Chemistry 202: Analytical Chemistry

# Term 1, 2018-2019

***Instructors:***

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***Office Hours:***

At least one of the instructors will be available from 11 am to noon and from 3 to 4 pm each weekday.

***Introduction:***

Analytical chemistry can be divided into two branches: qualitative analysis and quantitative analysis. Qualitative analysis deals with finding what constituents are in an analytical sample, and quantitative analysis deals with determining how much of a given constituent is in the sample. This course deals primarily with quantitative analysis.

***Learning Objectives: Students will…***

1. Demonstrate proficiency in a variety of analytical concepts and methods including errors and treatment of data, chemical equilibrium, volumetric methods, potentiometric methods, spectrochemical methods, and analytical separations (Knowledge).
2. Develop and demonstrate skills in solving conceptual and practical problems in chemistry (Inquiry, Reasoning).
3. Develop and demonstrate accurate and precise lab technique, draw appropriate conclusions from data, and calculate the error associated with results (Inquiry, Reasoning, Ethical Behavior).
4. Work effectively with others in the lab and communicate lab results clearly, both in writing and verbally (Communication, Ethical Behavior).

This course supports the Educational Priorities and Outcomes of Cornell College with emphases on knowledge, inquiry, reasoning, communication, and ethical behavior.

***Course Materials:***

The text for the course is ***Quantitative Chemical Analysis***, Ninth Edition, by Daniel C. Harris. You also need to purchase access to the Sapling Learning system. In addition you will need a carbonless-copy laboratory notebook with numbered pages, safety goggles, and a scientific calculator (not your phone).

***Course Schedule:***

The class will meet on Monday through Friday from 9 to 11 am for the first week. After the first week, class meetings will be on Monday, Wednesday, and Friday mornings.

The laboratory, which is a major part of this course, will meet from 12:30 to 3 pm each day. After the first week, lab will meet Tuesday and Thursday mornings as well, beginning with a pre‑lab meeting at 8:45 am. If you prepare for lab, arrive promptly, and work efficiently, you will be able to complete your lab work by 3 pm.

***Grading:***

Your grade for the course will be based on your scores on a midterm exam, a comprehensive final exam, problem sets, and laboratory work, with a total of 1000 points possible:

Homework problems 100 pts

Laboratory 500

Midterm exam 175

Final exam 225

Your laboratory work will be graded on the basis of precision, accuracy, and the organization and completeness of your report. Be sure to read the section on the laboratory notebook before you begin your lab work. Homework problems will completed through the Sapling Learning system.

Grading brackets are 11% wide. Cutoffs will be no higher than:

A-/B+ 89%

B-/C+ 78%

C-/D+ 67%

D-/F 56%

Cutoffs may be lower depending on the difficulty of the exams.

***Accommodations for disabilities:***

Cornell College makes reasonable accommodations for persons with disabilities.  Students should notify the Coordinator of Academic Support and Advising and their course instructor of any disability related accommodations within the first three days of the term for which the accommodations are required, due to the fast pace of the block format.  For more information on the documentation required to establish the need for accommodations and the process of requesting the accommodations, see <http://www.cornellcollege.edu/academic-support-and-advising/disabi-lities/index.shtml>.

***Academic honesty:***

Cornell College expects all members of the Cornell community to act with academic integrity. An important aspect of academic integrity is respecting the work of others. A student is expected to explicitly acknowledge ideas, claims, observations, or data of others, unless generally known. When a piece of work is submitted for credit, a student is asserting that the submission is her or his work unless there is a citation of a specific source. If there is no appropriate acknowledgement of sources, whether intended or not, this may constitute a violation of the College’s requirement for honesty in academic work and may be treated as a case of academic dishonesty. The procedures regarding how the College deals with cases of academic dishonesty appear in The Catalogue, under the heading “Academic Honesty."

**DAILY SCHEDULE**

Day Morning1 Afternoon2 Lab due dates

(usually 9-11 am) (12:30-3 pm)

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1 *CT* Ch. 0-4 Safety and check-in

Make solutions

PL: 12:30 pm

2 *CS* Ch. 4, 6 Exp. 1

PL: 12:45 pm

3 *CT* Ch. 6-8 Exp. 2a Exp. 1 due

4 *CS* Ch. 8, data workup Exp. 2b

5 *CT* Ch. 9, work session Exp. 3 Exp. 2 due

PL: 12:30 pm

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6 *CS* Ch. 10, work session Exp. 4

7 Exp. 5 Exp. 5 Exp. 3 due

PL: 8:45 am

8 Review **Midterm exam**

9 PL: 8:45 am Lab

Lab schedule for the remainder of the block will be distributed separately

10 *CT* Ch. 18, 20 PL: 12:30 pm Exp. 5 due

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11 *CS* Ch. 21-26 PL: 12:30 pm

12 PL: 9:00 am Lab Exp. 4 Oral Report

13 *CT* Ch. 14 Lab One exp. due

(your choice)

14 Lab Lab

15 *CS* Ch. 15, 17 Lab One exp. due

(your choice)

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16 Review Lab Two exp. due

(your choice)

17 Complete lab work and check out of drawer.

**No lab work allowed after 12 noon.**

18 **Final exam, 8 am** Remaining two exp. and notebooks due at 1 pm

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1We will not cover all of each chapter. Details on which sections will be discussed in class

2PL = pre-lab lecture. We will distribute a lab rotation schedule during Week 2.

# LAB NOTEBOOKS

A properly kept laboratory notebook is essential to a successful laboratory project, whether it is for a course, graduate research, or professional industrial research. The key is *documentation.* All observa­tions, both qualitative and quantitative, should be entered in the notebook. Ideally, anyone should be able to reconstruct what was done, by whom, when, and the results. Please follow these guidelines carefully:

1. A bound notebook with consecutively numbered pages must be used so that pages cannot be added or deleted. The notebook you will use in this course is a bound book that makes carbonless copies of each data page. When you finish taking data for a particular experiment, you are to remove the carbonless copy (or copies) and turn it in at the front lab table.
2. Use the first page of your notebook for a **table of contents** so that any given experiment can be found quickly.
3. All data pages must contain your name and the date when the data were collected.
4. All data obtained in the laboratory **must** be recorded directly in the notebook at the time the work is performed. **Espe­cially forbidden is the recording of data on loose paper or in a calculator with the idea of copying it into the notebook later.** While neatness is sacrificed somewhat by taking the notebook directly into the laboratory and recording all data immediately, the prevention of loss of data and errors in transcribing more than counterbalances this.
5. Entries should be recorded in ink. If a mistake is made and a recorded value is invalidated, it is not to be erased, but is crossed out ***lightly*** so as to be still legible. A notation as to why it is rejected should be entered in the notebook.
6. The notebook should be reasonably neat and or­ganized so that data, observations, and results of any experiment may be found quickly.
7. Under no circumstances are you to enter data for two different experiments on the same page.

**LAB REPORTS**

You will submit a lab report for each experiment you perform. If you work as a member of a group, each member of the group will submit his/her own report. The audience for your lab report is a person who has taken a course in analytical chemistry and knows basic principles, concepts, and laboratory techniques, but is not familiar with the particular experiment. Lab reports must be word processed and must follow the format below.

**Heading: Experiment Title, Student Name, and Date**

**Method:** Write a brief paragraph describing the method used. Give a reference to the printed procedure and describe any deviations from the procedure. Your method need not include details such as volumes or concentrations, if they are provided in the printed procedure. A competent chemist should be able to take your method section (including the procedure to which you refer) and reproduce what you did in the laboratory.

**Reactions**: Include a balanced net ionic equation for all reactions studied. Since this is the basis of the stoichiometry, a balanced equation is required for calculating your results. The reactions may be written by hand if you prefer.

**Data:** Present the facts: the data and observations that you collected during lab. Arrange your data in tabular form, taking the essential data from your lab notebook. You may require more than one table; if so, clearly label each table (Standardization, Titration, etc.) It is not necessary to copy all of your original data from your notebook. For example, if you recorded initial and final buret readings and then calculated the net volumes, your report may show only the net volumes. You may include results in a table with your data if you wish.

**Sample** **calculations**: Set up an expression for your calculations based on the stoichiometry of the balanced equations and any dilutions you have made. Carry an extra sig­nificant figure throughout your calculations to avoid rounding errors. Round to the ap­propriate number of sig figs when you reach the final result. You do ***not*** need to show how you calculate a standard deviation. This section may be written in by hand.

**Results and** **Discussion:** In this section, you will use the facts presented in the data section to reach a conclusion (your results), and you will interpret your results for the reader. ***Clearly highlight your results;*** a person reading your report should be able to find your results quickly. It is acceptable to present the results in one table with the data, rather than in the Results and Discussion section. Be sure to include the following when applicable:

1. The result of each trial and a mean value with its uncertainty. The uncer­tainty will usually be the standard deviation or range and will be indicated in the directions for the lab. As in the Data section, tables are often helpful for presenting quantities clearly. See the table in Exp. 9 for an example. Don't forget units!
2. Spectra and/or graphs with proper meaningful captions. Be sure to include a table of any data you present in graphical form.
3. If your result can be compared to a published value, such as the percentage of bleach, a pKa, etc., then be sure to provide the published value and compare it to your value. Indicate where you obtainedthe published value by giving a reference.
4. Give your interpretation of your results. If your results did not agree well with the published value (where appropriate), what are the possible sources of error? As you write this section, ask yourself how confident youare in your results.

**EXPERIMENTS**

1.(20) Preparation of 0.1 M Solutions of Hydrochloric Acid and Sodium Hydroxide; Acid Base Ratio.

2. (40) Standardization of Sodium Hydroxide Solution with Potassium Hydrogen Phthalate. Standardization of Hydrochloric Acid Solution with Sodium Carbonate.

3. (40) Titration of Antacids.

4. (40) Column Chromatography.

5. (50) Either:

a. Analysis of Commercial Hypochlorite Solution by Iodometric Titration, or

b. Analysis of Calcium in Milk by EDTA Titration.

6. (50) Spectrophotometric Determination of the pKa of an Acid Base Indicator.

7. (50) Determination of Iron in Breakfast Cereals.

8. (35) Analysis of Metal Ions in Food.

9. (65) Titration of an Amino Acid.

10. (40) Blood Alcohol Analysis by Gas Chromatography/Mass Spectrometry.

11. (40) HPLC Determination of Caffeine in Beverages.

Numbers in parentheses are points. You must do Experi­ments 1 through 11; in Experiment 5 you have a choice between two options. The overall quality of your lab notebook will also be assessed, with a maximum score of 30 points, to give a total of 500 points possible for the lab portion of the course. If you have extra time at the end of the course, you may attempt to improve your score on a lab by repeating it. Speak with one of the instructors before you repeat any experiment.

Lab reports are to be turned in by 5 pm on the dates indicated above for grading of Experiments 1 through 5. As you complete other experiments, turn in your reports in a timely fashion, following the due dates listed above. It will be to your advantage to complete each report promptly, while the work is still fresh in your mind. ***Reports with egregious errors will be returned for rewriting and the maximum points achievable will be reduced by 10%. Late reports will be assessed a penalty of up to 10% per day.***

For each pre-lab lecture missed, 5 points will be deducted from your total score. Point deductions for being late to a pre-lab can be up to 5 points.

No iPods or other listening devices (except hearing aids) are allowed in the lab or during exams.

When you work with a partner on an experiment, both partners must be present and participating throughout the experiment.

On Tuesday, Day 17, all laboratory work will end by 12 noon and all drawers will be checked in by 4 pm. All remaining reports and your notebooks for final grading are due no later than 1 pm on Wednesday, Day 18.

**RULES OF THE LABORATORY**

1. Safety goggles must be worn by everyone in the lab.

2. Wear closed shoes in the lab. Sandals or open toe shoes can expose your feet to broken glass or spilled chemicals on the floor.

3. Keep your lab area clean. Pay particular attention to the area around the balances. Any amount of a spilled chemical, whether solid, liquid, or solution, must be cleaned up immediately and disposed of properly. Don't hesitate to ask if you're unsure of the best way to clean up or dispose of a chemical.

4. Learn the location and use of the emergency equipment, including the fire extinguisher. safety shower, and eye wash fountain.

5. Report any cuts, burns, or other injuries to the instructor.

6. Place broken glass in the containers provided for that pur­pose, not in the regular trash cans.

7. Avoid contaminating the reagent bottles. Pour some of the reagent into a clean beaker for your own use when neces­sary. Do not use a dropper to remove a solution from a reagent bottle, and do not pour the excess back into the bottle.

8. Do not bring food or beverages into the lab, and do not taste anything in the lab.

9. Do not remove any chemicals from the lab.

10. Never work alone in the lab, and never work without the instructor's knowledge and consent.

11. Do not perform unauthorized experiments -- check with the instructor first.

12. Don't hesitate to ask questions!

I have read and understood the rules of the laboratory.

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Name Date

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Signature Signature of Instructor