

Chemistry 1B: Summer Session II 2015

Overview:

Welcome to Chemistry 1B (Summer Session II 2015). According to the official course description, Chemistry 1B is the second quarter of an integrated study of general chemistry. Coverage includes quantum mechanics; the hydrogen atom; many-electron atoms and chemical periodicity; elementary covalent bonding; transition metals; and chemical kinetics. Lecture: 3-1/2 hours, discussion: 1-1/4 hours. Chemistry 1P or strong high school level chemistry equivalent to 1P is strongly recommended; Chemistry 1A or equivalent is also strongly recommended. Concurrent enrollment in course 1M is recommended. Lecture: 3-1/2 hours; discussion: 1-1/4 hours.

Dates, Time and Location:

Lectures:

Section 01, Summer Session II Quarter 2015, 07/27/15 - 08/28/15, MWF 9:30 am in Nat Sci Annex 101, which is [here \(link to map\)](#).

Discussion Sections:

M-W 1-2:30 E2 Rm. 192.

Homework:

Homework assignments are due (via Webassign) before each lecture.

Exams:

We will have two non-cumulative exams. The condensed summer session **does not allow for a conventional final exam week**. The two exam dates are as follows:

- Exam 1: Wednesday, August 12, 2015

- Exam 2: Friday, August 28, 2015



Chem1Bsummer

[Today](#)

Monday, July 27 ▾

[Week](#) [Month](#) [Agenda](#)

Showing events after 6/15. [Look for earlier events](#)

Monday, July 27

9:30am Intro & Why we need Quantum Mechanics

Wednesday, July 29

9:30am Quantum Mechan- ics, Hydrogen Atom and Atomic Orbitals

Friday, July 31

9:30am Many Electron Atoms

Monday, August 3

9:30am Bonding

Wednesday, August 5

9:30am Bonding

Friday, August 7

9:30am Hybrid Orbitals and Geometry

Monday, August 10

9:30am Molecular Orbitals

Wednesday, August 12

9:30am Exam 1

Friday, August 14

9:30am Coordination Chemistry

Monday, August 17

9:30am Spectroscopy

Wednesday, August 19

9:30am Kinetics

Friday, August 21

9:30am Kinetics

Monday, August 24

9:30am Reaction Mechanisms

Wednesday, August 26

9:30am Intermolecular Forces and Crystals

Friday, August 28

9:30am Exam 2

Showing events until 11/15. [Look for more](#)

Chemistry 1B: Summer Session II 2015

What Do I Have To Know from Chapter 12?

Homework:

- You are responsible for everything in the homework problems, unless explicitly told otherwise by me.

Equations and Constants:

- You do not have to waste your time memorizing equations, mathematical identities, constants, or other stuff like this that you can look up in tables in books.

Light and Photons:

- Know that light is a wave, know what amplitude, frequency, wavelength, velocity and energy are, and how they are related. Be familiar with the electromagnetic spectrum, know whether ultra-violet light is more energetic or less energetic than red light. Be familiar with how the color of light relates to its frequency, wavelength, energy, and so forth. Be able to work with common units (Hertz, meters, Joules, meters/second, etc.)
- Know what diffraction and interference is, and why it is important in the context of proving something is a wave.
- Know what Blackbody Radiation is. You don't have to memorize Planck's Law, but you should know what "color temperature" means.
- Know what the Photo-Electric Effect is. Know who (Einstein) explained it. Know why it is important, and why it implies light is a particle (quantum, or photon). Be able to use this equation:

Electrons:

- Know that electrons are particles with a finite mass and with a single negative charge.
- Know that moving electrons also are waves (or at least are somehow associated with waves), that electrons diffract, and that their mass, velocity and wavelength are all related by the de Broglie relation, which you also need to know how to use:

Bohr Atom:

- Know the Bohr model for the hydrogen atom, and how to work with the equation he came up with, i.e.,:

Become Familiar with the Schrodinger Equation:

- Even though I don't expect you to know how to solve this, you should know that this and this are two examples of what is called the Schrodinger Equation, and you should be able to explain what the Schrodinger Equation is, and to know why it is useful (even if you can't run the thing yourself). You should be able to tell me what H is (it is called the Hamiltonian Operator, or the sum of the Kinetic and Potential Energy Operators), you should be able to tell me what E is (the Energy), and what is ψ (psi, the wavefunction, which specifies all the information there is to know about the particle -- usually the electron(s)) and what it means. We will soon learn that these are the orbitals, in the case of hydrogen.

Heisenberg Uncertainty Principle:

- Know the Heisenberg Uncertainty Principle and the equation Heisenberg came up with, i.e.,: You need to know how to use it, and even more importantly, what it means.

Meaning of the Particle in a Box Problem:

- I would like you to know a little bit about the Particle in a Box problem. In particular, I want you to be able to look at the solution we got for the energy, and tell me what each term means: You need to know how to use it, and even more importantly, what it means. Be prepared to tell me what E means, n means, and what L is. You should be able to look at this and tell that the energy increases

quadratically, that is, as the square of the number of the energy level.

Then, I would like you to be able to look at the solution for the wavefunction itself, and tell me what it means. You should know that these are a series of standing (not propagating) waves or stationary states (they do not change with respect to time except oscillating up and down). You should know that the number of nodes increases with the energy, and that the curvature of the wavefunction increases with increasing energy, and that the frequency increases with increasing energy.

- You should be all over Figure 12.14.

Wavefunctions, Probability Amplitudes and Probability Functions:

- You should know that is what we refer to as the "probability amplitude" but that what we are really after is a probability function, which is equal to the (absolute) square of the probability amplitude, i.e.,
Again, Figure 12.14 is key.

Hydrogen Atom and Schrodinger's Equation

- Again, I do not expect you to be able to solve the Schrodinger Equation, so this goes for the hydrogen atom problem. But you should be able to tell me what the terms mean, and be able to tell me the significance of the "radial part" and the "angular part" of the solution.
- You should know that atomic orbitals are individual solutions to the Schrodinger Equation for the hydrogen atom. (You should also know that orbitals are generalizable to any atom.)
- You should know what each of the four quantum numbers is, i.e., be able to tell me what n is, what l is, what m_l is, and what m_s is.
- You should be able to identify an orbital as S, P, D or F on the basis of its shape. Conversely, you should be able to draw these, given the letter designation OR given the angular momentum quantum number l

- You should be able to calculate the energy of a hydrogen atom atomic orbital given the principal quantum number and the equation for the energy. (Again, I don't expect you to memorize the equation, but I expect you to know how to use it.)
- You should know what defines the surface of an orbital. (It is, arbitrarily, the surface that contains 90% probability of finding the electron within the enclosed volume.) You should know the difference between the orbital itself (which is the probability amplitude function), why we typically show the phase as false-color, and the probability density function (which is also sloppily referred to as the orbital), and why the probability density function never shows a two-color phase representation. (Squaring the absolute value of the amplitude gets rid of the phase.)

Multi-Electron Atoms, Orbital Filling, and Electron Configurations

- You should know how the periodic table corresponds to multi-electron atomic orbital energies, orbital occupancy, and the order in which orbitals fill.
- You should understand the concepts of "core" electrons and valence electrons.
- You should understand the difference between neutral atoms, cations and anions.
- You should know that the number of protons is what determines the identity of the element, and that the number of electrons equals the number of protons in a neutral atom. Likewise, you should know that every proton has the same charge, every electron has the same charge, and that the charge of a proton is exactly equal in magnitude but opposite in sign to an electron.
- You should know that orbitals can house zero, one or two electrons, and if there are two electrons, they must possess opposite spin quantum numbers (up and down).
- You should know what the Pauli Exclusion Principle is, and what its importance is for orbital filling.
- You should know what it means for orbitals to be energetically degenerate. You should know that p orbitals have a degeneracy of 3, and that d orbitals have a degeneracy of 5, for example.
- You should know what Hund's Rule is, and that the lowest energy state is one in which there are a

maximum number of unpaired electrons within a degenerate state. For example, if you have three p electrons, Hund's Rule predicts there will be one unpaired electron in each of the three p orbitals.

- You should be able to write out full electron configurations and abbreviated electron configurations for any of the non-irregular atoms (eg: first 3 rows of the periodic table) simply by looking at the periodic table. I do not expect you to memorize the deviations from the regular pattern of orbital filling, but if I give you an atom and tell you there is an exception in, for example, how the d or f orbitals are filled, I would like you to be able to offer an explanation in terms of energies and Hund's Rule.
- You should be able to use electron configurations to predict ionization properties. This means you should be able to tell me why K^+ and Na^+ are monovalent cations, why Mg^{++} and Ca^{++} are divalent cations, and why Cl^- is a monovalent anion, just from looking at the orbital configurations of the neutral atoms.

Periodic Trends and the Periodic Table

- You should be able to use the periodic table to predict ionization energies, electronegativities, atomic radii, and all the other periodic trends described in the book. You should be able to explain these trends in terms of basic chemical and physical interactions. e.g.: Why do atomic radii get smaller as you move left to right within one row of the Periodic Table?

[Link to a PDF of the cover page for Exam 1](#)

These equations will look even better if you [install these free fonts](#).

Chemistry 1B: Summer Session II 2015

What Do I Have To Know from Chapter 13?

Homework:

- You are responsible for everything in the homework problems, unless explicitly told otherwise by me.

Equations and Constants:

- You do not have to waste your time memorizing equations, mathematical identities, constants, or other stuff like this that you can look up in tables in books.

Types of Chemical Bonds:

- Know the difference between a covalent bond and an ionic bond.
- Know what a polar covalent bond is, and what partial charges are.

Electronegativity:

- Know how Pauling defined electronegativity. I don't expect you to memorize the equation.
- Know the periodic table electronegativity trend.
- Be able to explain the relationship between electronegativity and bond type.
- Be able to do problems like that in Example 13.1.
- I don't expect you to know anything about Allen electronegativity.

Bond Polarity and Dipole Moment:

- Know what a Dipole is and what a Dipole Moment is.
- You need to know the difference between a dipole in a bond and a dipole in a molecule.
- You should know that a "nonpolar" molecule means a molecule with no net dipole moment.
- You should be able to identify what molecules will have a dipole moment (or are polar), and which ones won't, based on their geometry.
- You should be able to understand every aspect of Figures 13.5, 13.6 and 13.7.
- Study Table 13.4.

Ions and Ionic Compounds:

- Know what an ion is, what Coulomb's law is and why it is relevant, know what a cation is, and what an anion is. Describe how ions interact in a crystal lattice (eg: NaCl crystals).
- Know what atoms tend to form anions and what atoms tend to form cations.
- Be able to predict ionization states based on atomic electron configurations.
- Study Table 13.5 I expect you to be very familiar with the first three rows.
- Know the periodic table trends for ionic radius, as shown in Figure 13.8. Be able to explain it.
- I'm not going to ask you a lattice-energy question on the exam.

Partial Ionic Character of Covalent Bonds:

- Understand Figure 13.13.

Covalent Bonds:

- Know what a covalent bond is.
- Skip the crapola on "properties of models." Realize that a model is a hypothesis and usually a simplification of reality.

Bond Energies and Reaction Energies:

- Be able to predict reaction energies from bond energies. I will provide you with bond energy tables, but I expect you to be able to use the information.
- Understand the bond enthalpy sign convention they use in the book.
- Working through Example 13.5 and any problems that look like it is a good use of your time.
- Know what the limitations are on the idea that you can calculate reaction energies simply by subtracting the enthalpies of bonds formed from those broken.
- Recognize that enthalpy is a State function and that it is path-independent, and know why this might be both useful and important.

Localized Electron Bonding model:

- Know what it is, and what are its limitations.

Lewis Structures:

- Be able to draw Lewis structures and use them to predict bonding between atoms.
- Know what the Octet Rule is and its relevance to Lewis structures.
- Know why we only show valence electrons in Lewis structures.

- Know how to calculate formal charges on every atom of a molecule, using its Lewis structure.
- Example 13.6 is a good one to study and understand.

Resonance Structures:

- Know what resonance is and what resonance Lewis structures are supposed to represent.
- Be able to draw all the resonance structures of something like a carbonate ion, CO_3^{2-} .

Violations of the Octet Rule:

- Read through the examples and understand how they arise.
- Know what a Lewis Acid is and what a Lewis Base is.
- Examples 13.8 and 13.9 are good ones.

The VSEPR model and molecular geometry:

- Be able to use Valence Shell Electron Pair Repulsion theory to predict the geometries of molecules.
- Study Table 13.8.
- Know what its limitations are.

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What Do I Have To Know from Chapter 14?

Homework:

- You are responsible for everything in the homework problems, unless explicitly told otherwise by me.

Equations and Constants:

- You do not have to waste your time memorizing equations, mathematical identities, constants, or other stuff like this that you can look up in tables in books.

Orbital Hybridization:

- Know what it means to create linear combinations of atomic orbitals (equations on p. 662).
- Know that you get as many hybrid orbitals out as atomic orbitals you put in. So if you combine an s orbital and two p orbitals, you get THREE sp^2 hybrid orbitals, and you have one atomic orbital left over.
- Know what sp^3 orbitals are, sp^2 and sp are, as well as d^2sp^3 dsp^3
- Understand hybridization energy diagrams like Fig 14.5, 14.9 and 14.15.

Predicting Molecular Geometry from Orbital Hybridization:

- Know how to use orbital hybridization states to predict molecular geometry.
- Table 14.24 is worth memorizing, or better yet, understanding so that you don't have to memorize it.

- Build models of molecules corresponding to five rows of Table 14.24. Buy, beg, borrow or steal a molecular model kit.

Molecular Orbital Theory:

- Know that molecular orbitals are to molecules what atomic orbitals are to atoms. That is, if you solve Schrodinger's equation for a molecule, the solutions you get, if you nail down the atomic nuclei so that the inter-atomic distances are fixed, ARE the molecular orbitals.
- The book doesn't do a good job of clarifying this, but you should be aware that you don't NEED to use atomic orbitals to create molecular orbitals (see previous point).
- One simple way to get an approximation to molecular orbitals is to create them by taking Linear Combinations of Atomic Orbitals. This is called LCAO-Molecular Orbital theory, or LCAO-MO. It is the approximation that we start to use in section 14.2.
- Since LCAO-MO is a simple-minded and approximate way to create molecular orbitals without having to do any calculations. Because of this, it doesn't always get every detail right. That is why we start running into exceptions, not because there is anything "wrong" with the idea of molecular orbitals per se.
- Be able to use and explain molecular orbital energy interaction diagrams like Figure 14.26a and 14.27.

Bonding and Anti-Bonding Orbitals:

- Know that if you combine X atomic orbitals, you get X molecular orbitals, half of which are bonding molecular orbitals, and half of which are anti-bonding.
- Know what a bonding molecular orbital is, and what an anti-bonding molecular orbital is.
- Be able to use molecular orbital theory to predict what molecules can form, and what ones can't. (Eg: H₂ vs. He₂)

- Be able to calculate bond order, and know what "bond order" means.
- Be able to use molecular orbital theory to predict what molecules can form, and what ones can't. (Eg: H_2 vs. He_2)
- Be able to calculate bond order, and know what "bond order" means.
- Know what a sigma bond is, and what a pi bond is. Know how many electrons you can put into each.

Molecular Orbital Energy Diagrams and Electron Configurations:

- Spend a lot of time studying and understanding Figure 14.41, and be able to draw and label the top half of this figure for each of the five atoms listed. Be able to predict the bond-order, and know what this means in terms of single, double, and triple bonds. Do not memorize the bond lengths and energies, but try to understand them in terms of the table.

Spectroscopy:

- The spectroscopy sections of Chapter 14 will not be covered on the exam.



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What Do I Have To Know from Chapter 19?

Homework:

- You are responsible for everything in the homework problems, unless explicitly told otherwise by me.

Equations and Constants:

- You do not have to waste your time memorizing equations, mathematical identities, constants, or other stuff like this that you can look up in tables in books.

19.3: Coordination Compounds

- Study table 19.12. You should also know that Mg^{2+} will coordinate six waters via the oxygen atoms when in an aqueous solution. Sometimes one or more of those water oxygen atoms can be replaced with a phosphate oxygen or a nitrogen in a compound like chlorophyll. At the same time, you should look at Figure 19.6 so you know what the coordination geometries mean.
- Understand, but don't memorize, table 19.13. Pay particular attention to the unidentate ligands at the top of the table.
- There will be nothing involving electrochemistry or electrochemical potentials on the exam, as we do not cover this topic in the Chem 1B part of the sequence.
- I will not ask you questions specific to the nomenclature section on pp. 948-950.

19.4: Isomerism

- Understand the flow-chart in Figure 19.9.

- Understand what is going on in Figures 19.10-12, and cis/trans isomers.
- Understand what optical isomers (enantiomers) and chirality are.

19.5: Bonding in Complex Ions

- Understand Figures 19.19 and 19.20.

19.6: Crystal Field Theory

- Understand all of the figures in this section. Be able to explain Figure 19.28. I go into more detail in my lecture slides, so have a look at those.
- I will not ask you any questions about the Jahn-Teller effect.

19.7: Ligand Field Theory

- The only thing I want to make sure you know is that this is the "proper" molecular-orbital-based treatment of what we did in 19.6.
- I will not ask you any questions about the Jahn-Teller effect.



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What Do I Have To Know from Chapter 15?

Homework:

- You are responsible for everything in the homework problems, unless explicitly told otherwise by me.

Equations and Constants:

- You do not have to waste your time memorizing equations, mathematical identities, constants, or other stuff like this that you can look up in tables in books.

15.1 and 15.2: Reaction Rates

- Treat 15.1 as an introduction. I don't plan to ask you to calculate an "average rate".
- Understand what rate laws are. Know the difference between a differential and integral rate law (p. 721).
- Orders of reaction. Be able to look at a rate law and tell whether it is 0, 1st, 2nd, etc order (overall, and with respect to an individual reactant.)

15.3: Forms of Rate Laws

- You need to be able to figure out a rate law given a table of measurements, as with the homework problems.
- Be able to use the method of initial rates.
- Work through example 15.1.

15.4 and 15.5: Integrated Rate Laws

- Start by studying Table 15.6.
- On the exam, I will give you the first two but not the last three rows of Table 15.6, i.e., I will give you differential and integrated rate laws for 0th, 1st and 2nd-order rate laws, but I will not tell you what you need to plot to get a straight line, what the slope of that line is, or what the half-life equations are. I expect you to be able to figure those things out from the first two rows (it is easy, but make sure you can do it. Don't memorize it. Understand it!!!)
- Make sure you can do all of the problems I have assigned that have to do with section 15.4. Work through all of the worked examples. Be able to explain what is going on in each of the graphs in the figures in section 15.4. There is a lot in this section, and it is at the very heart of the topic, so give it some very serious attention.

15.6: Reaction Mechanisms

- The most important fundamental point is this: The overall balanced chemical reaction may correspond to two or more individual steps in a reaction, where intermediate species that don't show up in the overall balanced reaction may appear. These individual steps are what the book calls "elemental steps" in the reaction. If you have all of the individual elemental steps, you have a reaction mechanism.
- Rate laws often don't make a lot of sense when you look at the overall balanced reaction.
- Rate laws do make sense when you look at the slow (rate-limiting) step of the reaction. The rate law can allow you to guess what that elemental step will look like, or given the elemental step, you should be able to guess what the rate law looks like. (Guess = make a hypothesis).
- Study what is going on in Figure 15.8 and on page 739 (and what I did in lecture).
- Work through Example 15.6 and relevant homework problems.

- Know what a catalyst is and does.
- Understand the temperature dependence on reaction rate law.
- Know what a transition-state is, what an activated complex is, and what the difference is between those and a reaction intermediate. Be able to draw and identify these things on a reaction energy diagram.

15.7: Steady-State approximation

We skip this.

15.8 and 15.9

- Please be familiar with the figures and the principles represented in them from both of these sections



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Course Materials and Textbook

Webassign and e-book:

[UCSC bookstore Chem 1B summer session page](#)

You should be choose from several options, including

1. CHEMICAL PRINCIPLES UCSC BOOKW/ 3QTR HW WEB CODE & EBOOK for \$159
2. WEBASSIGN ALONE MULTI TERM CODE *EBOOK Ed: 1ST for \$112
3. WEBASSIGN HOMEWORK CODE ONE QUARTER ACCESS ONLY*E- BOOK for \$75

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CHEMICAL PRINCIPLES UCSC BOOKW/ 3QTR HW WEB CODE & EBOOK

ISBN: 9781285126159
Author: CHEM-1P&1A/B/C BUNDLE
Edition: 7TH
Year: 2012

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<p>Course Subtotal: Min \$0.00, Max \$655.25</p>	

Textbook:

The text book for the course is Zumdahl, *Chemical Principles*, 7th (5th or 6th is fine) edition. You should buy the ebook subscription if you don't already own a hard copy, or otherwise have reliable access to, a recent hard copy edition of this shockingly overpriced book. There are various study guides and other add-ons that you may want, but I am not requiring these extras. Other intro chem textbooks are in the library and are useful resources.

