SYLLABUS - CHEM 171, ADVANCED GENERAL CHEMISTRY (Fall 2018)
Class Meets: M 1130-1220, TR, 1200-1315, in BIL 335

INSTRUCTOR: Prof. Tom Apple **EMAIL:** tapple@hawaii.edu
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Professor Apple's Office Hours: Mon. 8:30-10:00, Tuesday 10:30-12:00

GENERAL COURSE INFORMATION
REQUIRED TEXT: General Chemistry:Principles and Modern Applications, 11th Edition, Petrucci, Herring, Madura, Bissonnette

Publisher: Pearson

TEXTBOOK & SUPPLEMENTAL MATERIAL:

- The online access to the publisher's site ("Mastering Chemistry") is included in the cost of a new book.

Here is the course ID: <TAPPLECHEM171FALL18> or <CHEM 171-Fall 2018-11th Edition>. Don't enter the "<>".

Course Grading
Exams: There will be a weekly test each Monday. Your best 10 grades will be averaged.
Homework: This will account for 20% of your grade. Full credit is awarded by completing 10 points for each assignment.

Final grade:
Option 1: 80% of grade from weekly test average as calculated above plus 20% from homework.
Option 2: 60% of grade from weekly test average, 20% from final exam, 20% from homework.

OTHER IMPORTANT REGISTRATION & PROGRAM NOTES related to this course and your academic plans:

- As always, you should check with your academic advisors to confirm the minimum grade you need to make progress towards graduation with your desired degree.

- The prerequisite for Organic Chemistry I (CHEM 272) is a C (not C-minus) or better in CHEM 162 or 171.

- Your degree program will count *either* CHEM 161-162 *or* 171 (not both!) towards fulfilling your requirements.

DO YOU HAVE THE RIGHT BACKGROUND FOR THIS COURSE?

1. CHEM 171 covers the material that is taught in the CHEM 161-162 sequence, with some key **differences:**
a. **CHEM 171 moves at a significantly faster pace than either CHEM 161 or 162.** Because:
It covers the material in ONE semester, instead of two.
You earn 4 credits for 171, and 1 credit for 171L as opposed to 6 credits for 161-162.
We meet for 200 minutes every week, instead of 150.
b. **CHEM 171 starts at a different place from CHEM 161 or 162,** because the expectations for the students in this course are different.

It is expected that all students who are taking this course have had at least one year of high school "college prep" chemistry. (If your high school chemistry class was not a rigorous one, you may not be as prepared as others in this class.)

A passing Placement Exam was required before you were allowed to register for this course. The 171 Placement Exam was used to assess your competence in certain areas, and it is different from the exam used to determine readiness for CHEM 161.

2. "*How do I know that I learned enough stuff in my high school chemistry class?*"

Before the end of the first week of classes, you should review the first four chapters of the book. We will not cover this material to any great extent in lecture, as **it is expected that these topics have been covered in your most recent chemistry course.**

Ch. 1 – Matter: Its Properties and Measurement

Ch. 2 – Atoms and Atomic Theory

Ch. 3 – Chemical Compounds

Ch. 4 – Chemical reactions

Ch. 5 - Intro to Reactions in Aqueous Solution

Ch.6 - Gases

If you find that the majority of these topics are unfamiliar and/or too challenging, you should consider taking CHEM 161 & 162. Remember, it is assumed that you already know how to, e.g., balance equations, do the conversion to moles, calculate concentrations in molarity, and know some of the basic vocabulary of chemistry. If you do not, then 171 is not the right course for you.

TENTATIVE SCHEDULE OF TOPICS

UNIT 1 – ATOMIC STRUCTURE, PERIODIC TRENDS, BONDING (WEEKS 1-3)

Ch. 7 - Thermochemistry

Ch. 8 – Quantum Mechanical View of the Atom

Ch. 9 - The Aufbau Principle, Periodic Properties of the Elements

Ch. 10 – Chemical Bonding I: Lewis Theory

CHEM 171 begins with a discussion of energy and the heat of chemical reactions. We then examine the atom. By consideration of atomic structure we will develop the Periodic Table. This is followed by application of these ideas to predict properties of the elements, such as electronegativity, electron affinity and reactive tendencies. This will lead into formation of molecules and molecular structure. We make use of the idea of valence electrons (of atoms) to draw structures on paper, as in Lewis theory. Key concepts include Lewis structures, and the representation of ionic and covalent bonds using this formalism.

UNIT 2 – MOLECULAR STRUCTURE, CONDENSED MATTER, THERMODYNAMICS (WEEKS 4-7)

Ch. 11– Chemical Bonding II: Molecular Shapes, Valence Bond & Molecular Orbital Theories

Ch. 12 – Intermolecular Forces and Condensed Matter, Phases

Chs. 20, 23 – Solids, Polymers, and Composites

We continue with molecular structures and various bonding theories. MO theory is presented with the understanding that it will provide a basis for understanding not only a great deal about the structure of molecules, but also provide a starting point for band theory in solids. These ideas lead to an understanding of the strength of chemical bonds and their corresponding energies and thermochemical properties. We then move into the attractions between molecules and condensed phases. We describe the intermolecular forces & their roles in the physical properties of pure liquids and solids. Crystal structures of solids and mechanical, electrical and optical properties of materials will be interpreted in light of their microscopic structure.

UNIT 3 – EQUILIBRIUM; (WEEKS 8-12)

Ch. 19– Free Energy & Thermodynamics

Ch. 13 – Phase equilibria, Colligative Properties

Ch. 15 – Chemical Equilibrium

Chs. 16,17 – Acids and Bases

We introduce entropy, free energy and chemical potential in order to understand equilibria, colligative properties, and phase changes. Phase diagrams and qualitative & quantitative aspects of aqueous solutions, particularly colligative properties, are discussed. We expand the concept of acid-base chemistry, while incorporating quantitative and qualitative aspects of chemical equilibrium. We define strong and weak acids and bases and also cover concepts such as the relationship of molecular structure to acid (or base) strength, acid-base titrations & buffer chemistry, as well as solubility equilibria. Redox chemistry, electrochemical cells, batteries and corrosion will be addressed.

UNIT 4 – ELECTROCHEMISTRY; KINETICS, NUCLEAR CHEMISTRY (WEEKS 13-16)

Chs. 18,20 – Aqueous Ionic Equilibria, Electrochemistry

Ch. 14 – Chemical Kinetics, Systems Not at Equilibrium

Ch. 26, 27 – Intro to Organic Chemistry

This last set of lectures covers topics that you will likely encounter at key points in your training in the physical sciences. These last 3 chapters cover chemical kinetics, electrochemistry and its applications, and nuclear chemistry.

Chemical kinetics covers the relationship of time and chemistry, which is not addressed in the previous chapters. Key concepts include rate laws, the integrated rate law, collision theory, and reaction mechanisms. The application and relevance of catalysis are described here.

Time-permitting, we'll discuss radioactivity and nuclear chemistry. We'll apply ideas covered in previous chapters to, e.g., decay processes, and we'll familiarize ourselves with the terminology related to this subfield.

STUDENT LEARNING OUTCOMES

Student Learning Outcomes (SLO's) for General Chemistry are listed at the UHM Chemistry website, as follows:

"Upon completion, the student should understand:

1. The basic structures of atoms, ions, and molecules, and ways to quantitatively describe the properties of atoms and molecules in the various phases of pure matter and in mixtures.

2. The reactivity of atoms, ions, and molecules, and the various qualitative and quantitative methods for describing or depicting chemical reactions.

3. The concept of chemical equilibrium, and the energies that drive chemical reactions: an introduction to the field of thermodynamics.

4. The concept of chemical kinetics and the energy required to initiate a chemical reaction.

5. The relationship between the electronic configurations of atoms and molecules and their chemical properties: an introduction to the field of quantum mechanics."

In CHEM 171, this material will also be complemented by examples of particular interest to students who are either pre-engineering or physical science majors. Thus, an additional SLO is:

6. Upon completion, the student should be able to cite numerous examples of the applications of these chemical concepts to problems in engineering and the physical sciences.