

## Chem 251

### Purpose and Approach:

The quantitative analyst seeks to answer the question, "How much of substance is in material? What are the tools used and how can one do the measurements?" In *Analytical Chemistry* course you will study some of the important ideas in analytical chemistry and do quantitative measurements. By the end of the course, we hope that you will have an improved understanding of:

- The distinction between the goals of qualitative and of quantitative determinations.
- Statistical methods for evaluating and interpreting data.
- Sources of error in chemical and instrumental analysis.
- Interferences in chemical and instrumental analysis.
- The concept of instrument calibration.
- The basic concepts of stoichiometry.
- The importance to quantitation of equilibrium theory.
- The concept of an analytical standard.
- Instrument components and principles of their operation in the following areas:
  - Spectroscopy (UV-vis, fluorescence, atomic absorption, IR, Raman, x-ray)
  - Separations (GC, HPLC, electrophoresis, ion chromatography, affinity chromatography)
  - Mass spectrometry including the distinction and utility of different ionization methods (e.g., EI, CI, ESI, MALDI) and mass analyzers (e.g., quadrupole, TOF, ion trap)
  - Electrochemistry (ion selective electrodes, amperometry, voltammetry)
  - Hyphenated techniques (GC-MS, LC-MS)

The laboratory experiments that you will do and much of the equipment that you will use to do them are new to Rutgers. Sizeable grants from the university and from the National Science Foundation have made it possible to acquire the equipment. We will do our best to see that the experiments work smoothly. As in any new venture, however, we expect to have to improvise along the way. We will need your cooperation, patience, and, perhaps at times, your help. If actual seawater is not available, we will provide artificial seawater.

**Lector:** Dr. Kornienko ([akern@chem.rutgers.edu](mailto:akern@chem.rutgers.edu))

**Office hours:**

**Lectures:** Mondays, 9:00 AM to 10:20 AM in SEC-210 on Busch campus.

**Open-Source Textbook:** [Analytical Chemistry 2.0](#)

### **Lecture Schedule**

<i>Week#</i>	<i>Date</i>	<i>Lecture Topics</i>	<i>Textbook Chapters*</i>	<i>Practice Exercises*</i>
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2	9/8/2021	Course Introduction. Calculations in Analytical Chemistry	1, 2	2.2- 2.6
3	9/13/2021	Evaluation of Analytical Data and Analytical Methods	4, 5	4.1- 4.3, 4.5- 4.11, 5.1, 5.2, 5.4- 5.7
4	9/20/2021	Titrations and Electrochemistry	9A, 9B, & 9D 11.B1, 11B2 & 11B5	9.1-9.11, 9.17-21 11.1-11.3, 11.6
5	9/27/2021	Molecular Orbitals and Complex Compounds	9C	9.12-9.16
6	10/4/2021	Spectroscopy	10	10.1-10.7
7	10/11/2021	Nanoparticles	Reading materials on canvas	On Canvas
8	10/18			
9	10/25	Separation sciences	12A-E	12.1-12.6
<b>10</b>	<b>11/1/2021</b>	<b>Exam I</b>	<b>Ch 1, 2, 4, 5, 9, 10, and 11(B1, B2, B5), reading materials on Canvas and material from experiments 1-8</b>	
11	11/8/2021	Gravimetric Analysis	8 A & 8 B	8.2-8.5
12	11/15/2021	Chromatographic Separations	12A-12F	12.1-12.7
13	11/22/2021	Mass spectrometry	Reading materials on canvas	On Canvas
14	11/29/2021	No lecture, Wednesday class schedule		
15	12/6/2021	<b>Exam II</b>	<b>Ch 8, 12, and reading materials/problems on Canvas and material from experiments 7 - 12</b>	

\* **Open-source Textbook:** [Analytical Chemistry 2.0](#)

### **Laboratory Instructors:**

Sec 01 Lab meets on Wednesday from 9:00 AM to 1:40 PM \_ Eric \_ [eoh7@rutgers.edu](mailto:eoh7@rutgers.edu)

Sec 02 Lab meets on Wednesday from 3:00 PM to 7:40 PM \_ Seungwoo \_ [sl1627@rutgers.edu](mailto:sl1627@rutgers.edu)

Sec 03 Lab meets on Thursday from 9:00 AM to 1:40 PM \_ Zach \_ [zc257@chem.rutgers.edu](mailto:zc257@chem.rutgers.edu)

Sec 04 Lab meets on Thursday from 3:00 PM to 7:40 PM \_ Koustav \_ [kss168@chem.rutgers.edu](mailto:kss168@chem.rutgers.edu)

### **Laboratory Schedule:**

Week #	Sections 01_02_W	Sections 03_04_Th	Lab* Title	Reports** Due Date	
				Sec	Sec

				<b>01_02</b>	<b>03_04</b>
<b>1</b>	9/1/2021	9/2/2021	Safety in chemistry laboratory, check in, familiarization with laboratory	In class	
<b>2</b>	<b>11/29/2021</b>	9/9/2021	<u>Exp 1.</u> Suspended and Dissolved Particle Matter in Seawater	<b>Full 12/9</b>	Full 9/15
<b>3</b>	9/15/2021	9/16/2021	<u>Exp 2.</u> Alkalinity of seawater	Intro 9/21	Intro 9/22
<b>4</b>	9/22/2021	9/23/2021		Full 9/28	Full 9/29
<b>5</b>	9/29/2021	9/30/2021	<u>Exp 3.</u> Complexometric titration	Full 10/5	Full 10/6
<b>6</b>	10/6/2021	10/7/2021	<u>Exp 4.</u> Turbometric Determination of Sulfate in Seawater	Full 10/12	Full 10/13
<b>7</b>	10/13/2021	10/14/2021	<u>Exp 5.</u> Synthesis and Characterization of Silver Nanoparticles	Full 10/19	Full 10/20
<b>8</b>	10/20/2021	10/21/2021	<u>Exp 6.</u> Synthesis of Fluorescent Carbon Quantum Dots	Full 10/26	Full 10/27
<b>9</b>	10/27/2021	10/28/2021	<u>Exp 7.</u> Ion Chromatography – Anions in Seawater	Full 11/9	Full 11/10
<b>10</b>	11/3/2021	11/4/2021			
<b>11</b>	11/10/2021	11/11/2021	<u>Exp 8.</u> Gravimetric Analysis of Chloride and Sulfide	Full 11/16	Full 11/17
<b>12</b>	11/17/2021	11/18/2021	<u>Exp 9.</u> Ion Chromatography – Cations in Seawater	Full 11/30	Full 12/01
<b>13</b>	Reports Evaluation				
<b>14</b>	12/1/2021	12/2/2021	<u>Exp 10.</u> Identification of chemical compounds using mass spectrometry	Full 12/7	Full 12/8
<b>15</b>	12/8/2021	12/9/2021	Oral presentation.		

**\*Procedures for all laboratory experiments are on Canvas.**

**\*\*All reports must be submitted on Canvas by 11:59 PM on the indicated dates.**

**Laboratory Notebook:** Canvas assignments.

**Course page is on Canvas:**

All communication with students will be done using Canvas. If you are new to Canvas review tutorials at <https://onlinelearning.rutgers.edu/getting-started-canvas-students> and if there are still questions, please call to help desk at (877)361-1134. You should login to this website using your Rutgers net ID and password. **You are responsible for checking Canvas announcements and Rutgers email.**

**For tech help with Canvas**, please visit <https://it.rutgers.edu/help-support>.

### **Grades and Grading**

Grades will be calculated based on the total number of points obtained in labs and exams.

All laboratory experiments 60% or 6 % each.

Oral presentation 5%.

Two exams 30% or 15% each.

Participation during laboratory periods and lectures 5%.

Total 100%

**You need to complete both, the laboratory and theoretical parts to pass the course.**

Your final grade will be based on your overall percentage and the grading scale would be as follows:

A 90%

B 80-89%

C 65-79%

D 55-64%

F < 55%

### **Lecture Schedule**

\* **Open-source Textbook:** [Analytical Chemistry 2.0](#)

Check Canvas for suggested additional reading materials and homework problems before each lecture period. Any general chemistry book would be helpful to review some topics.

- **Lecture notes** will be posted on the canvas site for this course usually on Sunday night prior each lecture. Any lecture handouts will be posted at the same time.
- **Participation** in lectures and during lab periods is essential in order for a student to do well in this course. Participation will be 5% of your final grade. Significant amounts of

additional material, including modifications to the lab procedure is provided in the lecture. Much of the exam material as well as what is required in the lab report will be provided during the lecture for the course in conjunction with the textbook. Tas will assume that students have attended the lecture and will not provide information that has already been provided in the lecture.

- **Lecture Exams** will be given on the specified dates. The material for the exams will come from your lab experiments, pre-labs, homework problems, readings and lecture material. Make sure you do all the Practice Exercises. The Practice Exercises may be randomly collected.
- **Missed Lecture Exams:** If you fail to take an exam at the scheduled time and place, you must notify your lecturer, Dr. Kornienko, promptly by e-mail and provide an acceptable explanation for your absence, or you will receive a score of zero (0) for that exam. No exceptions!

**Promptness:** Laboratory session will begin and end promptly as scheduled; students will not be allowed to work overtime or during off-hours. If a student arrives late to the lab, the instructor may not authorize the student to perform the experiment. In any event, if a student arrives late to lab, he or she cannot stay longer after the lab is officially over. A record of late arrivals will be kept and will affect the grade.

- **All Laboratory experiments** are on Canvas and will be graded based on three parts:
  - Pre-lab (20 points) should be submitted before the lab period each week.
  - In lab performance (30) based on your performance during experiments. To get a full credit, you should come to the lab with printed copy of the lab procedure and be ready to ask questions and perform the experiment independently.
  - Data Sheet (10 points) should be submitted on the day of the experiment each week.
  - Report (40 points) usually should be submitted before next week experiment.
- **Make-up:** A missed lab period may be made up only for valid reasons, which should be discussed with Dr. Kornienko. **No more than two make-ups will be possible during the semester.**
- **Chromatography oral presentation** will be based on a given research paper and should be completed during the last lab period and will be 5% of the final grade.
- **Laboratory Reports Guidance** (*written by Corey Frank*) In Chem 251 you will be asked to write a lab report at the end of each experiment. Effective communication is essential in any science, and it is important to practice this skill as early and often as possible. Refer to a chemistry journal (such as JACS) for examples of the type of writing, figure labelling, and tables that are expected in this course. We recognize that, for many students, this course is the first course where they are expected to independently generate an entire report, and therefore a detailed guide has been provided on the course website.

Unless otherwise specified in the laboratory write up, all lab reports must include the following:

1. **Abstract:** Minimum 50 words. Maximum 100 Words. A summary of the important findings. Report the average; do not report individual findings. Include the units.
  2. **Introduction:** Minimum 75 words. Maximum 200 words. A brief description of the purposes of the measurements.
  3. **Experimental Methods:** Maximum ½ page. A catalog of the types of measurements made and the techniques used.
  4. **Results and Discussion:** The most important section of your report. Length will vary, but will usually be 1 to 4 pages. Numerical results should be presented as (properly labelled) tables or graphs.
- **A laboratory report** for each experiment should be completed according to the laboratory schedule (usually the week following its completion at the beginning of the laboratory).
    - In a *Full* report, **all of the above sections are required** whether explicitly stated on the grading rubric or not. These reports are generally expected to be at least 4 pages and include graphs and tables, which need to be explained in the body of the text. A graph or table that is not described in the text of the report is basically useless and cannot be afforded full points.
    - In a *Short* report, all which is graded is **what is listed specifically in the grading rubric**. For some experiments, this includes an introduction, for others it does not. Descriptions of graphs and tables should still be included in the body of the text, but should be brief. These reports are expected to be 2-3 pages.
    - **Late lab reports will not be accepted.** With the permission of the lab instructor and course coordinator, only one lab report may be accepted 2 days late with 20% penalty

### **Absences:**

- For a planned absence to be excused, Dr. Kornienko and TA should be notified within a week of the absence. Otherwise, the absence will not be excused.
- For an emergency absence Dr. Kornienko and TA should be notified ASAP.
- If you have been told to quarantine, please remain at home and do not attend labs and lectures.
- **Please remember to notify Dr. Kornienko and your TA about your absences.**
- Students are responsible for all the material from a missed lab/lectures and will be tested on it during the exams.

**Special Needs.** Any student requiring extra time and/or other unusual testing accommodations must provide documentation supporting their circumstances and needs directly to Dr. Kornienko during the first week of classes, or immediately after these needs have been documented. ALL requests for extended time and/or other special accommodations for exams must be handled through the Office of Disability Services (<http://disabilityservices.rutgers.edu/>). The Office of Disability Services will be responsible for all necessary proctoring arrangements.

**We must treat every individual with respect.** We are diverse in many ways, and this diversity is fundamental to building and maintaining an equitable and inclusive campus community. Diversity can refer to multiple ways that we identify ourselves, including but not limited to race, color, national origin, language, sex, disability, age, sexual orientation, gender identity, religion, creed, ancestry, belief, veteran status, or genetic information. Each of these diverse identities, along with many others not mentioned here, shape the perspectives our students, faculty, and staff bring to our campus. At Rutgers university, we will work to promote diversity, equity and inclusion not only because diversity fuels excellence and innovation, but because we want to pursue justice. We acknowledge our imperfections while we also fully commit to the work, inside and outside of our classrooms, of building and sustaining a campus community that increasingly embraces these core values.

**Academic Integrity:** Rutgers University policies on academic integrity and procedures for disciplinary action (<https://nbprovost.rutgers.edu/academic-integrity-students> ) will be strictly followed. Amongst all other considerations noted in these policies, please note in particular that all exams and quizzes are **closed-book/closed-notes**, that electronic devices other than calculators are not allowed on your person during any exams, that it is strictly forbidden to share information with any other person or receive information from another person during an exam or quiz, and that it is strictly forbidden to impersonate or otherwise represent yourself as another student in any exam or quiz or have another person impersonate or otherwise represent themselves as you in any exam or quiz.

**Mask Requirement:** In order to protect the health and well-being of all members of the Rutgers university community, masks must be worn by all persons on campus when in the presence of others (within six feet) and in buildings in non-private enclosed settings (e.g., common workspaces, workstations, meeting rooms, classrooms, etc.). **Masks must be worn during class meetings; any student not wearing a mask will be asked to leave.**

Masks must always fully cover the wearer's mouth and nose.

Masks should conform to CDC guidelines and should completely cover the nose and mouth: <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/about-facecoverings.html>

Each day before you arrive on campus or leave your residence hall, you must complete the brief survey on the [My Campus Pass symptom checker](#) self-screening app.

**Other safety considerations:**

- The university continues to recommend frequent handwashing, the use of hand sanitizer when soap and water are not available, and avoiding touching eyes, nose, and mouth always.
- Papers and other artifacts may be passed around in the classroom and instruments may be shared among students in laboratories, use hand sanitizer, sanitizing wipes or wear gloves during lab periods.

**Weather and Other Emergencies:** Check the Rutgers website (<http://campusstatus.rutgers.edu/>) to confirm if classes are cancelled due to weather or other emergencies. If classes are on schedule, then labs will be held as scheduled. If there is a delay in opening, as long as there are 2 hours remaining for the lab period, students should attend lab for the remaining time. Changes in

schedule and other adjustments will be announced in the lecture. Students are still responsible for all the material from readings, homework problems and lecture even if a particular lab is cancelled due to weather emergency.

Campus status information will also be available through: RU-info Channel on RU-TV Channel 3, RU-info Call Center at 732/932-INFO (4636), or via these local media outlets (class cancellations only): WCTC (1450 AM), WRSU (88.7 FM), WRNJ (1510 AM), WKXW (101.5 FM), WCBS (880 AM), WINS (1010 AM), News 12 New Jersey (Channel 12)

**The faculty and staff at Rutgers are committed to your success. Students who are successful tend to seek out resources that enable them to excel academically, maintain their health and wellness, prepare for future careers, navigate college life and finances, and connect with the RU community. Resources that can help you succeed and connect with the Rutgers community can be found at [success.rutgers.edu](https://success.rutgers.edu), and nearly all services and resources that are typically provided in-person are now available remotely.**