

## **CHEM 251 - ANALYTICAL CHEMISTRY - Fall 2020**

**Lectures: Mon., Wed. & Fri. 1:00 - 1:50 pm** <https://SDSU.zoom.us/j/97636146595>

**Labs: CLS 424 Tue. or Thur. 8:00 - 12:40 or 1:00 - 5:40** \*\*\*page 5 for details

**Instructor:** Prof. Christopher R. Harrison

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Office hours: By appointment - <https://harrison-sdsu.youcanbook.me>

Zoom meeting room: <http://sdsu.zoom.us/my/charrison>

**Textbook:** “Analytical Chemistry 2.1” David Harvey (**FREE**)

Downloadable at: <http://bit.ly/2kQioMo> or as print on demand from the bookstore.

**Lab Manual:** Free electronic lab manual and notebook through [benchling.com](http://benchling.com)

**Course Objective:** This course will allow you to develop the foundational knowledge to understand modern analytical chemistry tools and techniques. This is done by learning how fundamental equilibria, and chemical reactions, alter the quantitative composition of a chemical system. In particular this course focuses on the quantitative aspects of chemistry, and the mathematical treatment of chemical equilibria.

### **Expected Student Learning Outcomes:**

#### **In the lecture:**

- Students will evaluate and interpret the error and uncertainty in measurements.
- Students will apply statistical tools, such as Student T's, F, and Grubbs tests to the comparison of data from chemical analyses in order to identify different and/or equivalent results.
- Students will be introduced to a range of sampling techniques/methods and their advantages and limitations.
- Students will apply their knowledge of acid/base equilibria for the preparation and evaluation of buffers to meet specific requirements.
- Students will calculate chemical equilibria using both chemical concentrations and chemical activities, thus identifying the limitations in the use of chemical concentrations in calculations.

- Students will explore a range of titrimetric analysis techniques and use their knowledge of the related chemical equilibria to predict the chemical changes through the process of the titrations.
- Students will be introduced to the techniques related to gravimetric chemical analysis.
- Students will apply their knowledge of redox chemistry to the calculation and evaluation of electrochemical analytical methods.
- Students will quantify chemical concentrations based on spectroscopic data, relating chemical interactions with light to the quantity of chemical present in solution.
- Students will be introduced to the fundamental equilibria which govern chromatographic chemical separations.

### **In the labs:**

- Students will master classical and fundamental analytical techniques for chemical measurement and analysis.
- Students will evaluate the robustness and validity of quantitative chemical measurements.
- Students will use modern chemical analysis tools to quantify the composition of unknown substances.
- Students will learn safe chemical handling and disposal practices.
- Students will learn to maintain a detailed and accurate digital laboratory notebook.
- Students will develop independent time management skills for complex and detailed laboratory procedures.
- Students will become familiar with reading and interpreting standard operating procedures.

**Lecture format:** As this is a flipped classroom the lectures have been prerecorded and are available through Canvas. The lectures are to be watched as “homework” prior to coming to class. The class time, held in a Zoom call, will be used to work on problems and master the topics covered in the lectures.

### **Course Materials:**

All course materials will be made available through Canvas.

### **Homework:**

Most weeks there will be a homework assignment. The homework is more challenging than typical exam questions. The homework is designed to be done in groups. With

only one result submitted and graded by the group. Group size and policy will be discussed and finalized in class.

### Lab Results:

All lab results will be submitted via through a Google form. Lab results will need to be submitted periodically, as indicated in the course calendar. For each lab that is late to be submitted at a deadline a 1 point deduction to your total lab grade will be incurred.

### Lab Notebook:

Digital lab notebooks, [benchling.com](http://benchling.com), will be used in this class. Details on how the lab notebooks work will be reviewed in class. The week following each lab result submission deadline the lab notebooks will be reviewed by your TA and graded for proper data recording, as indicated in the lab manual.

### Exams:

All mid-semester exams (4) will take place in the regular class time in the designated classroom. The exam questions will include calculations and theory, from both the lectures and labs. The final exam is scheduled by the university and will be two hours long, the final exam is a cumulative exam.

### Grading Plan:

As with any course, the grade that you receive is based upon your demonstrated knowledge of the course material. With this in mind, each graded element of this course will be used to evaluate your mastery of the material. In the table below you will find the point values for each course component.

Component	Quantity	Each	Total	% of Total
Lab Notebook	3	5, 5, 5	15	4%
Homework	12	5	60	14%
Lab Results	Best 7 of 8	10	70	16%
Top Analytical Scientists	2	10	20	5%
Mid-semester Exams	4	50	200	47%
Final Exam (cumulative)	1	60	60	14%
<b>Total</b>			<b>425</b>	

## Lecture schedule

Week	Dates	Topics	Chap.	Videos	Problem Sets
1	8/24 - 8/28	Analytical chemistry overview, calculations	1	1-3	1
2	8/31 - 9/4	Measuring Tools & Measurements	2A-E & 4A	4-7	2
-	Mon. 9/7	<i>Labor Day Holiday - No Class</i>			
3	9/9 - 9/11	Distributions & Statistical Analysis	4B-F	8-15	3-5
4	9/14 - 9/18	Sampling & Equilibrium	7A-C & 6A-F	16-19	6,7
-	Mon. 9/21	<b>Exam 1 - Videos 1-19</b>			
5	9/21 - 9/25	Acid-Base Equilibrium	6G	20-22	8
6	9/28 - 10/2	Buffers	6H	23-25	9
7	10/5 - 10/9	Activity coefficients & Equilibria	6I	26-27	10
-	Mon. 10/12	<b>Exam 2 - Videos 20-27</b>			
8	10/12 - 10/16	Titrimetric Analyses - acid-base	9A-B	28-31	11,12
9	10/19 - 10/23	Titrimetric Analyses - complexation & redox	9C-D	32-37	13-15
10	10/26 - 10/30	Titrimetric Analyses - precipitations	9E	38-39	16
-	Mon. 11/2	<b>Exam 3 - Videos 28-39</b>			
11	11/2 - 11/6	Standardization & Calibration	5A,B,C,E	40-43	17
12	11/9 - 11/13	Electrochemical Analyses	11A-B	44-47	18
-	Wed. 11/11	<i>Veterans Day - No Class</i>			
13	11/16 - 11/20	Spectroscopic Analyses	10A,B,D-G	48-52	19
-	Mon. 11/23	<b>Exam 4 - Videos 40-52</b>			
-	11/25 - 11/27	<i>Thanksgiving Break - No Class</i>			
14	11/30 - 12/4	Chromatography & Electrophoresis	12	53-56	N/A
15	12/7 - 12/9	Review			
-	Fri. 12/11	<b>Final Exam 1:00-3:00 pm</b>	<b>Cumulative</b>		

## **Covid-19 Lab Policy**

Due to the ongoing pandemic several measures are being taken to allow for the crucial hands-on lab instruction to take place, while ensure the safest possible environment for the students and TAs in the lab. These measures in place are:

- Reduced lab capacity - only 10 students will be allowed in the lab at one time
- Enhanced PPE - face masks will be mandatory, face shields will be available
- Temperature screening - contactless temperature measurements will be taken by the TA before entering the lab
- Sanitation - the lab will be stocked with hand sanitizer and disinfectants for cleaning workspaces.
- No labs after Thanksgiving - the final lab of the semester will be Nov. 19th.

### Reduced lab capacity

To achieve adequate spacing in the lab the number of students in the lab will be limited to 10 at one time. As each section has 20 students this means that the lab will be split into an A and B group, which will attend labs on alternating weeks. On the weeks that students are not attending the physical labs, they will be provided with either a take-home lab kit, or a virtual lab to supplement the physical lab experiences.

### Enhanced PPE

Effective personal protective equipment (PPE) is the primary defense against transmission of Covid-19 when social isolation is not possible. In addition to the regular lab PPE (lab coat/apron, safety goggles, and optional gloves) you will need to wear PPE that will protect you from the airborne Covid-19 virus.

**To this end no student will be allowed to enter the lab without wearing a proper face mask** (see below for acceptable face masks). You must wear your face mask at all times while indoors on campus and in the labs. *If you remove your face mask during a lab you will be removed from the lab and not allowed to return until Dr. Harrison is convinced that you no longer pose a risk to yourself and other students.*

**Reusable face shields** will be provided for any student who wishes to use them during the lab period. The face shields will be kept in the lab and disinfected between lab periods.

## Recommended and prohibited face masks

Not all face masks are created equal and some are frankly ineffective - [see a recent study of the droplets produced with various face masks](#). As such some types of face coverings will be prohibited. A key determinant of the efficacy of the mask will be how well-fitted the mask is. If someone can see under the edge of your mask (e.g. see your lips or nostrils) the mask isn't working

### Recommended face masks:

- ✓ N-95 or KN-95 mask
- ✓ Surgical mask
- ✓ Multilayer polypropylene masks
- ✓ Multilayer cloth (cotton) masks
- ✓ Half-face respirators

### Prohibited face coverings:

- \* Bandanas
- \* Scarves
- \* Gaiter type neck fleece

## **Reusing face masks**

Most of the best face masks are designed to be single use, which frankly can become quite expensive, and challenging given supply constraints. Below is some guidance on how to most safely reuse the "single use" face masks; obviously cloth masks can easily be washed between uses.

For paper masks like the N-95 and KN-95 versions, the best approach to reusing them is to use one per day of the week. When you are done with that day's mask carefully place it in a paper bag and seal the bag (paper clip, binder clip...). If using multiple masks label each bag with the day of the week to avoid confusion. Leave the bag undisturbed until the following week, at that time any Covid-19 viruses on the outer surface of the bag should have dried out and be rendered harmless. Heat and sunlight help speed the drying/destruction of the virus, so placing the bag on a sunny surface for several days will further help destroy the virus.

*At the time of writing this syllabus it was unclear what level of support the university will provide (if any) for face masks for students. If you do not have a recommended face mask please contact Dr. Harrison as soon as possible, he will work with you to find/provide you with a suitable mask(s).*

### Face shields

Dr. Harrison has made (3D printing, and laser cut) face shields for use in the lab if desired. The shields will provide an extra layer of protection, in addition to the required face masks. They shields may be used in place of goggles for students who may be experiencing excessive fogging of their goggles while wearing a face mask.

### Temperature Screenings

If you are feeling feverish, or experiencing any of the symptoms of Covid-19 do not attend the lab. Dr. Harrison will work with you to make up any missed labs.

As an added precaution before you will be allowed to enter the lab your TA will use a contactless thermometer to take your temperature (forehead). So long as your temperature is <100.0°F you will be allowed to enter the lab. If your first temperature reading is above 100.0°F you will be asked to wait in the hallway for 10-15 minutes before a second temperature test is taken (as you may be warm from walking to the lab). If you pass the second temperature check (<100.0°F) you will be allowed to enter the lab. If you are still above 100.0°F you will not be allowed to enter the lab, and you are self-quarantine and monitor your temperature until you are below 100.0°F.

### Sanitation

The lab will have several bottles of hand sanitizer available for you to use as needed in the lab (you are encouraged to sanitize your hands upon entering the lab). Soap and water is also available to wash your hands, but sink space is limited. Though gloves protect your hands, the gloves can still carry the virus. If you are wearing gloves in the lab be cognizant of what you are touching with your gloved hands, as you may be spreading the virus between surfaces due to unclean gloves.

Disinfectant spray will be provided in the lab. You are required to clean your work area with disinfectant at the end of your lab period. You are also encourage to not trust that the student in that space before you cleaned the area well, and you should probably clean your work area before you begin your lab.

### **Lab Schedule:**

- Labs begin on **August 25<sup>th</sup>**.
- The first two weeks of the lab are designated for lab check-in, training, and equipment calibration - come to the labs prepared.
- There will be a set schedule for each student to do the analyses in either.

- The lab grades are based on your quantitative analysis results for each lab, those results are submitted online (link in Canvas), with the grade determined by the accuracy of the analysis.
- There are designated lab submission deadlines (see Course Calendar) when a specific number of analyses must be submitted for grading.
- Labs can be graded upon request outside of the scheduled submission deadlines.
- Labs will only be graded ONCE. The grade received is FINAL.

### Lab Grade Review

- If the grade for an analysis is below 5 points the student can earn up to 2 points of credit. To do this the student must meet with Dr. Harrison and present a viable reason for why the analysis result was far from the true value. If a definitive cause for the error can be found, the student will get 2 points of credit added back to their score. If no clear source of error is found they will receive 1 point of credit.
- *This review of the lab grades must take place within one week of the lab having been graded.*

### Grading:

- The lab grades are determined by the accuracy of your analysis and are ranked out of 10 points. To obtain 10 points for a lab you must have a very accurate analysis. The lowest grade for any submitted lab will be 2 points.
- Your final letter grade will be determined based upon the total number of points you have earned throughout the course. A tentative grade distribution (in percentages) is tabulated to the right. Note particularly high or low class averages may shift the grade distribution.
- Note: The grading scale (right) is only an example. You are NOT guaranteed the corresponding letter grade for achieving a given percentage grade. Your final letter grade will be influenced by the overall class grade distribution to reflect your rank in comparison with your classmates.
- The Grade Center in Canvas is used to display all your individual grades, it is not used to calculate your final grade, due to the best X of Y nature of some of the grading components. Please use the Grade Center to verify that the correct grade has been entered for your assignments and midterms.

Letter	Cutoff
A	85%
A-	80%
B+	76%
B	73%
B-	70%
C+	66%
C	63%
C-	60%
D	53%
F	< 53%



**On-Line Material:**

- Please ensure that Canvas has your correct/active email address as the Canvas email feature will be frequently used to relay pertinent course information. It is your responsibility to ensure that you are receiving these communications.
- All course materials will be distributed and accessed through Canvas.
- Some course components will be conducted through Google Drive, such as Google Forms for the submission of lab results. Links to these items will be provided through Canvas.

**Absence & Deadline Policies:**

- All deadlines are firm and extensions will not be provided on an individual basis.
- Technology failures (e.g. webpages not loading, dog ate my computer, internet being down...) are likely to occur, do not leave the submission of homework or labs to the last minute. No extensions will be provided for such occurrences.
- Each student will be allowed one unexcused absence from a lab. For this absence the student will be allowed to make-up the missed lab period in one of the other lab sections. The student is not guaranteed to have access to any of the labs that require advanced sign-up when making-up a lab in a different lab section.
- Subsequent absences from lab may be allowed to be made-up provided that there was appropriate justification, as determined by the course instructor, for the missed lab.
- Unexcused absences for an exam will be treated as a zero. If an excused absence is allowed (e.g. medical reason, conference schedule conflict...) the points value for the exam will be redistributed over the other exams, or an estimate of the likely exam grade will be made based on all other exams taken in the course during the semester (comparing the student's performance to that of all their classmates as a benchmark).

**Test Accommodations:**

If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact Student Disability Services at (619) 594-6473. To avoid any delay in the receipt of your accommodations, you should contact Student Disability Services as soon as possible. Please note that accommodations are not retroactive, and that accommodations based upon disability cannot be provided until you have presented your instructor with an accommodation letter from Student Disability Services. Your cooperation is appreciated.

Students who have made arrangements with SDS for test accommodations and require a signature from an instructor must make arrangements to meet the instructor outside of

the class time to obtain a signature. Absolutely no forms will be signed immediately prior to, during, or after a lecture.

### **Preferred Names & Pronouns**

Any student who wishes to be addressed by a name other than what is presented in Canvas is encouraged to contact Dr. Harrison via email with the name you wish to use in this course. Similarly, if you have preferred pronouns that you wish to be addressed by please contact Dr. Harrison.

Dr. Harrison will communicate your desires to the TAs and all instructional staff will gladly honor your request.