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Fall 9-1-2021

### CHMY 311.00: Analytical Chemistry - Quantitative Analysis

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## Chemistry 311: Analytical Chemistry - Quantitative Analysis

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**Professor:** Royce Engstrom Office: Chemistry 002.

Office hours Mon. 1:00-2:00; Tuesday 1:00-2:00 or by appointment (phone: 406 529-2574 or e-mail royce.engstrom@umontana.edu).

**Learning Outcomes:** Quantitative laboratory skills include sample and standard preparation, gravimetric and volumetric measurements, instrumental methods (e.g. potentiometry, absorbance, and fluorescence spectrophotometry, liquid chromatography), data analysis with spreadsheet programs, and concise clear presentation and discussion of results. This course has several significant learning outcomes:

1. Prepare the student to perform careful, reproducible and accurate laboratory work: important practical skills that the student will ultimately need in order to perform well in any laboratory environment.
2. Develop skills to analyze and evaluate experimental data.
3. Develop a deeper understanding of the principles underlying quantitative chemical analysis:
  - a. solution thermodynamics and equilibria
  - b. solubility calculations
  - c. acid/base and buffer calculations
  - d. metal complexation chemistry and calculations
  - e. gravimetric procedures and analysis
  - f. titrations and quantitative volumetric procedures and calculations
  - g. spectroscopy applications, procedures and calculations
  - h. chromatography applications, procedures and calculations

**Text:** David Harvey, *Analytical Chemistry 2.1*, Online edition

[http://dpuadweb.depauw.edu/harvey\\_web/eTextProject/version\\_2.1.html](http://dpuadweb.depauw.edu/harvey_web/eTextProject/version_2.1.html)

If you seek a reference text, we recommend Quantitative Chemical Analysis, 7<sup>th</sup> edition, by Daniel Harris. On the course schedule, chapters are shown for both the Harvey online text and the Harris text.

**Homework:** Homework will be taken from the Harvey online text.

**Grading:**

- Labs (8), 800 pts (100 pts each)
- Lab Notebook, 100 pts
- Homework, 174 pts
- Exams (3), 300 pts (100 pts each)
- Final (ACS standardized exam), 150pts

Total: 1524 pts

Your overall course grade will depend strongly upon your laboratory work and your ability to calculate and clearly report results. However, the exams and final are challenging and can have an impact on your grade. The homework, exams and final will focus on the more fundamental material presented in the lecture. We cover about 11 Chapters in Harvey, so keep up on the reading and do relevant homework problems or your exam/final grades will suffer. Grades will be curved but grade cutoffs are usually close to the traditional ranges. The plus/minus system of grading will be used.

**Laboratory notebook and reports:** A bound laboratory notebook with page numbers is required. **You MUST have and use your lab notebook for all labs.** Separate laboratory reports will be submitted for each lab. A detailed description of the laboratory notebook and report format is provided elsewhere. All laboratory reports are to be submitted on Moodle and are due on the Wednesday following the final day of the experiment. Lab report grades will be reduced by 10%/day if they are late and will only be accepted up to 5 days after the due date (except in cases of illness or family emergency, explained prior to the deadline if possible).

**Other:** Safety goggles are required for this course and must be worn at all times. You will be working with strong acids and bases which can cause irreversible loss of eyesight and significant scarring. A lab coat is also recommended for those who wish to keep their clothing from mysteriously acquiring holes. Do not wear shorts or open-toed shoes to lab! Food and drink are not allowed in the lab. Students are expected to adhere to the lab schedule. Lab make-ups will not be possible due to the limited availability of the lab. There is more than enough time devoted to each experiment and we are not responsible for poor time usage on your part.

**Academic misconduct** is subject to an academic penalty by the course instructor and/or disciplinary sanction by the University. Academic misconduct is defined as all forms of academic dishonesty. All of the academic policies found in the Student Conduct Code ([http://life.umt.edu/vpsa/student\\_conduct.php](http://life.umt.edu/vpsa/student_conduct.php)) apply to this course. Of particular relevance to this course, it is considered academic misconduct to represent another person's words, ideas, data, or materials as one's own. It is also considered academic misconduct to copy from another student's paper, consult unauthorized material, give information to another student or collaborate with one or more students without authorization during an examination or academic exercise without the instructor's permission.

**Students with Disabilities:** If you are a student with a disability and wish to discuss appropriate accommodations for this course, contact me privately to discuss the specific modifications you wish to request. Please be advised I may request that you provide a letter from Disability Services for Students verifying your right to reasonable modifications. If you have not yet contacted Disability Services, located in Lommasson Center 154, please do so in order to verify your disability and to coordinate your reasonable modifications. For more information, visit the Disability Services website at <http://www.umt.edu/disability>.

**Important Dates:** Deadlines regarding registration, adding or dropping courses, or changing grading options for courses can be obtained from the Registrar on the following website:

<http://www.umt.edu/registrar/students/dropadd.php>

**Important COVID -19 Information: (Please note that the following reflects policies and practices in place at the beginning of the semester. Changes may occur during the course of the semester.)**

- Mask use is required within the classroom
- The expectation is that you will use your cleaning kit supplies to clean your personal workspace when you arrive for class, and before you leave the classroom
- Classrooms may have one-way entrances / exits to minimize crowding
- Please do not congregate outside the classroom before and after class
- Specific seating arrangements will be used to ensure social distancing and support contact tracing efforts
- Class attendance will be recorded to support contact tracing efforts
- Drinking liquids and eating food is discouraged within the classroom (which requires mask removal) and not allowed in the lab.
- Stay home if you feel sick and/or if exhibiting COVID-19 symptoms
- If you or someone else is sick or displaying symptoms, please contact the Curry Health Center at (406) 243-4330
- Up-to-Date COVID-19 Information from the University of Montana
  - UM Coronavirus Website: <https://www.umt.edu/coronavirus>
  - UM COVID-19 Fall 2020 website: <https://www.umt.edu/coronavirus/fall2020.php>
- You are strongly encouraged to remain vigilant in mitigating the spread of COVID-19 outside the classroom

<b>Chemistry 311 Lecture Schedule (LA 103b) Fall Semester 2021</b>		<b>Reading</b>	
<b>Date</b>	<b>lecture subject</b>	<b>Harvey 2.0</b>	<b>Harris 8<sup>th</sup> Ed.</b>
M, Aug 30	Course overview and orientation, The Analytical Process	Ch. 1	Ch 0
W, Sept 1	The Analytical Process, Measurements and Units	Ch. 2	Ch. 0,1
M, Sept 6	Labor Day Holiday, no class		
W, Sept 8	Experimental Error and Significant Figures	Ch. 3,4,5,7A,B	Ch. 3
M, Sept 13	Statistics and Calibration	Ch. 3,4,5,7A,B	Ch. 4,5
W, Sept 15	Statistics and Calibration	Ch. 3,4,5,7A,B	Ch. 4,5
M, Sept 20	<b>Exam 1 (Chs. 1, 2, 3,4,5,7A,B)</b>		
W, Sept 22	Spectroscopy	Ch. 10A,B,C	Ch. 17-19
M, Sept 27	Spectroscopy	Ch. 10A,B,C	Ch. 17-19
W, Sept 29	Solution Equilibria	Ch. 6	Ch. 6
M, Oct 4	Equilibria, Activity and Activity Coefficients	Ch. 6	Ch. 6,7
W, Oct 6	Activity and Activity Coefficients	Ch. 6I	Ch. 7
M, Oct 11	Systematic Treatment of Equilibria	Ch. 6G	Ch. 7
W, Oct 13	Systematic Treatment of Equilibria	Ch. 6G	Ch. 7
M, Oct 18	Systematic Treatment of Equilibria	Ch. 6G,H	Ch. 7
W, Oct 20	<b>EXAM #2 (Chs 6, 10A,B,C)</b>		
M, Oct 25	Acid/base equilibria and Titrations	Ch. 6, 9A,B	Ch. 7-10
W, Oct 27	Acid/base equilibria and Titrations	Ch. 6, 9A,B	Ch. 7-10
M, Nov 1	Metal Complexation equilibria/EDTA titrations	Ch. 6, 9C	Ch. 11
W, Nov 3	Metal Complexation equilibria/EDTA titrations	Ch. 6, 9C	Ch. 11
M, Nov 8	Metal Complexation equilibria/EDTA titrations	Ch. 6, 9C	Ch. 11
W, Nov 10	Electrochemistry/Redox Titrations	Ch. 11, 9D	Ch. 13-15
M, Nov 15	Electrochemistry/Redox Titrations	Ch. 11, 9D	Ch. 13-15
W, Nov 17	<b>EXAM #3 (Chs 6, 9, 11)</b>		
M, Nov22	Electrochemistry/Redox Titrations	Ch. 11, 9D	Ch. 13-15
W, Nov 24	Thanksgiving travel day- no class		
M, Nov 29	Separations/Liquid Chromatography	Ch. 12A,B,E,F	Ch. 22, 24
W, Dec 1	Separations/Liquid Chromatography	Ch.12A,B,E,F	Ch. 22, 24
M, Dec 6	Fluorescence Spectroscopy	Ch. 10F	Ch. 18
W, Dec 8	Wrap-up		
Tue. Dec 14	<b>Final Exam 1:10-3:10 PM</b>		

<b>Chemistry 311 Lab Schedule (CHCB 213) Fall Semester 2020</b>				
<b>Date</b>		<b>Lab Description</b>	<b>Reading</b>	
			Harvey, 2.0	Harris 8 <sup>th</sup> Ed.
Aug. 31, Sept 1		Lab overview, tools of analytical chemistry, check-in.	Ch. 2	Ch. 2
Sept. 2-3		Lab #1 – Statistics, data analysis, spreadsheet programs	Ch. 1-5	Ch. 0-4
Sept. 7-8		Lab #1 – Volumetric and gravimetric measurements	Ch. 1-5	Ch. 0-4
Sept. 9-10		Lab #1 – Spectrophotometric verification of pipettor performance	Ch. 1-5, 8	Ch. 0-5
Sept. 14-15		Lab #2 – Gravimetric determination of chloride	Ch. 6,8	Ch. 6,7,8,26
Sept. 16-17		Lab #2 – Gravimetric determination of chloride	Ch. 6,8	Ch. 6,7,8,26
Sept. 21-22		Lab #2 – Gravimetric determination of chloride	Ch. 6,8	Ch. 6,7,8,26
Sept. 23-24		Lab #2 – Gravimetric determination of chloride	Ch. 6,8	Ch. 6,7,8,26
Sept. 28-29		Lab #3 – Spectrophotometric determination of Fe	Ch. 10	Ch. 4,5,17-19
Sept. 30-Oct 1		Lab #3 – Spectrophotometric determination of Fe	Ch. 10	Ch. 4,5,17-19
Oct. 5-6		Lab #3 – Spectrophotometric determination of Fe	Ch. 10	Ch. 4,5,17-19
Oct. 7-8		Lab #4 – Spectrophotometric determination of Mn in steel	Ch. 10	Ch. 5,17-19
Oct. 12-13		Lab #4 – Spectrophotometric determination of Mn in steel	Ch. 10	Ch. 5,17-19
Oct. 14-15		Lab #4 – Spectrophotometric determination of Mn in steel	Ch. 10	Ch. 5,17-19
Oct. 19-20		Lab #5 – Acid-base analysis: the Gran plot	Ch. 9	Ch. 6,7,8,10,14
Oct. 21-22		Lab #5 – Acid-base analysis: the Gran plot	Ch. 9	Ch. 6,7,8,10,14
Oct. 26-27		Lab #5 – Acid-base analysis: the Gran plot	Ch. 9	Ch. 6,7,8,10,14
Oct. 28-29		Lab #6 – EDTA titration of Ca and Mg in natural waters	Ch. 9	Ch. 12
Nov. 2-3		Lab #6 - EDTA titration of Ca and Mg in natural waters	Ch. 9	Ch. 12
Nov.4-5		Lab #6 – EDTA titration of Ca and Mg in natural waters	Ch. 9	Ch. 12
Nov. 9-10		Lab #7 - Fluorimetry /Lab #8 HPLC	Ch. 10/12	Ch. 17-19/22,24
Nov 11-12		No lab- Veterans Day Holiday		
Nov 16-17		Lab #7 - Fluorimetry /Lab #8 HPLC		
Nov 18-19		Lab #7 - Fluorimetry /Lab #8 HPLC		
Nov. 23=26		No lab- Thanksgiving week		
Nov 30-Dec 3		Finish Labs 7 and 8 as needed, and check-out		