop. The Instructor will inform you. If deemed a distraction, Instructor or TA will request it be put away.

Cell phones are not a calculator substitute. Cell phones are NOT allowed for use during pre-lab quizzes, the Exam, nor allowed to be used as a calculator during lab experiments. They are distracting and a safety hazard.

Footwear/Clothing: Closed toe, closed heel shoes are required [no sandals, flip flops, slippers, Crocs, ballet flats, boat shoes, perforated shoes, etc.] No skin on legs, ankles, or feet can be exposed. Long pants are recommended. Shorts and skirts [unless floor length] are not allowed. Bare skin on the lower extremities is a safety hazard: Be advised, concentrated acids/bases will be used in most of the lab experiments. *Lab coats & goggles are required and must be worn at all times. This even applies to cleaning glassware!* Lab coats must be fully buttoned to be an effective shield against chemicals. Students will be sent home if proper clothing or footwear is not worn, this counts as an absence. A safety lecture will be given the 1st day of class; this lecture is required to perform lab experiments. Students will sign a lab safety sheet acknowledging their understanding and commitment to adherence of lab safety rules/policies. If a student is absent the 1st day and misses the safety lecture, he/she is not allowed to perform wet chemistry until the safety lecture is completed & safety sheet is signed. It is advised students do not wear contact lenses in the laboratory, as contact lens material may react with chemicals/chemical vapors if they get into the eye. Do understand all of these safety rules are meant to keep students safe in the laboratory.

Blanket statement about "technical difficulties:" It is *strongly encouraged* that all required submissions to Sakai as well as writing & printing lab reports, opening course/data/experiment files, be completed on a reliable wired internet connection [not wireless], that of which the University itself provides in the Information Commons and

various computer labs on the Lake Shore Campus. Under NO circumstances will excuses of “technical difficulties” be accepted as this syllabus is stating all students should use a wired internet University computer [not wireless internet] to submit work in Sakai, take pre-lab quizzes, write & print lab reports, open course/data/experiment files. Emailing lab reports, Sakai results, or other is not allowed in place of the required means of turning in lab reports or required submission of items in Sakai. This list is not exhaustive and do note that any activities this course may require a computer or internet connection for should be completed using University computers with wired internet connection. Use of home internet [wired or wireless], University wireless, or public wireless is at your, the student’s, own risk. It is not prohibited but as the Instructor has stated in this syllabus, the Instructor is not responsible for ANY technical difficulties of non-University devices [cell phone, tablet, home/work/public wireless internet or computer]. Do not submit items in Sakai using a cell phone or a tablet device as these devices do not count as reliable internet connection tools [and the Sakai website display on these mobile devices isn’t reliable]. Printing issues on or off-campus are not accepted as excuses for lack of having a lab report. There are many on-campus options for printing items.

Laboratory Procedures:

Instructor and TA explain the procedures and goals for each lab experiment/assignment prior to its execution. Students are given all handouts beforehand. Handouts will also be available in Sakai as a PDF. Students are expected to read procedures before lab to comprehend the work and complete it safely in the laboratory. Students are encouraged to look over the pre-lab lectures provided in Sakai, for further experiment information. Online pre-lab quizzes assist in reinforcing the notion of accountability. A laboratory schedule, detailing projected start/end dates for each lab experiment, pre-lab quizzes, lab report due dates, and other information will be provided to students on the 1st day of class. This schedule is posted in FH-313 and in Sakai and also at the end of this syllabus. Therefore, there are no excuses to not knowing what is required of you, the student, each day of lab and outside of lab. Any aspect of the schedule is subject to change. If change occurs, students are notified to write it on their copy of the schedule as it is not reprinted [for sustainability]. Changes will be posted in Sakai if needed.

Lab Experiment Unknown Samples (referred to as “Unknowns”):

Most of the lab experiments are completed *individually*, which emphasizes development of an individual’s laboratory skills. Each student will choose an unknown sample whose composition is known (to us) to at least **FOUR** significant figures. **Each student quantifies an analyte of interest in their unknown and is graded on how accurately the student’s experimental determinations reflect the unknown’s true [theoretical] composition.** Write down the unknown # in a lab notebook AND sign for it on formal sign-up sheets provided by the TA.

Each lab experiment is completed once and in the order shown in the laboratory schedule. Essentially, a new experiment is completed start to finish each week of class. Come to lab prepared; nothing can be done if a student doesn’t finish the experiment [a grade of 50% is earned as the student doesn’t have unknown data]. If a student is absent for an experiment, a zero (0) is earned as the student was not present to do work. **There are NO make-up labs.** However, the lowest accuracy grade (only one) earned out of the eight experiments will be dropped. If an absence occurs, that is the lowest accuracy grade [as it is a zero] that will be dropped. Only ONE accuracy grade is dropped so if you are both absent AND also earn a low accuracy grade on another experiment, only the absence accuracy grade is dropped. Attendance is taken seriously; you pay tuition to attend each week.

A second absence in the course warrants a zero (0) for the experiment too; you will have to earn enough points to pass the course with that zero included in the grade. If more than 2 experiment absences occur, you automatically do not pass the course. For each lab experiment's unknown, students will report VIA SAKAI, their data of each individual determination (trials), mean/average concentration (or percent composition), standard deviation, and parts per thousand (ppt) associated with the overall determination. *Students are NOT permitted to repeat a lab experiment* so take care to use proper lab technique and ask Instructor and TA questions during experimentation (and during office hours, etc.) to clearly comprehend the tasks at hand. The accuracy grade for each experiment is directly related to student's lab technique.

Students MUST report experimental results for their unknowns via SAKAI as soon as possible [no later than a week after the experiment is completed]! For example, Lab #1 is completed on Tuesday, January 24th which means students must submit their results in Sakai no later than by 2:30 pm on the next Tuesday, January 31st. LATE submissions earn a 20% reduction in the overall accuracy grade for the experiment. I encourage all of my students to see me outside of class time whether its during office hours or via an appointment, to answer any calculation questions that are not resolved during lab time. I am here to help guide you but you have to ask!

Only after Sakai submission of results will an accuracy grade be calculated by the Instructor. If the Instructor finds a calculation error [or has to ask a student to double check their work due to invalid results] in the student's Sakai submission a **10-point deduction** is applied to the "fixed" [re-submitted work]. A student must submit revised data if Instructor finds a mistake or other errors in the calculations/results. Therefore, try to ask Instructor and TA questions before submitting results in Sakai. We are very friendly and helpful, but we must know you need the help in order to assist you. Unknown numbers must be a part of the results submission or accuracy will not be graded [all Sakai results submissions have directions to tell you exactly what to submit]. Lab experiments must be completed sequentially as defined in the laboratory schedule. For Iron, Refractive Index, and Polyprotic Acid there is a chance to work with one lab partner. Teamwork in science is very common. Graded accuracy of laboratory work will determine 53.90 % of the course grade.

Laboratory Notebook:

One bound Composition style notebook is required. Metal spiral notebooks or notebooks with 'tear-able' pages are not allowed. Complete notebooks in PEN. Detailed notebook requirements are listed on pages 12-13 of this syllabus. Notebooks must be organized but not necessarily perfect. They can contain strikeouts. Do not rip pages out of the notebook or points will be deducted in the notebook grade. White-out is not allowed.

Students must come to lab prepared in order to optimize lab efficiency. **At the start of every NEW experiment (which is every week) each student must have written in their notebook:**

- 1) The date and title of the experiment*
- 2) An introductory paragraph summarizing experiment purpose & overview. This need not be more than one full notebook page.*
- 3) A procedure outlining steps of the experiment. This can be bullet points or paragraph form & may take several notebook pages to complete, depending on the experiment.*

*Use the lab schedule to know when to complete this. A student will receive a zero (0) for this portion if it information is not completed before a student walks into the lab for that particular experiment/day. Notebooks are checked/signed by Instructor or TA at the start of each new lab experiment as well as during the exam. The notebook grade determines 10.27 % of the overall course grade.

Laboratory Reports:

Lab reports must be computer generated and follow the format defined on page 10-11 of this syllabus. They are to be completed individually. Plagiarizing other students' reports (current or former), book or internet sources, or lab procedures will not be tolerated. YOU CANNOT COPY the Chem 214 lab manual text word for word; that is plagiarizing. Cite outside sources when applicable and ALWAYS cite the Chem 214 lab manual. All experimental data and calculations must be included in the lab report. Graded lab reports determine 10.27 % of the overall course grade.

An example citation (lab #1 KHP) for the Chem 214 lab manual is as follows:

Chem 214 Quantitative Analysis Laboratory Packet of Lab Experiment Procedures, Spring 2017.
Acid-Base Titrations: Determination of Potassium Hydrogen Phthalate; Binaku, K., Ed.; p 1-4.

Lab report due dates are located in the laboratory schedule. Lab reports **are not** accepted via email. Reports must be printed and handed to the TA in lab, on the due date, within the first 15 minutes of the official lab start time (2:30 pm). After 2:45 pm, a lab report is considered a day late if it is not in the possession of the TA. If a student is not present at the beginning of class on the date a lab report is due, but comes into FH-313 at any point after the first 15 minutes of the official lab start time, their lab report is *still* considered late when turned in and there are no exceptions to this statement. Printing issues, etc. are not an excuse, see 'blanket statement about technical difficulties.' If a student is present on time in lab and forgets to turn in the lab report on the due date [or claims it would not print, or asks to leave the lab to print it], it is considered a day late. One cannot show TA or Instructor a lab report on a laptop or other device; that does NOT count as turning in a lab report on time as it is not printed as required. If a student is absent on the day a lab report is due, said student must turn in the lab report at the beginning of the next lab period and will not receive a late penalty. If said absent student forgets their lab report on next lab period, it is considered late. If a student turns in the incorrect lab report i.e. a lab report that is not one of the required reports listed no credit is given so a zero (0) is recorded and the student is offered an opportunity to turn in the correct report, but it is considered late based on the late lab report policy.

Late lab reports will receive a 20% penalty deduction each business day the report is late and result in a grade of zero (0) if not received within one week of the due date. Business day is defined as Monday through Friday.

To assist students in improving writing skills and address any deficiencies, the first lab report (only) Lab #1 KHP may be resubmitted (revised) after the first version has been graded to receive at most ½ the lost points back. Both the original graded version and revised version must be handed in or no credit is given to the revised report. Do discuss any questions/concerns about lab reports and revisions with the Instructor or TA.

Over the course of the semester, 8 lab experiments will be completed. Each student is required to complete all 8 lab experiments and turn in experimental data for each lab experiment. Writing skills are important to explain results and other important information in the “real world,” but the Instructor realizes completing lab reports is labor intensive. Students will only write lab reports for two (2) of the eight (8) lab experiments in this course.

The following list includes the lab experiments for which a written lab report is required:

- 1) Lab Experiment #1: Determination of % KHP in an Unknown (Acid-Base Titration)**
- 2) Lab Experiment #4: Total Hardness (EDTA Titration and Ion Chromatography)**

If a student is absent for one of these lab experiments listed above, the student will be given an alternative assignment to the lab report [since he/she has no experiment data] called the Journal Article Assignment worth 200 points. That will offset the zero (0) out of 200 on the lab report the student earned. This alternative assignment however does not offset the zero (0) for the accuracy grade for the missed lab work.

Laboratory Exam:

One in-class written exam will cover concepts pertaining to the laboratory experiments. The Exam will include **Experiments 1-8**, so cumulative. Try not to worry, you will be allowed an ‘equation sheet,’ which we will discuss when the exam is closer in time. The exam covers theory, lab technique, significant figures, dimensional analysis, calculations, and error analysis. The exam may have a social justice question(s) pertaining to science. The exam is not curved. Exam grade is final unless Instructor made a grading error [which must be brought to the Instructor’s attention *no later than 2 business days after* the graded exam is returned to the student]. Be advised students graded exams are scanned as PDFs. See lab schedule for exam date. Make-up exams are not given under any circumstances, so be present otherwise you earn a zero (0) on the exam. Exam determines 12.83 % of the course grade. Viewing the graded exam the last day of class and checking out of the lab locker is worth 20 points, or 1.03 % of the course grade. The graded exam cannot be viewed on any other day than the last lab day.

Laboratory Quizzes (Pre-lab Quizzes):

Before the start of each new experiment a timed [30-minute] pre-lab quiz must be taken in Sakai. There are eight pre-lab quizzes to take this semester. Each pre-lab quiz is open for one week preceding the date of the lab experiment [hence the name pre-lab quiz, it is done BEFORE coming to do the experiment that day]. *Each pre-lab quiz can only be taken once. No late submissions are allowed* [i.e. if you forget to take a pre-lab quiz it is a zero (0)]. Don’t open the pre-lab quiz until you are ready to take it. Take it as an individual (no help from others as that is cheating). You ARE allowed to use the Chem 214 lab manual, lecture book, calculator, etc. When 30 minutes are up the pre-lab quiz is auto-submitted and graded. If you don’t finish, it is graded as is. Read the lab procedure for a particular experiment a couple of times before taking the pre-lab quiz. The pre-lab quiz can have questions on background information, procedure/equipment, and calculations to determine student preparedness for the lab experiment. **Grades for each of the pre-lab quizzes are released when all students complete it each week.** Absent or ill students do not get extensions on pre-lab quiz deadlines; one week of time is more than sufficient to access Sakai and complete the 30-minute quiz each week. Due dates are posted in Sakai and the laboratory schedule. Pre-lab quizzes account for 9.86 % of the overall course grade.

Services for Students with Disabilities (SSWD) Policy:

Necessary accommodations will be made for students with disabilities who procure a SSWD letter. However, extra time in lab to complete experiments is not an option. Discuss your academic needs with the Instructor as soon as possible! However, to receive any accommodations self-disclosure, proper documentation, and registration with the SSWD office at Loyola University Chicago is required. Accommodations cannot be made until the Instructor receives proper documentation. Furthermore, accommodations are not retro-active and begin only once appropriate documentation has been received by the Instructor in a timely manner. Recognize the time the course is scheduled in LOCUS is fixed. No extra time on wet chemistry is given to a student with an SSWD letter; it is simply not possible. Only those accommodations that are specifically listed in the formal SSWD letter will be provided. SSWD Policies and procedures can be found here: <http://www.luc.edu/sswd/>

Academic Honesty:

Both the Instructor and TA encourage students to consult one another in class during lab experiments and outside of class. Students can converse, brainstorm, and work through questions together but copying other students' (current or previously in Chem 214) work and presenting it as one's own is unacceptable. There is a difference between sharing knowledge and cheating. If lab reports, data, pre-lab quizzes, or other materials in this course are plagiarized or have been shared between students (current or past), no credit will be given for the work in question. Cases of suspect academic dishonesty will be handled according to University guidelines. Review LUC Policy: http://www.luc.edu/academics/catalog/undergrad/reg_academicintegrity.shtml

Laboratory Safety Points:

Unsafe actions in the lab are NOT tolerated. Each lab day (12, as first day, spring break, and Easter break are not counted) is worth 3 safety points. Students either earn the points, or do not. It is all or nothing. A student is told when a safety infraction is witnessed by TA/Instructor and that safety points were deducted. This is documented on the sign-in sheet. Safety points count towards 1.85 % of the overall course grade.

Safety point deductions occur if Instructor/TA witness unsafe behavior such as: * Coming late to lab, not signing the sign-in sheet when present in the lab, not wearing or needing to borrow borrowing lab goggles or a lab coat, eating/drinking in the lab, chewing gum, taking goggles off in FH-313 when chemicals/glassware are still on any of the 3 lab benches (even if not your chemicals/lab bench), not wearing goggles when using/cleaning glassware, chemicals, or equipment, touching face/cell phone/personal belongings with gloves on, leaving laboratory with gloves on, not cleaning up spills on bench top/analytical balance/fume hood, standing/kneeling on chairs, improper chemical disposal, etc. *The list is not exhaustive; if it is determined an [unlisted] action is unsafe, a student will lose a safety point. IF LABORATORY BENCHES, ANALYTICAL BALANCES, OR OTHER EQUIPMENT IN FH-313 ARE LEFT DIRTY, THE ENTIRE CLASS [all students] LOSES THE DAY'S SAFETY POINT.

Lab Clean-up:

Each lab period is 2:30 pm – 6:30 pm on Tuesdays. Students must leave the laboratory at 6:30 pm. Students are REQUIRED to begin cleaning everything no later than 6:20 pm each day of the scheduled lab. Students are not allowed to stay past 6:30 pm to do wet chemistry under any circumstances [unless in an extremely rare case Instructor deems it necessary and allows entire class to do so] NOR can a student gain access to the laboratory room, FH-313, outside of the scheduled class day/time in LOCUS. An exception is when TA or Instructor allows students to enter FH-313 early at 2:15 pm on Tuesdays to sign-in and prepare for the tasks for that day.

Grading Policy:

The established grading policy is subject to change at Instructor discretion. The University uses the +/- grading scale system and it is implemented in this course. Grade rounding only applies to the final course grade percentage. Sakai reports course grades to TWO digits past the decimal (XX.XX%); this percentage is rounded to the closest integer. For example, an 89.50% or 89.90% (B+) rounds up to a 90% (A-), BUT an 89.30% or 89.45% (B+) round to the integer 89% (B+), as it is the closest integer. There are no extra credit assignments in Chem 214 because, frankly, there is nothing of the sort in the "real world." If you miss more than 2 lab experiments, you will not pass the course. That is too much content to miss out on. Enroll for a section of lab and fully commit.

Grading Category	Pts	Percent
Analytical Findings (Accuracy)**	1050	53.90%
Lab Reports (100pts/each)	200	10.27%
Pre-lab Quizzes (24pts/each)	192	9.86%
Lab Notebook	200	10.27%
Safety Points	36	1.85%
Exam	250	12.83%
Checkout last day & exam view	20	1.02%
Total	1948	100.00%

** 7 lab experiments @ 150 points accuracy for each; the lowest accuracy grade out of the 8 labs is dropped.

Typical Grading Scale* (%): A 100-94, A- 93-90, B+ 89-87, B 86-83, B- 82-80, C+ 79-77, C 76-73,
C- 72-70, D+ 69-67, D 66-63, D- 62-60, F \leq 59

*subject to change at the discretion of Instructor.

Lab Report and Notebook Grading Rubrics:

The following is a guide of lab report/lab notebook grading.

Lab Report	Points
Title Page	5
Introduction/Purpose	15
Procedure	15
Results	35
Conclusion	20
Grammar/Formatting/Spelling	10
TOTAL	100

Notebook (Pts breakdown based on 8 experiments)	Points
Name and section # on front of notebook cover (not on the inside)	4
Table of Contents (2pt/experiment & pg #s listed + 2pts for title)	18
Title & Date of Experiment (each signed, 3pt/experiment)	24
Introduction (each signed, 4pts/experiment)	32
Procedure (each signed, outlined as points or paragraph, 3pt/experiment)	24
Results/Raw Data and Calculations (6pts/experiment + 1pt/exp for unknown # listed explicitly in this section)	56
Conclusion (4pts/experiment)	32
Organization (sections labeled, writing legible, pages numbered)	10
Total	200

IDEA (Individual Development and Educational Assessment):

IDEA is a course/instructor evaluation system. *Essential* and *Important* objectives have been selected by the Instructor which represent the goals/development to be achieved during and as a result of completing Chem 214. Near the end of the semester, an email is sent by IDEA administrators requesting completion of the IDEA course/instructor rating for Chem 214–001. *Essential* and *important* objectives are discussed with students the first day of lab.

Essential objectives:

3. Learning to apply course material (improve thinking, problem solving, and making decisions)
4. Developing specific skills, competencies, and points of view needed by professionals in the field most closely related to this course

Important objectives:

1. Gaining a basic understanding of the subject (e.g. factual knowledge, methods, principles, generalizations, trends)
13. Learn appropriate methods for collecting, analyzing, and interpreting numerical info.

See the next several pages for lab report and lab notebook guidelines!

Lab Report Format and General Guidelines: Chem 214

Lab reports for Quantitative Analysis are more detailed than those in General or Organic Chemistry labs. The lab report is an **IMPORTANT** part of a laboratory course, both at the undergraduate and graduate levels. It allows one to articulate the experimental work in report form and reflect on the data.

Basic formatting: 12pt Times New Roman font, 1 inch margins double-spaced, and print the lab reports double-sided. Lab reports must be stapled! Define each section of a lab report in **bold (Introduction, etc.)** with respective element names below. Use of SUBSCRIPTS and SUPERSRIPTS is required. Lab reports must have good spelling, sentence structure, etc. Do not use run-on sentences, fragments, or personal pronouns (I, we, me, etc.). PROOFREAD!

Lab reports must consist of the following elements:

Title page – lab experiment title and number centered on the page; your name, lab partners name (for partner labs only), course section #, TA's name, unknown #, and date the report is due should all be in the lower right corner of the page

Introduction/Purpose – begin with a statement of the reason for completing the experiment and the goal of the work. Then, expand on the chemistry principles. Any relevant CHEMISTRY i.e. chemical reactions must be in the introduction! This is NOT a rehash of the lab procedure so do NOT simply summarize the procedure [will not receive credit for that]. Introduce principles, techniques i.e. what is being learned and accomplished as a result of completing the lab experiment. MINIMUM length is 1 page, double-spaced. Maximum is 2 pages double-spaced.

Procedure – a *narrative* of all the steps necessary to perform the experiment, including any changes that may have been made to the original printed procedure.

- This must be summarized from the lab manual in complete sentence form. Do NOT copy the lab manual word for word. Procedure must be written in one's own words! **Do not plagiarize.** The lab manual must be cited at the end of this section!
- CANNOT use bullet points. NARRATIVE form is required.
- ALWAYS note starting & ending color of a reaction mixture (i.e. indicator use for example)
- It must be so clear that anyone not familiar with the lab would know exactly what to do.
- It should not contain the actual masses, volumes, etc. used by the student.
- Be careful writing preparatory instructions for solutions. You will dissolve/dilute chemicals in a volume smaller than what the final volume will be and then dilute to the final volume mark.
For example: Dissolve approximately 12 grams of potassium hydroxide (KOH) in 300 mL H₂O, dilute to 500.00 mL mark in a volumetric flask, parafilm, and invert to mix.
- It should NOT be in 1st or 2nd person (no "I", "you", "we", "he" or "she")

Results – list data obtained, such as volumes measured, weights, temperatures, in a table format

- Be mindful of SIGNIFICANT FIGURES of glassware!
- Define chemical formulas, abbreviations before use: sodium hydroxide (NaOH), milliliters (mL)

- Multiple trials are necessary to verify data has good precision. All data must be shown, including repeat 'redo' lab experiment data if applicable.
- Data must be represented in table format with appropriate column and row headings and include individually determined trials' values, averages (concentrations, percent, unknowns, etc.), standard deviation, ppt and other. When applicable include units in column headings i.e. "NaOH volume (mL)" or "mL of NaOH." Tables must be labeled with appropriate brief titles.
- Statistical analysis (average, standard deviation, Grubb's Test, parts per thousand, etc.) of data should also be included in this section whenever these statistics are applicable.
- ALWAYS note starting & ending color of a reaction mixture (i.e. indicator use for example)
- If applicable, include graphs/figures. All must be labeled with a title, proper x and y axes labels (including units). Graphs should be constructed in Excel or a similar program.
- If graphs/figures are included (spectra, chromatograms, or calibration curves) they must be properly labeled i.e. Figure 1, and brief description directly below it.
- Include calculations labeled appropriately with units, chemical identity. Properly identify what is being calculated and the trial # the calculation is being completed for.
- Include general (also known as skeletal) equations corresponding to each calculation i.e. general equation for **dilutions** (see example), average, standard deviation, ppt, to name a few.
Example calculation for volume of HCl for 0.100 M HCl. The calculations may be written in pen neatly so they can be read and understood.
 - Show an outline of equation being used and at least one example with your values
 - ex.: $M_1V_1=M_2V_2$ 12.0 M x (v_1)=0.100 M x (1000.00 mL) $v_1=8.33$ mL
 - Please utilize leading zeros before the decimal point (0.1 mL and NOT .1 mL).
- **A required paragraph explaining the results must also be present** to show the student interpreted the experimental results/data shown in tables, figures, and/or graphs. Results include any preparation & standardization work AND the unknown analysis.

Conclusion – a restatement of results, and what the results reveal

- The first sentence should state the purpose of the lab experiment. Then, state the unknown #, % composition/molarity of the unknown analyte, standard deviation, and ppt of the work. This part can be similar to the Results paragraph but NOT just a copy.
- Discuss precision (ppt), discuss accuracy based on accuracy grade. State confidence level in the experimental work completed.
- Include a **detailed** analysis of error (3 separate errors) in paragraph form based on student's own data/results. Analysis of error may be on theoretical errors too, even though a student may not have actually made the error(s). Errors must be TECHNIQUE dependent. An example is improper buret reading and how it affects all measurements and calculations.
Dirty glassware & blaming instrumentation or raw chemicals for example, is NOT a valid error.
 - How does the error affect subsequent steps in the lab experiment? How does it change the calculated value of an analyte (concentration higher/lower than it would be if mistake didn't occur, etc.)?
- MINIMUM length of the conclusion section is 1 page double-spaced; there is no maximum limit.

Additional Considerations

- Page numbers are required in the bottom center of each page.
- All parts of the lab report must be typed (example calculations are an exception).
- Keep entire tables on a single page. If you split a table, include column/row headings again.

The following has been said:

“A student could do mediocre work and write up an excellent lab report, and the work will be thought of as wonderful. A student could do wonderful work and write it up poorly, and the work will be thought of as mediocre.”

Lab Notebook Guidelines and Grading Rubric

The notebook **MUST** be bound (spiral notebooks are not accepted). **NOTEBOOK MUST BE COMPLETED IN PEN.** Leave the first 2 pages of the notebook blank. At the top of these two pages, write **TABLE OF CONTENTS**. Over the course of the lab, # the pages in the notebook. In the table of contents, write the name of each experiment on a separate line. Next to the experiment name, write the page #s that the experiment work is on. The table of contents does not need to be more detailed than that.

Every day of lab work, the date should be written in the notebook at the beginning of class. This allows a student to keep track of what was completed on a particular date.

Each notebook section must be labeled with roman numerals and section headings displayed below.

At the start of each new experiment the following is required in the notebook at the beginning of lab (i.e. completed before coming to lab):

- I. Title of experiment, date
- II. Introduction
A paragraph synopsis/overview of what the point of the experiment is, methods (titration, precipitation, etc.) or instrumentation (if applicable) utilized in the experiment. Include some theory. From this someone reading your notebook will have a basic idea of what the experiment entails. The **FIRST SENTENCE** of the introduction should state the purpose/what will be discovered in the particular experiment. The Introduction can be roughly ½ a page but no more than 1 page long.
- III. Procedure
students find it helpful to write out the lab experiment's procedure in their own words, **SO** it is a **REQUIREMENT** to do so in the notebook. Students will have the printed experimental procedure to reference while completing each experiment. But, you must summarize exactly what you are doing in this section of the notebook for each experiment **BEFORE** coming to class to complete it.

Note: Instructor and TA initial all above sections at the START of lab each week. It is the student's responsibility to get a notebook signed. If these sections are not initialed, heavy point deductions are applied according to the grading discussed earlier. Falsifying any initials will result in a zero (0) out of 200 points for the notebook score.

IV. Results

This section should contain calculations for solutions physically prepared in class and all observations/pertinent data generated during the experiment. This includes but is not limited to color changes (initial solution color and endpoint color in a titration for example), initial/final buret readings for all experimental trials, balance weights for solid samples, balance #, instrument settings, stock solution concentrations, etc. All values should have units and chemical identity accompanying them i.e. 15.05 mL of NaOH. All data should be written in pen. Sometimes drawing a data table in a notebook is helpful to organize data. Strikeouts are acceptable as no notebook is perfect. If alterations in an experimental procedure occur, note it in this section. *The unknown number should be clearly visible in this section when beginning to record data for the unknown!* **If experiments require generating graphs in Microsoft Excel (or other program), print out the graphs & tape/staple them in notebook. If an instrument generates data, a graph, calibration curve graphs, you are also required to include that in your notebook!**

V. Conclusion

Brief. Restate the purpose of the experiment and what was accomplished (one or two sentences that state the unknown number and what was quantified in the unknown). If any major errors occurred in the experiment i.e. student accidentally disposed of a sample, lost product, etc state that here as well.

Example: The purpose of this experiment was to quantify the percent sodium carbonate in an unknown sample. In unknown #12, it was determined that the solid unknown sample contained an average of 39.57 % sodium carbonate (Na_2CO_3). Standard deviation was 0.1256 and parts per thousand was 3.17, indicating great precision of lab work. To the experimenter's knowledge no major errors occurred during the completion of the experiment. In terms of accuracy, reported to me in Sakai via the instructor, the experimental value of 39.57 % sodium carbonate versus the theoretical composition of unknown #12 earned 187.5 out of 200 points, a 93.8 % accuracy grade. This indicated a high degree of accuracy of the experimental work considering the resulting grade.

*Format Check (optional): Request from Instructor or TA after completing lab experiment #1.

ALL portions of the Chem 214 syllabus as well as ALL course materials (paper or electronic) are NOT allowed for distribution elsewhere outside of class nor allowed for distribution outside of the University. Uploading, posting, copying, or sharing any electronic or non-electronic course materials pertaining to Chem 214 outside of class [i.e. uploading to share sites] is NOT allowed. If it is discovered a student completes such action, the University will be notified immediately. It is a serious offense.

Tentative Semester Schedule

Chem 214-001 Quantitative Analysis Schedule* (Spring 2017, Tuesdays 2:30-6:30PM)				
Assignment Dates	Week #	Date	Lab Experiment	Proposed Tasks**
First Day. Check-in, solution prep, etc.	1	Tuesday, January 17, 2017	Syllabus, Safety, Equipment/calculation review, locker check-in, solution prep	<i>Syllabus. Safety. Sig fig/Equip review. Check-in lab locker. Prepare NaOH soln for Lab #1. Prepare EDTA soln for Lab #4</i>
Lab 1 Pre-Lab Quiz Due in Sakai by 2:30pm	2	Tuesday, January 24, 2017	1) Determination of % KHP in an Unknown	<i>Standardize NaOH soln. Titrate unknowns. Complete all calculations in lab. Additional titrations if appl. Submit results to Sakai by next lab period.</i>
Lab 2 Pre-Lab Quiz Due in Sakai by 2:30pm; Lab #1 (KHP) Lab Report Due in class at 2:30pm	3	Tuesday, January 31, 2017	2) Polyprotic Acid Titration: pH Titration Curve to Determine I.D. and Conc. of Unknown Acid (Partner Lab) BRING A LAPTOP	<i>Check NaOH molarity if appl, complete pH titration curve of unknown, then derivative curves, calculations, etc all in lab. Work efficiently w/partner; do not sit around! Submit Lab #2 results to Sakai by next lab period.</i>
Lab 3 Pre-Lab Quiz Due in Sakai by 2:30pm	4	Tuesday, February 07, 2017	3) Gravimetric Analysis of Sulfate reported as an Assay of % SO₃ in an Unknown	<i>Prepare sulfate unknowns. Digest for 1.5 hours. Obtain empty crucible wts during digestion. Filter digested unknown samples. Store crucibles w/product in the oven until next lab period.</i>
	5	Tuesday, February 14, 2017	FINISH LAB 3; then recap of techniques, etc learned thus far.	<i>Weigh crucibles w/ product. Complete Lab #3 calculations in lab. Clean crucibles thoroughly, have TA/instructor check, then crucibles in oven. Then...</i>
Lab 4 Pre-Lab Quiz Due in Sakai by 2:30pm	6	Tuesday, February 21, 2017	4) Determination of Total Hardness (as Ca) of Unknown via EDTA Titration and Both Speciation (Ca & Mg) and Total Hardness (as Ca) by Ion Chromatography (IC)	<i>Prepare CaCO₃ soln. Standardize EDTA soln. Half of class prepare unknown dilution for IC & analyze during lab (can do some titrations while waiting). Other half of class complete unknown titrations first (no IC).</i>
	7	Tuesday, February 28, 2017	FINISH LAB 4	<i>Swap. Other half of class prepare unknown dilution for IC & analyze. Rest of class complete unknown titrations. All EDTA lab work must be finished by day's end. Submit Lab #4 results in Sakai by next lab period.</i>
	8	Tuesday, March 07, 2017	Spring Break; NO CLASS	NO CLASS
	9	Tuesday, March 14, 2017	5) Spectrophotometric Determination of Fe in Unknown (Partner Lab) OR 6) Refractive Index Quantification of %H₂O in Unknown (Partner Lab)	<i>Concurrent experiments! Partners (pairs) assigned Lab #5 or Lab #6. Complete the lab you/partner are assigned. Must be completed start to finish on day assigned. Work on calculations in lab, results, etc. Submit results to Sakai by next lab period.</i>
BOTH Lab 5 AND Lab 6 Pre-Lab Quizzes Due in Sakai by 2:30pm, Lab #4 (EDTA) Lab Report Due in class at 2:30pm	10	Tuesday, March 21, 2017	SWAP experiments 5) OR 6) depending on lab assigned	<i>Swap experiments. Same rules apply as last week; complete lab start to finish. Work on calculations, etc. Submit results to Sakai by next lab period.</i>
	11	Tuesday, March 28, 2017	7) FT-IR (Partner Lab) OR 8) Determination of %wt. Dye in Marshmallow Candy (Partner Lab)	<i>Concurrent experiments! Partners (pairs) assigned Lab #7 or Lab #8. Complete the lab you/partner are assigned. Must be completed start to finish on day assigned. Work on calculations in lab, results, etc. Submit results to Sakai by next lab period.</i>
BOTH Lab 7 AND Lab 8 Pre-Lab Quizzes Due in Sakai by 2:30pm	12	Tuesday, April 04, 2017	SWAP experiments 7) OR 8) depending on lab assigned	<i>Swap experiments. Same rules apply as last week; complete lab start to finish. Work on calculations, etc. Submit results to Sakai by next lab period.</i>
	13	Tuesday, April 11, 2017	NO CLASS	NO CLASS (to keep on schedule with Thurs/Fri lab sections that have off for Easter Holiday)
Cumulative EXAM	14	Tuesday, April 18, 2017	Cumulative Exam / Notebook Grading / Misc.	<i>Bring Calculator, LabCoat/Goggles, and Notebook!</i>
Last Day. Check-out etc.	15	Tuesday, April 25, 2017	Last day / Points for checkout & view of graded exams / Re-cap semester labs & applicability / Misc.	<i>Clean up all chemicals & check-out of lab locker. Point value for completion of locker check-out today and view of graded exam (zero points if absent). Recap of experiments and applicability.</i>

* This schedule is subject to change at the discretion of the Instructor or TA at any point during the semester

Lab is scheduled once a week on Tuesdays from 2:30-6:30PM. Attendance is EXPECTED every lab period. No make-up day/time is offered. No extra time is allowed.

Lab clean-up begins at 6:20pm to ensure all students are out of the laboratory by the scheduled end time of 6:30pm.

ALL LAB REPORTS ARE TO BE PRINTED OUT AND HANDED IN AT THE BEGINNING OF LAB [within the first 15 minutes after official lab start time] ON THE DUE DATE. They are late if not printed & turned in on time.

Emailed lab reports will NOT be accepted under any circumstances.

** Please be advised that these proposed tasks should be used as a guide and are under no circumstances the only tasks that can be performed. This is the bare minimum.

*** This schedule is meant to be a guide, to clearly map out the vigor and expectations for this course. It is not all encompassing and students must be responsible enough to keep track/stay on task.

This laboratory course is designed to emphasize many important principles/concepts from the lecture course *but* the topics in lecture & lab rarely are concurrent on a day to day basis, due to the extra detail in which lecture requires to satisfactorily cover said topics. That being said, some material will be covered & discussed lab before lecture. Students will be prepared appropriately for the tasks at hand. After all, lab and lecture are two *different* courses.