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Chem 15: Chemical Equilibrium and Analysis

Course Syllabus – Spring 2020

Chemistry and Chemical Engineering, California Institute of Technology

Course Instructor

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Course Description

Prerequisites: Ch 1 ab, Ch 3 a or Ch 3 x, Ch 14,or instructor's permission. Laboratory experiments are used to illustrate modern instrumental techniques that are currently employed in industrial and academic research. Emphasis is on determinations of chemical composition, measurement of equilibrium constants, evaluation of rates of chemical reactions, and trace-metal analysis.

Course Welcome

Although current events will not allow for a traditional laboratory course we will go through the exercise of planning experiments and analyzing data from past years. Students will construct homebrew visible light spectrometers as platform to discuss common instrument specifications. If possible some experiments will be done by the instructor or TAs and shared via video.

Learning Outcomes

By the end of this course, students will be able to:

- Explain basic theory of spectrophotometry, inductively-coupled plasma mass spectrometry, and gas chromatography.

- Design a laboratory procedure appropriate for quantitation
- Analyze data based on external standards
- Assess the quality of an instrumentally generated dataset
- Evaluate the suitability of a proposed analytical method

Texts and Other Resources
There is no required text for Ch 15. I do recommend you pick up a copy of *Quantitative Analysis* (Dan Harris) or a similar textbook. Serviceable copies of the Seventh Edition of Harris can be purchased for a very fair price via a website that shares a name with a notable South American river. We may have access to the electronic version via the Caltech library for the duration of the term.

You will need to create a free academic account on www.CHROMacademy.com. Follow the links for an academic account and be sure to use your Caltech.edu email for free access to the resources.

Course Website or Learning Management System
Moodle will be used to post materials for the class.

Remote Interaction
We will use Zoom for class meetings. Zoom sessions will be recorded to facilitate access for anyone who cannot join live.

Assessment Rubric
We will cover 3 labs and I will weight them equally. Each lab will include:

Problem Type Assignments – relatively light problem sets for you to demonstrate your understanding of the method – 20%
Data Analysis – you will analyse data from the vast EAC archives following approaches we read about and discuss – 30%
Writing/Presentation Assignments – this is likely to be formal report write-ups but a reserve some flexibility depending on video presentation capabilities - 30%
Interaction – demonstrate your (on-line) communication skills by participating in class activities – 10%
Data Analysis and Writing/Presentation Assignments may be combined, and if so the weighting will be equal.

Attendance and Participation
This section used to read *"This is a lab course, and therefore attendance and participation are essential. To account for this a small fraction of points is awarded for showing up and being prepared."*

Obviously this term is different. I expect that you will maintain communication with me and with the rest of the class to the degree your individual situation and internet connectivity allows. Please communicate proactively throughout the term especially if any difficulties arise.

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Academic Integrity

Caltech's Honor Code applies: "No member of the Caltech community shall take unfair advantage of any other member of the Caltech community."

The honor code of a local secondary school[1] resonates with me:
*My **responsibility** as a student, teacher, or parent in the school community is to be honest, kind, generous, and respectful.* Thus, the Chem 15 honor code will be my **responsibility** as a participant in Chem 15 is to be honest, kind, generous, and respectful. We are able to use research instruments for this lab because of the generosity of donors and the kindness of the researchers who depend on these instruments to do their work. It naturally follows that we can all be respectful and honest, and even grateful.

Understanding and Avoiding Plagiarism: Plagiarism is the appropriation of another person's ideas, processes, results, or words without giving appropriate credit, and it violates the honor code in a fundamental way. You can find more information at: http://writing.caltech.edu/resources/plagiarism. (This paragraph written by CTLO, not me.) All instances of plagiarism or other academic misconduct will be referred to the Board of Control for review.

Collaboration Policy

Discussion of problems and data analysis is allowed and in fact encouraged. You may collaborate through all parts of data analysis. However, you should be able to produce answers to problems or analyses of the data sets working on your own with only textbooks, papers from the literature, or your own notes. Going back and reproducing an analysis independently is an excellent way to uncover errors. Spreadsheets, data tables, and figures should be the product of your own work beginning from data provided to you.

Students with Documented Disabilities

Students who may need an academic accommodation based on the impact of a disability must initiate the request with Caltech Accessibility Services for Students (CASS). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty dated in the current quarter in which the request is being made. Students should contact CASS as soon as possible, since timely notice is needed to coordinate accommodations. http://cass.caltech.edu/. Undergraduate students should contact Dr. Lesley Nye, Associate Dean of Undergraduate Students (administrative contact: Beth Larranaga) and graduate students should contact Dr. Kate McAnulty, Associate Dean of Graduate Studies (administrative contact: Angelica Medina-Cuevas).

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[1] Flintridge Preparatory School, La Canada, CA

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Course Schedule

During the first week we will establish a course meeting time and protocol. This schedule should be considered a guideline. Topics will be moved earlier or later as circumstances require. All online meetings will be recorded and shared to the class. I have left week 10 unscheduled to accommodate seniors in the course and to allow for unforeseen delays.

Week	Date	Topic/Objective	Associated Readings	Homework Due
1	3/30/2020	First class meeting/Test Communications, Get Acquainted	Zoom orientation	None
	4/2/2020	Second class meeting/Discuss syllabus, class goals	Syllabus	None
2	4/6/2020	Spectrophotometry Theory, Instrument Concepts	Spectrometer plans on line	
	4/8/2020	Discuss prototype progress		
3	4/13/2020	Present spectrometer prototypes and first light results		Spec Report Part I
	4/15/2020	ICPMS Method Introduction, Laboratory Protocols	Chromacademy webinar (CA)	
4	4/20/2020	ICPMS Data Analysis and Study Design		PS
	4/22/2020	Possible lab demo		PS
5	4/27/2020	Work with ICPMS data		
	4/29/2020	Present results, cover Standard Addition, Internal Standards		
6	5/4/2020	GC Introduction	CA	ICPMS Report
	5/6/2020	MS Introduction	CA	PS (GC)
7	5/11/2020	Bench Method, lab demo	Paper provided	PS (MS)
	5/13/2020	GCMS Data Analysis		
8	5/18/2020	pKa determination planning	Methyl Red Lab handout	GCMS Report
	5/20/2020	Recorded Lab Demo		PS
9	5/25/2020	Memorial Day		
	5/27/2020	Final meeting		Spec Report Part II

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