Syllabus: CH301 Principles of Chemistry I (51140)

Hello and welcome to The University of Texas at Austin! CH301 is the first of a two-semester sequence designed to prepare you for study in math or science-related fields such as: medicine, pharmacy, engineering, chemistry, biochem, textiles, and many other areas. Chemistry is considered the central science that connects physics, biology, even sociology. The skills you learn this semester will help you in future classes and in your future career. These skills include, but are not limited to: attention to detail, problem-solving, analysis, critical thinking, graphing, estimation, and deduction based on chemical principles.

Excitement aside, this course demands much of its students, with study time in and outside of class and in thoughtful reflection and application of knowledge. We touch on a variety of topics including gases, electronic structure and periodic trends, classical bonding, VSEPR, Lewis Dot structures, quantum, VB and MO theories, polarity, intermolecular forces, liquids, solids, and thermodynamics.

Course:	CH301 Principles of Chemistry
Instructor:	D. R. Walker, Ph.D.; debwalker@utexas.edu
Office:	WEL 4.242
Meets:	TTh 8-9:30am
Textbook:	Any used
+/- Grading?	Yes
Grade depends on:	exams, online work
Required Materials:	course packet, Quest, nonprogrammable calculator
Computer access:	Required (but can use campus facilities)
Drop Deadlines:	April 2, 2012
Exam Dates:	Feb 2, Feb 23, Mar 29, May 3, **May 15**

Prerequisites:

Credit with a grade of at least C- or registration for one of the following: Mathematics 305G, 408C, 408D, 408K, 408L, 408M, 408N, 408S, Statistics and Scientific Computation 302; and an appropriate score on the ALEKS chemistry placement examination.

Course Packet and Text:

The course packet may be purchased at the printing center in WEL 2.228. The student may select any college-level chemistry textbook (used or eBook) or utilize the free online textbook at http://wiki.chemprime.chemeddl.org/

Course Set Up and Content:

This class meets Tuesdays and Thursdays each week. The course will cover stoichiometry through thermodynamics, as shown on the course calendar (included herein).

Course Website for announcements, notes: http://courses.utexas.edu
Course Gradebook and HW: http://quest.cns.utexas.edu

Instructor:

	Deborah R. Walker, Ph.D.
Contact:	debwalker@utexas.edu
Office:	WEL 4.242
Office Hours:	Tues 11am-1:30pm; Wed 12-1:30pm; Thurs 11am-12:50pm Other times by appointment—please schedule in advance via email

TA:

Matt Raiford Please see the syllabus posted on Blackboard for info.

Email Etiquette:

When using email to contact us, please write "CH301" on the subject line, address the email properly (Dear …), and make sure you sign with your full name. Include your UTEID when the email pertains to grades. Also include your version number when the email pertains to an exam. Ignoring proper etiquette could result in your email being overlooked.

Homework:

Homework assignments will be administered at http://quest.cns.utexas.edu/student/. This is the online homework system and gradebook. You are encouraged to work the problems offline (on printed sheets), then submit your answers online before the due date and time. Working problems actively is essential to achieving an understanding of the material. Homework due dates will be visible on the homework system. Only homework submitted before the deadline via the website shown above will receive points.

This course makes use of the web-based Quest content delivery and homework server system maintained by the College of Natural Sciences. This homework service will require a $22charge per student for its use, which goes toward the maintenance and operation of the resource. Please go tohttp://quest.cns.utexas.edu to log in to the Quest system for this class. After the 12th day of class, when you log into Quest you will be asked to pay via credit card on a secure payment site. You have the option to wait up to 30 days to pay while still continuing to use Quest for your assignments. If you are taking more than one course using Quest, you will not be charged more than $50/semester. Quest provides mandatory instructional material for this course, just as is your textbook, etc. For payment questions, email quest.fees@cns.utexas.edu.

Notes about Grading HW: The system allows multiple guesses for most problems. However, the system uses negative scoring. You earn NEGATIVE points for answering a question wrong. Successive wrong responses earn you increasingly negative scores. One wrong response followed by a correct response earns you partial credit—a partial positive score (not full points). Full credit is awarded for a correct response on the first try. We recommend that you minimize guessing because the more you guess, the lower your score. The answer key, with select problems worked out, becomes available at the due time on Quest; late homework will NOT be accepted.
Introductory info at http://cns.utexas.edu/quest/student/aboutQuest.pdf . Instructions on how to enter answers and how negative scoring works may be found at https://quest.cns.utexas.edu/student/help/view .

Attendance and Participation:

Participation in class activities increases student retention and understanding of the material—and raises grades. Class-related discussions may include information and topics not covered in the textbook or on the syllabus; you will be held responsible for (tested on) that information.

Hour Examinations:

Four examinations will be administered during class, in a location to be announced. The scheduled dates are the Thursdays of Feb 2, Feb 23, Mar 29, May 3. KEEP ALL PAPER COPIES OF EXAMS!! No make-up exams will be offered. Each missed exam will count as a zero. One score (the lowest) will be dropped. Alternative exam arrangements can be made ahead of time only if an official University activity requires your absence (religious, sports, other); you must request such consideration in writing by the 12th class day of the semester.

Final Exam:

Our comprehensive final exam is scheduled for Tuesday, May 15, 2pm-5pm. The location will be announced on the class website during the last week of classes. NOTE: Finals are set by the University and posted during registration for the class the prior semester. The final exam score cannot be dropped. If you need to request an alternate time for taking the final, the **request must be received by the 12th class day**.

Bonus Points:

Occasionally an assignment for bonus points will be offered in class or on Quest. Such bonus assignments will have due dates; listen for updates and offerings in class.

Religious Holy Days or Sports

Notify me of your pending absence by the 12th class day so that we may work together on a plan to make up the missed work.

Grading:

There will be no curves. Your score will be calculated by summing across raw scores (not percentage). Each question you answer correctly gets you closer to your goal. Your homework score will replace your lowest exam score if it helps your course grade overall. Students who complete every homework assignment will receive an additional bonus to their grade.

Exams and Homework (4 exams, or 3 exams + HW sum)		_____	800 points
Final Exam raw score (cannot be dropped)		_____	200 points
Bonus			
	TOTALS	= _____	1000 pts

Grade Cutoffs:

Score	Grade	Grade Points Awarded
900	A	4.0
860	A-	3.67
830	B+	3.33
800	B	3.0
760	B-	2.67
730	C+	2.33
700	C	2.0
660	C-	1.67
630	D+	1.33
600	D	1.0
550	D-	0.67
<550	F	0

Because bonus points are offered, scores will not be rounded up. A score of 859.999 earns a B+ in the class. The gradebook is available online at http://courses.utexas.edu

Dropping the Class

Though it may sound harsh, you are encouraged to drop the class if you (i) do not satisfy the math prerequisite, or (ii) have a grade of F (i.e. less than 110 pts raw score) on *either* exam01 or exam02. If you have questions or concerns, please contact me either before/after class or in office hours or via email: drwalker@mail.utexas.edu. For questions or concerns about what effect this drop will have on your schedule, scholarship, or other aspects of academic life, please contact your academic advisor.

The last day to drop the course for academic reasons is **April 2, 2012**. After this date, students must go to the Dean's office, WCH 2.112, to appeal for non-academic reasons. For more information about add/drops, please refer to the UT Austin General Information Catalog or visit the Lower Division Course Office in WEL 2.212 or meet with or email your advisor.

Scholastic Dishonesty will be prosecuted to the full extent. The definition and information is available in the current issue of the General Information Catalog published by the Registrar's Office or in the University Honor Code at http://registrar.utexas.edu/catalogs/gi09-10/ch01/index.html (a link is also provided at our Blackboard website). Turning in work that someone else did, but has your name on it is an

example of cheating. This type of cheating may occur via group work that you did not actively do sufficiently by yourself, or using results from a Google search. See above link for more info.

Students with Disabilities

Students with disabilities may request appropriate academic accommodations from the Division of Diversity and Community Engagement, Services for Students with Disabilities, 471-6259, http://www.utexas.edu/diversity/ddce/ssd/

Our Course Calendar

Below find a tentative schedule of upcoming topics. On occasion we may adjust the calendar: such updates will be shown in class. You are strongly encouraged to preview upcoming topics in a textbook of your choice before class time. (Locate topics via Index in textbook of your choosing.)

January

SUN	MON	TUE	WED	THU	FRI	SAT
		17 Syllabus, Reaction Stoichiom.	18	19 Limiting Reactant, PV=nRT	20	21
22	23	24 HW01 Due K-M Theory, Gas Laws	25	26 Stoichiometry w/Gases, Diffusion	27	28
29 HW02 Due	30	31 HW03 Due Effusion, Real Gases, Apps				

Schedule subject to change as needed; changes will be announced in class.
Exam dates are set.

February

SUN	MON	TUE	WED	THU	FRI	SAT
			1	2 Exam01	3	4
5	6	7 Quantum, waves, Photoelectric	8	9 Bohr model and spectra	10	11
12 HW04 Due	13	14 Schrodinger and Wave Functions	15	16 Quantum numbers, Econfig	17	18
19 HW05 Due	20	21 HW06 Due Trends Zeff	22	23 Exam02	24	25
26	27	28 HW07 Due Bond Types, Lewis Dot, VSEPR	29			

CH 301
Spring 2012

8-9:30am TTh
Instructor D. Walker

March

SUN	MON	TUE	WED	THU	FRI	SAT
				1 VSEPR expanded, Polarity	2	3
4	5	6 HW08 Due Polarity, VB Theory	7	8 MO Theory	9	10
11	12	13	14	15	16	17
18	19	20 HW09 Due Molarity	21	22 IMF	23	24
25	26	27 HW10 Due Liquids and Solids	28	29 Exam03	30 If need to drop, get form to me.	31

April/May

SUN	MON	TUE	WED	THU	FRI	SAT
1	2 DROPS DUE	3 HW11 Due Heat and Work	4	5 Heating Curves	6	7
8 Easter	9	10 HW12 Due Calorimetry	11	12 Enthalpy	13	14
15	16	17 HW13 Due Enthalpy	18	19 Entropy	20	21
22	23	24 HW14 Due Entropy	25	26 Gibbs	27	28
29	30	1 HW15 Due Gibbs	2	3 Exam04		

Final Exam is Tuesday, May 15 @ 2-5pm in location TBA.

Suggestions for Success in CH301/302

I. Do the Work

II. Attend Class

III. Study BETTER, Not Just Longer

- Find your "best" time and place to study (not necessarily in Jester)
- Know what to study.
    - Hint: Print and refer to the learning objectives provided herein & on Blackboard. Use them as a checklist when studying. Note that some exam problems will cover more than one objective at a time, so think of ways that questions that could span multiple learning objectives. Think about how one learning objective relates to another—see the bigger picture.
    - Identify weak areas and then work on them. Do the problems in the Course Packet frontwards and backwards.
- Focus.
- Study at a higher level.
    - Study at the analysis and synthesis levels of questioning. Seek the answers to "why" and "how" as you study. Then try to stump your study partner by asking the same.

IV. Get Help

While you should certainly attempt problems first on your own, when you find that you cannot do them on your own, get help. Resources available to you include (and this is not a complete list):

- Instructor or TA office hours (shown earlier in this document)
- UT Chemistry tutorial website: http://www.chemprep.cm.utexas.edu/
- Free Tutoring by the ACS student group (inquire at WEL 2.212)
- Other chemistry textbooks, such as General Chemistry by Davis (free in Chem Library)
- Chemistry problem drills and tutorials (example terms to Google: Sapling, Owl, Khan Academy, Senese Chemistry)
- Academic Communities (Jester tutors)

Strategies for Success in CH301/302

If you want a C or higher in the class, you will need to

- Keep up to date on the readings,
- Complete the packet notes and practice questions; do all the homework problems at least once
- Be able to answer worksheet questions or other practice questions (without peeking at your notes or the textbook), and take solid notes.

You can improve your notes by

- Being an Active Learner. Resist "lazy brain" syndrome.
    - Come to class knowing what will be covered that day. Read ahead. Look at the learning objectives and assigned sections before each class. (This takes 5-7 minutes daily.)
    - During class, think about what is being said. When you're confused, make a note to spend more time on this topic after class (example: draw a little box next to the topic heading). Resist the urge to write every word; you'll take better notes (and write less feverishly) if you read ahead and get prepared before each class. (Junior and senior students will sometimes space their classes to have an hour between classes for this purpose.)
    - After class, review your notes, read the textbook, and add additional notes to your packet so that all of the relevant information is in one place—the packet.
    - Use the assignments to their fullest by working alone, in a quiet area, and during your "best" time of day. (Practice questions you can do with others, but leave some questions, such as the homework, for doing alone.)
- Knowing How To Read: Yes, there's a right and a wrong way to read. Don't read the chapter page-by-page, front to end. Study better, not longer. Instead, know what to watch for while you're reading: determined from the learning objectives, from ALEKS, and from class cues.

If you'd prefer a B in the class, you will need to do all of the above plus extra practice problems: our exams will include some problems you've never seen before.

- Form a study group to challenge and support one another.
- Work the problems in the packet frontwards and backwards. You can do homework problems that way, too.
- Work alone sometimes, as well, to do a self-check to ensure you know the material and can do it on your own.
- Review any topics that didn't come easy for you initially.
- Write your own study questions (or those for your study group). Don't be afraid of writing questions and don't worry if it takes you "forever" to write just two practice questions for your study partner; it takes time to look up information in the textbook, to pull the necessary numbers from the appendix, to check your understanding of this or that concept, etc. In all seriousness, when you have two people in a study group and one writes the questions while the other takes the practice test, the one who is more likely to do well on the exam is the question writer. So, if you want a B in the course, become the question writer.

If you're striving for an A in the course, do all of the above plus the strategies below.

- Take a moment to read the suggestions for a B in the course.
- Ask the key questions, which usually begin with "How…" and "Why…" (Example: Why is lattice energy calculated in this way? Why is *x* always true?)
- Utilize strategies of successful students including: the 15-min method, preview/review method, mark and return, and self-challenge. For more info on these, drop by office hours or contact me to set up a meeting to discuss strategies utilized by successful students.
- Self-challenge: The key here is to know yourself. It involves finding your weaknesses, then seeking ways to strengthen them. For example, if you know you're weak at conceptual questions involving multiple variables, then actively seek out more of those questions. (I can help. Just ask.) Essentially, the A student doesn't give up and skip a topic just because it's challenging; instead, she uses the weakness as a hint that her brain wants/needs to learn more. This technique is best done partly by oneself and partly with trusted friends. Only you truly know your weaknesses, but they can remain hidden until you chat about topics in study group or in casual conversation. So it is incredibly important to have friends and to discuss chemistry with friends, study group, and others—to discover weaknesses and to hone skills and understanding. No one has ever become truly great by themselves: greatness is always achieved with help.

I have written these study tips to help you understand what is necessary to make each letter grade. The grades in this class are earned, not given. There is no curve. For more information or clarification on any of these study tips or for a more personalized set of recommendations, please don't hesitate to contact me.

The following pages list the learning objectives for the course, beginning with a listing of prerequisite knowledge, or items that you should already know how to do. Please note that adjustments may be made during the semester: such adjustments will be announced in class.

Prerequisite Knowledge for CH301

Note: In most textbooks, these topics are in the first few chapters. In Atkins, most of these items are in the "Fundamentals" section.

These topics may be incorporated into ALL exams for CH301.

You should already be able to:

- Distinguish between pure substances and mixtures.
- Distinguish among compounds, elements, and mixtures.
- Identify a given property as chemical or physical in nature.
- Identify a given change as physical or chemical.
- Use scientific notation in calculations (with or without a calculator).
- Define and convert among different metric prefixes.
- Perform conversions between English and metric units (with or without a calculator).
- Apply the concept of density to word problems and/or calculations.
- Convert among temperature scales.
- Identify an element by either its name or symbol.

- Answer questions using exponential notation (aka scientific notation), logarithms, the quadratic equation, and/or significant figures. (see Appendix in textbook).

- Engage in and apply the scientific method to new situations.
- Recite and apply the Law of Conservation of Mass.
- Recite and apply the Law of Conservation of Energy and Mass.
- Recite and apply the Law of Definite Proportions.
- Recite and apply the Law of Multiple Proportions.
- Describe Dalton's Atomic Theory and its relevance to chemistry.
- Describe the nuclear atom.
- Describe the proton, neutron, and electron.
- Describe the lessons learned from the oil drop and gold foil experiments.
- Determine the atomic number, mass number, and number of neutrons for any given isotope.
- Discuss the relevance of electrons to chemical reactivity and stability.

- Describe the general attributes of the periodic table.
- Predict the most stable ion for any representative element.
- Distinguish between representative and transition elements; periods vs. groups; metals vs. nonmetals vs. metalloids.
- Recognize and describe general properties of the elemental families: alkali metals, alkaline earth metals, halogens, noble gases.
- List the elements that naturally occur as diatomics.
- Compare/contrast covalent bonds and ionic bonds.
- Classify a given bond as covalent, ionic, or metallic.
- Convert between chemical formula and chemical name for ionic compounds, binary molecules, acids, or bases (and including polyatomic ions).

- Perform calculations involving average atomic mass of an element.
- Apply the mole concept and value to a variety of calculations.
- Calculate molar mass or molecular weight and apply to a variety of calculations.
- Perform calculations based on molecular stoichiometry.

- Balance a chemical reaction.
- Apply the law of conservation of mass to a chemical reaction.
- Convert word problems to chemical reactions.
- Interpret chemical reactions and solve word problems or puzzles.
- Perform calculations based on reaction stoichiometry (including, but not limited to limiting reactants and percent yield).
    - Predict amount of product, given amount of one reactant.
    - Predict amount of product, given amount of multiple reactants.
    - Predict amount of one substance, given amount of another substance.
    - Determine the amount of reactants remaining at the end of a reaction
- Classify reactions by type.
- Predict products of given reactants (or predict no reaction will occur).

- Write ionic, complete ionic, and net ionic equations for a reaction. Identify spectator ions.
- List and recognize the strong acids and strong bases.
- Define acid and base, each, using the Arrhenius theory of acids and bases.
- Define acid and base, each, using the Bronsted-Lowry theory of acids and bases.
- Compare/contrast the Arrhenius and Bronsted-Lowry theories of acids and bases.
- Determine the oxidation number for any element, atom, or ion.

- Other objectives or content, as presented in class.
- Complete any variation or combinations or applications of these objectives.

Math

What follows are select mathematical skills you need to nurture in order to succeed in chemistry. You should be able to:

- Create a generalized graph, given an equation (linear or exponential, two variables).
- Discover patterns and fill in the missing item(s).
- Understand scale and change of scale.
- Understand relationships among variables in an equation and be able to create relationships among them.
- Understand relationships among variables in a graph (or in a data table) and be able to create relationships among them.
- Predict the effects of a change in one variable on another variable.
- Solve for x, y, or z, or any other symbol in a formula.
- Use deductive reasoning.
- Solve word problems.
- Interpret graphs.
- Interpret equations.
- Given a set of relationships, write the mathematical equation that summarizes the relationships.
- Handle monomials and binomial functions.
- Other objectives, as listed in the summer chemprep website.

Learning Objectives: Exam01

NOTE: The prerequisite knowledge learning objectives (previous pages) are included in ALL of the exams, so refer back to those, as well.

- Discuss the various definitions of pressure.
- Describe gases. List the common properties of gases.
- Explain how a manometer works. Explain how a barometer works.
- Convert units.
- Describe an ideal gas.
- Define and apply the Kinetic Molecular Theory of Gases. Discuss the limitationsof this theory.
- Describe the relationships among P, V, n, T, and MW for gases.
- Describe the assumptions and limitations behind the gas laws.
- Predict the effects of changing P, V, n, or T for gases.
- Recite the two forms of the ideal gas constant and know when to use each.
- Apply reaction stoichiometry to gases.
- Define STP and derive molar volume.
- Apply the gas laws to new situations.
- Describe and apply the relationships among velocity, kinetic energy, mass, and temperature.
- Apply density to gases.
- Define and apply partial pressure of a gas.
- Define mole fraction.
- Describe a real gas. Identify a real gas.
- Compare/contrast ideal and real gases.
- Define Temperature. Perform conversions.
- Describe molecular motion, effusion, and diffusion of gases.
- Given a list of molecules, determine which will effuse more quickly. Determine which will diffuse more quickly.
- Compare/contrast diffusion and effusion.
- Perform calculations, including but not limited to:
    - Single-system ideal gases
    - Two-system ideal gases
    - Chemical reactions involving gases (reaction stoichiometry)
    - Density and/or molecular weight
    - Molar volume
    - STP
    - Partial pressures and/or mixtures of gases
    - Real gases (van der Waal's equation)
    - Others, as mentioned in class
- Visualize gas molecules or atoms in motion
- (or vice versa on all)

Learning Objectives: Exam02

(2 pages)

Quantum

- Apply information from earlier chapters and lectures as needed.
- Draw, label, and describe an electromagnetic wave.
- Describe the various models of the atom.
- Describe notable experiments and discuss the information gained from them. (Ex. Photoelectric effect).
    - One variation: match experiment to new knowledge gained.
- Classify electromagnetic radiation.
- Compare/contrast various forms of e-m radiation. (Know names, order for increasing wavelength, ROYGBIV, etc.)
    - One variation: Given a list of types of light, identify the highest energy wave.
- Interpret $H\psi = E\psi$ and ψ^2
- Discuss the lessons learned from the particle in a box treatment.
- Relate ψ to orbitals. List the types of orbitals.
- Apply the Bohr atom and the Rydberg equation to solve calculation or puzzling questions.
- List, define, and describe the four quantum numbers.
- Answer puzzling questions regarding the quantum numbers.
- Determine the quantum numbers for any given electron.
- Apply the Aufbau principle to determine electronic configuration for any atom or ion.
    - One variation: Apply Hund's rule to determine electronic configuration to exceptions to the general rule.
    - Another variation: identify core vs. valence electrons
- Use Hund's rule and electronic configuration to identify an atom as paramagnetic or diamagnetic.
    - Define paramagnetic, diamagnetic.
- For a given group or family, identify is generic electronic configuration.
- Describe emission and absorption spectra, separately.
- Apply the Rydberg equation to spectra and solve related questions.
- Describe an orbital.
- Calculate and compare Zeff for given atoms.
- Define any term presented in the chapter.
- Apply electronic configuration, valence electrons, and Zeff to periodic trends and exceptions.
- Given a set of atoms or ions, rank according to a given periodic trend.
- Discuss the energy levels for a particle in a 1-D box.
- Perform calculations with (including, but not limited to)
    - $c = \lambda\nu$
    - $E = h\nu$
    - Rydberg equation (quantum jumps)
    - $\lambda\rho = h$
- Others, as stated in class.

(More on next page…)

Bonding

- Compare (or rank) substances per periodic trends.
- Explain periodic trends and exceptions to the trends.
- Identify a bond as covalent, polar covalent, or ionic.
- Explain bonding (what, when, why, how).
- Write the electron configuration for an atom or ion.
- Draw the Lewis structures of molecules, atoms, radicals, or ions.
- Draw the resonance structures for a molecule or polyatomic ion.
- Apply formal charges and S=N-A as needed.
- Predict and explain relative bond strength and lengths.
- Recite and recognize exceptions to the octet rule.
- Identify the type and number of bonds in a molecule.
- Explain the basis of the VSEPR model of bonding in terms of repulsions between electrons.
- Use the VSEPR model to predict the electron arrangement, shape, and bond angles of a molecule or polyatomic ion.
- Answer other puzzling questions.
- Other, as mentioned in class.

Learning Objectives: Exam03

(2 pages)

Polarity:

- Memorize the electronegativity values for the Row 2 elements
- Calculate the difference in electronegativity for a given bond
- Predict which bond is more strongly polar (or has strongest dipole moment).
- Relate bond polarity and bond strength
- Identify polar bonds and identify the partial charges.
- Compare or rank the relative lattice energies among a given set of ionic compounds.
- Predict the polar character of a molecule.
- Rank molecules according to polar character.
- Apply these concepts to real-world or hypothetical issues.

VB and MO Theories:

- Know all definitions and be able to apply that knowledge to new or familiar situations.

- Predict hybridization for the central atom given the elements involved, molecular formula, HED, Lewis structure, or VSEPR geometry. (or any variation thereof)
- Predict hybridization for each of the two atoms engaged in a covalent bond.
- Identify the relative percent character for orbitals of a given hybridization.
- Describe and draw a sigma bond.
- Describe and draw a pi bond.
- Relate sigma and pi bonds to single, double, or triple bonds.
    - One variation: identify the number of pi bonds in a molecule
    - Another variation: identify the strongest bond
    - (other variations exist; these above are given as examples)
- Use VB theory to predict bonding, shape, and bond angles in a molecule.
- Apply VB theory to molecules with multiple centers.
- Recite the limitations to VB theory.
- Identify the exceptions to hybridization given in class.

- Describe a molecular orbital.
- Use MO theory to predict bond order for two atoms engaged in a covalent bond.
- Use MO theory to estimate which bond is stronger and/or shorter.
- Use a MO ladder to identify the molecular orbitals used for homonuclear or heteronuclear bonds.
- Write an MO configuration for a bond.
- Determine bond order.
- Apply bond order to bond length and strength and bond stability.
- Explain the need for different “ladders” for different elements.
- Apply MO theory to paramagnetic and diamagnetic.
- Given two atoms engaged in a bond, identify the atom with the greater MO character.

- Use VB and MO theories to explain resonance.

- Identify IR active molecules and IR active modes of vibration.
- Answer questions given an IR spectrum.

Molarity

- Define molarity.
- Perform calculations involving molarity. (See course packet for variations.)
- Answer puzzling questions regarding molarity.
- Integrate molarity and reaction stoichiometry.

Review of High School Chemistry Topics

- Perform calculations involving molarity (continued from above).
- Merge molarity with reaction stoichiometry.
- Given information about chemical reactants, determine reaction type and predict products.
- Predict whether a given substance is water-soluble. (Solubility rules)
    - Variation: Predict whether a product will precipitate out of solution.
- Write the total ionic and net ionic equations for a reaction. Identify spectator ions.
- Determine whether a given substance is an electrolyte.
- Apply the above objectives to determine what is in a solution at the end of a reaction.
- Identify Arrhenius acids and bases and answer questions based on their reactions.
- *Identify Bronsted-Lowry acid/base pairs.*
- Identify strong acids and strong bases.

Intermolecular Forces

- Define and describe each intermolecular force (IMF).
- Rank intermolecular forces from strongest to weakest.
- Apply intermolecular forces to solids, liquids, and gases.
- Define the phase changes and know them by name (ex. sublimation, evaporation, etc.)
- Give an example of each intermolecular force.
- Determine, rank, and/or describe the various intermolecular forces for a given sample.
- Distinguish inter- and intra-molecular forces.
- Rank a list of substances in order of increasing attractive forces.
- Use IF to make predictions about a substance's chemical or physical properties.
    - Variation: Use intermolecular forces to explain boiling point and/or melting point trends.
- Determine the strongest IMF for a given substance.
- Rank a list of substances in order, according to boiling or melting points.
- Describe the process of dissolution. Describe a solution and its constituents.
- Relate intermolecular forces and dissolution (ex. use IMF to explain "like dissolves like").
- Apply IMF to explain given "real life" observation(s).
- Predict solubility or relative solubility of a given substance in a polar solvent.
- Predict solubility or relative solubility of a given substance in a nonpolar solvent.

Liquids and Solids

- Define and describe surface tension.
- Define and describe viscosity.
- Recognize the various types of solids.
- Define each type of solid.
- List characteristics of solids, liquids, and gases. (ex. compressible, etc.)
- Define band theory.

Others:

- Apply prior knowledge as needed.
- Perform calculations as needed.
- Other objectives as mentioned in class or from problems given in class.

Learning Objectives: Exam04

- Define various terms and apply those definitions to solve problems.
- Relate internal energy, work, and heat.
- State the first law of thermodynamics.
- Calculate the change in internal energy of a system due to heat and work.
- Calculate work, heat, and change in internal energy when an ideal gas undergoes an isothermal expansion.
- Use the magnitude and sign of w, q, or internal energy, to describe a system or its surroundings.
- Calculate specific heat.
- Interpret the heating curve of a substance.
- Interpret graphs covered in class.
    - Example: Determine which substance has the greater specific heat, given a graph.
- Determine the amount of heat required for a given change.
    - Example: Calc heat required to warm H_2O from -10°C to 110°C.
- Compare/contrast bomb and coffee cup calorimeters. Identify the value of each.
- Use calorimetry data to calculate energy changes.
- Write and interpret a thermochemical equation.
- Perform stoichiometry calculations with thermochemical equations.
- State and explain the implications of Hess' law.
- Define heat of reaction.
- Calculate enthalpy change in one of these ways:
    - Standard heats of formation, using standard states
    - Standard heats of formation, from given values either in tables or given in the problem
    - Sequential reactions, Hess' Law
    - Bond energies
    - Calorimetry
- Draw and interpret enthalpy diagrams.
- Distinguish between endothermic and exothermic reactions.
- Discuss the link between bond strength and the heat of reaction.
- Identify the standard state for a given substance.
- Identify state functions and explain their importance.
- Compare/contrast internal energy and enthalpy.
- Other challenging questions related to H,I,T,S, or G.
- Predict which of two systems has the greater entropy
- For a single system that undergoes a change, predict the sign of ΔS_{sys}.
- Calculate the entropy change for a given process from
    - Values from an absolute entropy table.
    - Temperature and dH data
    - Boltzmann equation
- Calculate a standard free energy of formation (ΔG) from
    - enthalpy (ΔH) and entropy (ΔS) data, or
    - tabulated values of standard molar free energies of formation.
- Determine the conditions for which a given reaction is spontaneous. Relate T and dG.
- Determine whether a reaction or process is spontaneous at a given temperature.
- Predict temperature range in which a reaction occurs spontaneously
- Discuss how changes in temperature can affect the spontaneity of a process.
- Recite and discuss the implications of the second and third laws of thermodynamics.
- Predict the sign of ΔG, ΔH, and/or ΔS for a given situation.
- Perform calculations using the Gibbs function.

The final exam will be comprehensive.

Grading Contract

I, _(print name)_____, have read and do understand the grading policies for this course as described in the course syllabus and in class. I further agree with the statements below and have placed my initials at each statement.

____ I understand that I am responsible for my grades. This means that I am responsible for checking the validity of my grades as reported online and to notify the instructor or TA of any invalid score within 5 business days of the grade posting. This also means that I am responsible for preparing for and performing at the level needed to earn the grade I need or desire. I acknowledge that I cannot and will not be awarded a grade that does not match my performance.

____ I understand that my course grade is awarded in accordance to the syllabus. I understand that class attendance does not guarantee a passing grade. I understand that grades depend on points earned and that I must earn sufficient points for the grade I desire.

____ With regard to avoiding an F grade, I understand that if I have failing grades on my record during the drop period, then I am encouraged to drop this course and thereby avoid a score of F on my transcript. If I do not drop the course but then continue to earn failing grades or obtain a failing score at the end of the semester, then I will earn a grade of F in the course.

____ I understand that I can check my scores online and calculate my grade at any time and, if in doubt about my overall grade in the class, I can contact my instructor during office hours for help with the grade calculation.

____ I understand that bonus points will be awarded in this class. I recognize that these bonus points will be calculated as described in the syllabus. I further understand that asking for additional bonus points for my own use would be a breach of contract and would give me an unfair advantage above my peers.

____ I understand that I am allowed to drop one score, in accordance with the syllabus. I recognize that this option is due to the fact that no make-up exams are offered. I recognize that this function is for my benefit, to be used in case of emergency, and should not be used frivolously.

____ I understand that I am responsible for keeping the paper copy of all exams and other paper-based work until the end of the semester. I understand that I may be asked to show the paper copy at any time during the semester or during a grading reevaluation.

____ I agree to follow my instructor's Exam Policies and I agree to follow UT's policies on scholastic dishonesty, including those on cheating and plagiarism. I understand that action against any of these policies is basis for forfeiture of my grade.

Signed by _____ *on Date* _____

*UTEID:*_____

Student Copy

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Sign and Return to Instructor