Chemistry 210
Chemical Applications of Calculus and Physics
Spring 2020
Syllabus

- **Meetings:** GMCS-306 Fri 1-2pm
- **Schedule number:** 20732
- **Instructor:** Andrew Cooksy; CSL-310; 619-594-5571
- **Materials:**
  - **Book:** *Physical Chemistry: Quantum Mechanics and Molecular Interactions* with access to the *Mastering Chemistry* online homewo system. This is the same as the textbook for the CHEM 410A lecture. Solutions to the end-of-chapter problem are available online from Pearson.
  - **Blackboard** will be used to post announcements, assignment score final grades. Please be aware that the Blackboard gradebook is *not* th official gradebook for the course.

- Homework
- SASC Accommodation

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Catalog Description

CHEM 210A. Chemical Applications of Calculus and Physics (1)
One lecture per week. Review of chemical problems that demonstrate use of calculus a physics relevant to upper division chemistry. Chemical rate laws, molecular quantum mechanics, and chemical thermodynamics. Recommended if a grade of C- (1.7) or bel received in Mathematics 150, 151, 252, Physics 195, or 196.

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Student Learning Objectives:

In this course, we will examine the relationships among math, physics, and chemistry especially as they relate to physical chemistry (CHEM 410). The student successfully completing this course will be able to:

1. Solve elementary derivatives and integrals in the context of chemical problems.
2. Identify the formulas and/or principles from mathematics and physics needed to s word problem in physical chemistry.
3. Estimate values of physical properties such as (molecular masses or bond distance solved in a problem to check validity of calculations.
4. Calculate forces between atoms and subatomic particles using fundamental equati mechanics.
5. Demonstrate the physical implications of common chemical equations using graph limiting values.

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Prerequisites

This course is recommended for students intending to enroll in Chem 410A who recei or below in *any one* of the following: Mathematics 150, 151, 252; Physics 195, 196. Thi may be taken concurrently with Chemistry 410A. Most upper division coursework in c requires familiarity with how physics and math determine the properties and behavio molecules. Physical chemistry is the introduction to this way of approaching chemistr is a demanding course with little time available to review material from the foundatio and math courses. Chemistry 210 seeks to smooth the transition from the qualitative understanding of molecular structure given in earlier courses to this much more detai picture. We will work problems together and in small groups, using many of the same resources that you will use in Chemistry 410A, to learn effective techniques for answe questions about chemistry and assess our own responses.

If you satisfied any of these requirements by coursework at a different institution, ple

provide the transcripts for that work to the Chem 410A instructor to help us determin
or not you might benefit from Chem 210.

Overview

We try to avoid lengthy mathematics in chemistry problems. However, mathematics i
principal tool whenever we carry out any quantitative analysis of our data. Chemistry
easier to understand and to practice once we are comfortable with elementary algebra
geometry, and calculus (up to derivatives, simple integrals, and power series). The ma
manageable when taken one step at a time, but the upper division courses don't have
luxury of taking the time to break problems down that way. In this course, we take the
opportunity to work through quantitative problems step by step, and illustrate the rel
each step to the study of molecules.

The study of chemistry also relies heavily on physics. In particular, we call on results f
mechanics and electromagnetism to justify some of our conclusions about atomic and
molecular structure. You are probably familiar with most of the concepts from first-ye
physics, but may not have seen how they are important to chemists. We will exclusive
on problems related to the structures and dynamics of atoms and molecules, so that y
see why we need to know physics to learn chemistry.

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Course Material

In one sentence, the course covers how to solve problems that are based on principles
and molecular structure, molecular interactions, statistical mechanics, chemical
thermodynamics, chemical kinetics.

GENERAL

Chemistry 410A and 410B cover the fundamental physics of chemical systems, includ
structure, energetics, and interactions of molecules. The material can be applied to in
organic, and biochemical molecules and reactions. In fact, most of the important resu
physical chemistry will already be familiar to you from general chemistry. Chemistry
examine problems in all of these areas, focusing on problems relevant to Chem 410A.

Chemistry 210 will typically operate on a cycle of two weeks: problems introduced one
discussed and extended in the following week. This is intended to follow the cycle of e
Chem 410A.

TOPICS AND ORGANIZATION

1. quantum mechanics of atoms
2. quantum mechanics of molecules
3. molecular interactions at microscopic scale

4. statistical mechanics and extrapolation to the macroscopic limit
5. thermodynamics and bulk properties of non-reactive systems
6. bulk reaction thermodynamics and kinetics.

The primary reference for the course is the problems and lectures that we cover in cla
Additional reading may be assigned for material currently under discussion in Chem 4

For a tentative topic schedule, please see the course calendar for CHEM 410A.

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ACTIVITIES AND ASSESSMENTS

1. *Solve elementary derivatives and integrals in the context of chemical problems,* S
will be given brief lecture instruction including a solved example. Then students w
into groups, each group assigned to solve one of 3-5 selected problems, with applic
the interpretation of atomic wavefunctions, intermolecular forces, statistical mech
chemical thermodynamics, and kinetics. The problem that is most relevant to the c
lecture material will then be reviewed on the board by the instructor. Solutions to
problems will be published to Blackboard. We will explore the use of Maple softwa
Wolfram Alpha for solving these problems.
2. *Identify the formulas and/or principles from mathematics and physics needed to*
word problem. Students will be given brief lecture instruction including a solved e
Then the class will be presented with a new sample problem and asked to identify
relevant data, (2) the relevant equations from their notes or textbook, (3) the corre
between the data and the symbols in the equation, (4) the appropriate units, (5) th
magnitude of the expected solution. Once the class has worked together on this ex
set of 3 additional problems will be presented for students to work on individually
solutions discussed at the end of class.
3. *Calculate forces between atoms and subatomic particles using fundamental equa*
mechanics. Students will be given a brief lecture reviewing the laws of mechanics,
several short, worked example calculations. Students will then break into small gr
solve one of 3-5 assigned problems, with guidance from the instructor. One final p
will be given to the class to solve individually, then worked through on the board.
4. *Demonstrate the physical implications of common chemical equations using grap*
limiting values. Roughly every other week, an equation being discussed in Chem 4
be discussed in depth. A volunteer will be asked to draw on the board an approxim
of the function under discussion, The class will discuss the trends in the values, an
experiments that may be done to measure these quantities.

Assessment: Participation in the in-class problem solving will be the primary gradi
criterion. Homework will be assigned as needed to strengthen skills in areas needing
attention. The week-long homework assignments will allow students to work with the
instructor during office hours to correct any remaining difficulties with the material.

Grading Scheme

Each of the 13 class meetings will add up to a total of 5 points (combining participatio homework). One class may be dropped, for a total of (12 meetings) × (5 points/meetir points. Final grades will be assigned on the following scale:

A	≥ 56	C+	46-47
A-	54-55	C	44-45
B+	52-53	C-	42-43
B	50-51	D+	40-41
B-	48-49	D	38-39

Assignments

IN-CLASS PROBLEMS

Most of the class will be devoted to solving problems in small groups or individually, guidance from the instructor. These problems will usually be directly relevant to the C 410A lecture material, and the dates on which they are given may be changed during t semester to accommodate the variable lecture schedule.

- Initial problem topics will also include:
  - unit analysis and conversions,
  - stoichiometry,
  - reasonable values for physical quantities,
  - basic integrals and derivatives,
  - electron configurations for atoms,
  - Lewis structures and VSEPR theory for molecules.
  - more basic calculus, including power series approximations,
  - balancing chemical reactions,
  - calculating enthalpies, energies, and entropies of reaction,
  - elementary kinetics with rate laws.

HOMEWORK

Homework is assigned at the end of class and due the following week. Questions on th homework are welcome during office hours and any time by email. The homework wi or two short problems assigned as needed to reinforce skills covered during class. If y spending more than 15 minutes on one problem and not making progress, please com office hours or email the instructor. You are encouraged to assist each other on the co involved in homework problems, but any duplication of work (although it is unintenti subject to grade reduction.

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SASC ACCOMMODATION

Students who believe they qualify for special accommodations for these assignments s
first seek authorization by contacting the Student Ability Success Center at 619-594-6
(Calpulli Center, Suite 3101). Students with that authorization should then contact me
as possible so that we can agree on a suitable protocol for drills, quizzes, labs, and exa
cannot retroactively apply special consideration for assignment scores. You are welco
email me if you would like to set up an appointment outside regular office hours for th
discussion.

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