

Chemistry 141 – General Chemistry
Spring 2018

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Office Hours: I am usually in my office by 9:30 A.M. and stay at least until 5:00. Please feel free to stop by for help at any time. If you can't find me in my office, please check my lab, C-205. If I cannot help you immediately, I will make an appointment for you to come by later, on the same day if possible. If I am not in my office you can reach me by e-mail or by phone for an appointment. E-mail is generally the best way to reach me.

In addition to office hours I will be holding weekly problem sessions. We will arrange the time and day for the review sessions toward the beginning of the semester.

In addition to my office hours and problem sessions, we will have twice weekly peer tutoring sessions. These sessions will be Tuesday and Thursday from 7:00 P.M. to 8:30 P.M. They will be in Gottwald C-114.

Required Texts: John E. McMurry, Robert C. Fay, Jill K. Robinson "Chemistry", Seventh Edition, Prentice Hall, 2016. In order to give you the opportunity to save some money on your text, I will also allow students to use the 6th edition. Note that the problem numbers and chapter numbers are not the same for the 6th and 7th editions. In addition, please note that we will not be using Mastering Chemistry, so please do not spend the money to purchase it.

University of Richmond Lab Manual for General Chemistry, 2017-18

Welcome to Chem 141

You may be taking this course for a number of reasons – to satisfy a general education requirement, as a requirement for your major, or perhaps as a prerequisite for another course. Whatever the reason you chose, welcome. I hope that at the end of this semester you will end up as excited as I was when I first took college chemistry.

In the next few pages, I'll be outlining the plans and expectations for the course, the grading scheme, and some hints to help you succeed.

Course Goal: To facilitate, for each student, the development of reliable knowledge and solid appreciation of the fundamentals of chemistry – its inspired and time tested concepts and principles, impressive applications, and its historical and contemporary role in our world.

Specific Objectives:

To cover the fundamentals of chemistry in a way that will:

- i) Enable students majoring in the sciences to progress to higher level courses with a solid foundation in chemistry
- ii) Provide the knowledge and language needed for non-majors to improve their understanding of the nature of science and its place in modern society
- iii) (for the laboratory portion of the course, taught by a different instructor) demonstrate, in hands-on laboratory exercises, connections between theoretical ideas in chemistry and practical applications

Grading:

Grading will be based on problem sets, tests, your lab grade, your grade on the double entry notebook, and the final exam. The percentages for each activity are:

Problem Sets	10%
Double Entry Notebook	5%
Tests	40%
Lab Grade	25%
Final Exam	20%

The problem sets, double entry notebooks and tests are described further below.

Attendance Policy:

You are responsible for class attendance. I will not be taking attendance once I have learned all of your names, so there will be no grade penalty for missing class. However, if you choose to miss class you are still responsible for all material covered, and any and all announcements, including changes in the class schedule, test dates and assignments. In addition, students who miss class regularly tend to perform much more poorly than students who attend all classes, so it's in your best interest to attend. Note that this class is scheduled to meet for 60 minutes each session, not 50 minutes.

Course Materials: The syllabus and any other course materials that I post will be available on my webpage, www.richmond.edu/~sabrash. Look for the heading "Chem 141"

Assignments and Suggestions for Success in this Course:

First, a warning! This course will move extremely fast, especially in the first third of the semester. It is crucially important that you keep up with readings and

homework, or you will find the class unnecessarily difficult. So with that gentle warning, here is a suggestion on how best to study and learn the material for this course.

First, make sure that you read the text. It is best to read the text before the class in which we discuss the material. You will know in advance which material we will be covering because it is given in the tentative lecture schedule below (which actually is not very tentative.)

Once you've read a given section, write your summary and responses for your double entry notebook. This will help you understand the material, and give you a chance to see what you have questions about.

The double entry notebooks, which will constitute 5% of your semester grade, are an exercise that has been proven to increase depth and retention of knowledge. The assignment is to take a bound notebook, or a word file, and divide each page into two columns. Label the left hand column "Summary" and the right hand column "Responses". After you read each assigned section (i.e., Section 1.1 in your text) write a brief, 3-4 sentence paragraph summarizing the content of the section in the left hand column of the page. The paragraph should not be notes, nor bullet points, but written in clear English sentences, and should be labeled with the section number you are summarizing. Note that if the syllabus says to read Chapter One, it does not mean that you should do a single summary for the whole chapter. Rather, you should do a summary for each section in the chapter, 1.1, 1.2, etc.

In the right hand column you should write a brief response. A response is anything that the section made you think of. It might be a note to yourself that you don't completely understand the section. It may be that it reminds you of something you learned in another course or read elsewhere. Or it may be your speculation on some logical (or fantastic) consequence of the material. Anything goes in this section (up to a point). However, note that this section is NOT for additional notes or summary material.

In order to get a grade of B or higher on the notebook, summaries must be completed for all of the sections that are assigned for your reading. It is not necessary to have a response for every section, but an A notebook will have responses for about 2/3 of the sections. Again, a notebook that does not have summaries for all of the sections can earn no higher than a B-.

Second, after class, review your notes, and in addition, reread those chapter sections that you feel you need to understand more deeply. If your notes are unclear or poorly organized, rewrite them so that they are clear and correct. This has the dual purpose of clarifying the concepts in your minds and providing you with better study tools when you approach tests and the final.

Third, I will be assigning large numbers of ungraded homework problems (see below). The purpose of these problems is to allow you to learn how to solve chemistry problems. There will be one set for each chapter we study. While you do not need to do all of them, you should do enough of them that you are confident that you have mastered each type of problem. I suggest that you proceed as follows: after studying a given chapter of the book, try a problem. Try to do this problem without referring to the book (except for constants and other data not included in the problem). If you can do it, find another problem of the same type, and do it, and repeat this until you are able to do three such problems in a row without referring to the book. If you are unable to do a problem without referring to the book, feel free to find an example that you can follow, but do not stop working on that type of problem until you have completed three in a row without referring to the book. Then move on to the next type of problem.

Many pedagogical studies have shown the benefit of group work in learning chemistry and other quantitative subjects. As such I strongly suggest that you work on the reading and the ungraded problems in groups of 3-5 students. Please note that the double entry notebook must be an individual effort, and cannot be the fruit of a collaboration.

Fourth, I will be assigning graded problem sets for each chapter. These problem sets will either be online problem sets on the blackboard site, or be exercises to be completed and handed in on paper. The graded homework assignments will count as 10% of your final grade. You should complete these without the help of your book or other students. Problem Sets will be posted after class each Friday. They are due no later than the end of class on the following Wednesday.

If you follow these four steps faithfully, you should be well prepared for the tests and the final exam. The tests and final will have a combination of problems similar to those on the graded and ungraded homework sets, and problems in which you will have to explain concepts covered in the text and lecture. For this reason, preparation requires mastering both the problems and a deep verbal understanding of the material.

There will be three tests and a final exam. The tests, while cumulative because of the nature of chemistry, will focus on the material that was covered during the relevant third of the semester. The final exam will be cumulative. The dates for the tests will be February 9th, March 21st, and April 23rd, and the date for the final exam will be Monday, April 30th from 9:00 A.M. to Noon. You may also self-schedule the Final Exam for either 9:00 A.M. or 2:00 P.M. on any date between Monday, April 30th, and Friday, May 4th.

Date	Chapter	Topic
		Atoms, Molecules and Chemical Reactions; Introductory Concepts in Thermodynamics
Jan 17, 19, 22	Ch. 1.1- 1.11	Introduction – The Periodic Table i. Chemistry Defined and The Periodic Table ii. Properties of Matter- Chemical/Physical; Extensive/Intensive iii. Measurements and Units (read Sec. 1:12-13)
	Ch. 2.1- 2.12	The Periodic Table, Atoms, Molecules and Ions i. Atomism and Dalton’s Theory ii. Structure of the Atom; Isotopes; Atomic Number; Mass Number; Atomic Symbols iii. The Periodic Table – Ordering elements by properties iv. Molecules and Compounds (Molecular and Ionic) v. Naming Simple Compounds
Jan 24, 26, 29	Ch. 3.1- 3.8	The Mole and Chemical Equations i. (Relative) Atomic Mass, Molecular Mass, Molar Mass ii. Mass Percentages iii. Empirical and Molecular Formulas iv. Writing Equations for Chemical Reactions - Balanced Equations: Logic of Stoichiometry (Mass Conservation)
	Ch. 4.1 – 4.11	Stoichiometry and Chemical Reactions i. Limiting reagents and percentage yield ii. Concentration of solutions; - Dilution; Calculating New Concentrations iii. Reactions in aqueous solutions - Titrations explained with examples iv. Some classes of Chemical Reactions: - Precipitation Reactions: - Solubility rules for ionic compounds - Molecular, Ionic and Net Ionic Equations - Acid-Base Rxns.: Strong/Weak Acids/Bases - Oxidation/Reduction Rxns.: Concept, Simple Examples - Trends in oxidation/reduction tendency across the periodic table (oxidation preferences of metals vs. non-metals)
Jan 31, Feb 2, 5	Ch. 9.1- 9.10	Thermodynamics

		<ul style="list-style-type: none"> i. Concepts and Definitions: energy, heat, open, closed, isolated systems, exothermic, endothermic, state and state function ii. The First Law of Thermodynamics iii. Work and Heat iv. Enthalpy v. Calorimetry vi. Enthalpies of Formation and estimating Enthalpies of Reaction
Feb 9		Test One
		Electronic Structure Periodicity and Bonding
Feb 7, 12	Ch. 5.1-5.8	Electronic Structure of Atoms <ul style="list-style-type: none"> i. The Electromagnetic Spectrum: wavelength, frequency, energy ii. The Origin of Atomic Spectra iii. Bohr Model (and the Balmer-Rydberg Equation) iv. Dual Nature of the Electron v. Uncertainty Principle vi. Quantum Numbers and Orbital Representations
Feb 14	Ch. 5.9-5.13	Electron Configuration <ul style="list-style-type: none"> i. Pauli Exclusion Principle ii. Hund's Rule (Aufbau Principle) iii. Outer(or Valence)-shell electrons: (as the prime players in bonding) iv. Periodicity as a consequence of atomic charge and electronic configuration
Feb 16, 19	Ch. 5.14; 6.1-6.5; 7.3	Electronic Configuration and Periodic Trends <ul style="list-style-type: none"> i. Atomic and Ionic Size ii. Ionization Energy iii. Electron Affinity iv. Electronegativity
Feb 21, 23, 26	Ch. 6.6-6.8; Ch. 7.1-7.10	Bonding <ul style="list-style-type: none"> i. Introduction to Bonding: <ul style="list-style-type: none"> - metallic - ionic - covalent ii. Lewis Dot Diagrams – representing simple molecules <ul style="list-style-type: none"> - Multiple Bonding (σ and π bonds); lone pairs iii. Formal Charges iv. Resonance

		v. Exceptions to the Octet Rule vi. Bond Enthalpy
Feb 28, Mar 2, 5	Ch. 8.1-8.5	Molecular Geometry and Bonding Theories i. Shape of Simple Molecules; VSEPR Theory ii. Hybridization; Hybrid Orbitals; Valence Bond Theory iii. Molecular Orbital Theory - MO diagrams (homo- and heteronuclear diatomic molecules) - HOMO and LUMO
Mar 7	8.7-8.9	iii. Molecular Orbital Theory - MO diagrams (homo- and heteronuclear diatomic molecules) - HOMO and LUMO
Mar 9	Ch. 8.6	Non-Covalent Bonding Interactions i. Hydrogen Bonding ii. Van der Waals Interactions
Mar 10-18		Spring Break
Mar 21		Test Two
		Kinetics, Thermodynamics and Equilibrium
Mar 19, 23	Ch. 13.1-13.2	Chemical Kinetics i. Rate of Reaction - Overall rate of reaction; rate of formation (consumption) of products (reactants) - Obtaining (concentration vs. time) data for reaction rate graphs - The role of temperature, concentration and catalysts on rxn
Mar 26, 28, 20, Apr 2	Ch. 13.3-13.14	Chemical Kinetics, cont'd ii. Rate Laws – (Orders for Reactants and Overall Reaction) iii. Integrated Rate Laws - First Order Reactions - Second Order Reactions - Zero Order Reactions iv. Temperature Dependence of Reaction Rates - Arrhenius Equation (Experimental Determination of E_a and A) v. Reaction Mechanisms

		vi. Catalysis – Inhibition (Homeogeneous and Heterogeneous Catalysis)
Apr 4, 6, 9	Ch. 14.1-14.10	Chemical Equilibrium 1. Concepts i. Equilibrium constant ii. Connection between Chemical Kinetics and Equilibrium iii. Influencing Equilibrium - Le Chatelier's Principle - Changes in Concentration, Volume, Pressure, Temperature, Catalysis
Apr 11, 13, 16	Ch. 15.1-15.15	Chemical Equilibrium 2. Acids and Bases i. Brønsted-Lowry Definition of Acids and Bases - Inorganic (hydrohalic or oxo-) Acids and Organic Acids - Mono-, Di-, and Polyprotic Acids ii. Acid-Base Properties of Water iii. pH as a Measure of Acidity iv. Strong and Weak Acids and Bases - Ionization Constants
	Ch. 16.1-16.10	Chemical Equilibrium 3. Acid-Base Equilibria i. Common Ion Effect ii. Buffer Solutions iii. Acid-Base Titrations and Indicators
Apr 23		Test 3
Apr 18, 20, 25, 27	Ch. 9.12-9.13, 17.1-17.11	Thermodynamics, Spontaneity and Equilibria v. Calorimetry vi. Heats of Formation and Estimating Heats of Reaction vii. Spontaneity - Entropy viii. The Second Law of Thermodynamics - Entropy Changes ix. Gibbs Free Energy x. Free Energy and Equilibrium
April 30th		Final Exam

		9:00 A.M. to 12:00 Noon 4/30, or self scheduled at either 9:00 A.M. or 2:00 P.M. Between Apr 30th and May 4th.
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Honor Code

The Richmond College and Westhampton College Honor Codes are very special and have the full support of this department. You will be expected to sign an honor pledge on each test We expect that behavior in this class will be consistent with this code. However, collaboration on homework is allowed and encouraged.

Ungraded Problem Sets:

Remember, the purpose of these problems is to give you a chance to learn the material before working on graded homeworks and before the tests. You do not have to do ALL of these problems, but you should do enough that you are confident of your ability to solve each type of problem without referring to the book. (If you can solve three problems in a row of a given type without referring to the book, then you have solid evidence that you have mastered the problem. Reading someone else’s solution and saying “Oh, I get it”, is not convincing evidence.)

Ungraded Problem Sets for the 7th Edition:

Chapter	Problems
1.	28, 29, 30, 31, 33, 35, 37, 38, 39, 41, 42, 43, 44, 45, 47, 48, 49, 52, 54, 56, 57, 58, 59, 60, 61, 62, 71, 80, 81, 82, 83, 84, 85, 88, 89, 90, 91, 92, 94, 96, 97, 100, 103, 105
2.	36, 37, 41, 42, 46, 47, 48, 49, 52, 54, 55, 56, 57, 58, 59, 60, 64, 65, 67, 70, 71, 76, 77, 80, 81, 93, 94, 96, 100, 101, 105, 108, 116, 119, 121, 122, 123, 124, 130, 134, 136, 141, 144, 146, 148, 151, 160, 161, 162
3.	30, 31, 33, 38, 42, 44, 46, 47, 48, 49, 50, 52, 54, 56, 58, 60, 62, 64, 66, 67, 68, 70, 72, 74, 76, 78, 82, 86
4.	38, 41, 43, 47, 50, 54, 56, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 82, 83, 84, 85, 86, 88, 90, 91, 96, 98, 100, 101, 102, 103, 106, 107, 112, 117, 124, 133, 134, 138, 141, 150, 157
5.	26, 29, 30, 31, 34, 36, 40, 42, 44, 46, 48, 50, 54, 55, 60, 62, 64, 67, 68, 69, 70, 74, 76, 84, 86, 89, 91, 92, 98, 104, 105, 106, 108, 109, 110, 111, 130, 134, 136,
6.	26, 27, 32, 34, 37, 40, 44, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 64, 65, 66, 68, 69, 70, 71, 86, 88, 90, 92
7.	40, 42, 44, 45, 46, 47, 48, 52, 54, 60, 61, 64, 65, 66, 67, 69, 70, 72, 74, 78, 80, 81, 84, 86, 88, 90, 92, 94, 95, 96, 97, 99, 101
8.	31, 35, 42, 43, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 63, 64, 65, 67, 70, 71, 72, 73, 75, 76, 77, 80, 83, 86, 88, 89, 90, 91, 92, 93, 94, 95, 98, 99, 105, 109, 113, 114, 115, 116, 118,
9.	37, 38, 40, 46, 48, 53, 54, 55, 60, 64, 65, 66, 71, 72, 73, 74, 75, 78, 80, 81, 82, 89, 94, 95, 99, 106, 112, 114, 115, 116, 117, 119, 122, 124, 125, 126, 131, 136
13.	46, 48, 52, 56, 57, 58, 60, 62, 63, 64, 67, 68, 69, 71, 74, 76, 78, 82, 84, 86, 87, 88, 89, 92, 96, 98, 100, 102, 107, 108, 117, 118, 120, 125, 127
14.	41, 42, 52, 54, 56, 58, 62, 66, 67, 70, 74, 77, 84, 85, 89, 91, 93, 96, 97, 98, 99, 100, 101, 102, 104, 106, 107, 108, 111, 116, 118, 128, 133, 135, 140, 150
15.	37, 39, 46, 47, 48, 50, 52, 53, 54, 56, 58, 60, 64, 65, 66, 67, 70, 71, 72, 74, 75, 76, 78, 82, 84, 88, 90, 91, 95, 97, 98, 102, 103, 104, 106, 108, 110, 112, 113, 114, 116, 120, 124, 126, 132
16.	42, 46, 47, 48, 49, 54, 55, 58, 59, 60, 62, 66, 67, 70, 71, 72, 74, 78, 79, 80, 81, 82, 84, 89, 90, 94, 95, 96, 98, 99, 100, 101, 104, 105, 106, 107, 108, 109, 110, 111, 116, 118, 119, 122, 124, 126, 127, 134, 146

17.	30, 31, 33, 42, 44, 47, 49, 54, 56, 59, 62, 64, 66, 68, 72, 74, 78, 80, 82, 84, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 100, 101, 102, 106, 107, 109, 110, 112, 113, 115, 116, 118, 120, 135, 140
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Ungraded Problem Sets for the 6th Edition:

Chapter	Problems
1.	3, 4, 5, 8, 9, 10, 14, 18, 19, 22, 28, 29, 32, 33, 34, 36, 42, 43, 46, 49, 52, 54, 58, 60, 62, 64, 66, 67, 69, 70, 72, 74, 78, 80, 83, 84, 86, 87, 89, 90, 91, 93, 99, 106, 108
2.	32, 33, 34, 35, 36, 38, 39, 42, 44, 46, 49, 50, 51, 55, 56, 60, 64, 65, 69, 70, 75, 76, 77, 79, 80, 82, 83, 84, 88, 91, 92, 93, 94, 100, 102, 103, 105, 107, 110, 112, 115, 124, 125, 128
3.	30, 32, 33, 35, 40, 44, 46, 48, 49, 50, 51, 52, 54, 56, 58, 60, 62, 64, 66, 68, 69, 70, 72, 74, 76, 78, 80, 86, 90, 92, 96, 98, 100, 102, 132
4.	26, 27, 31, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 53, 54, 55, 56, 58, 60, 61, 62, 64, 66, 67, 68, 69, 72, 73, 76, 81, 84, 86, 88, 90, 92, 100, 104, 106, 110, 113, 129
5.	23, 26, 27, 28, 29, 32, 34, 38, 40, 42, 44, 48, 50, 52, 54, 56, 58, 60, 62, 63, 64, 66, 71, 73, 74, 80, 82, 86, 87, 88, 91, 112, 116, 118
6.	22, 26, 30, 31, 33, 36, 38, 50, 51, 54, 55, 56, 74, 75, 76, 77, 78, 84, 86, 88, 90, 94, 96, 105
7.	32, 35, 38, 40, 42, 43, 44, 45, 46, 48, 50, 52, 55, 56, 57, 58, 60, 62, 64, 66, 68, 70, 72, 76, 77, 78, 80, 82, 84, 86, 88, 90, 92, 94, 95, 96, 97, 98, 99, 101, 102, 103, 110, 111, 118, 123, 124, 132, 133, 135
8.	33, 34, 36, 40, 42, 47, 48, 49, 52, 54, 56, 57, 58, 61, 62, 63, 64, 65, 66, 67, 68, 69, 72, 73, 78, 79, 79, 83, 88, 91, 92, 94, 95, 96, 97, 99, 102, 104, 105, 106, 113, 122
12.	30, 32, 34, 38, 39, 40, 42, 44, 45, 46, 48, 49, 50, 51, 53, 56, 58, 60, 64, 70, 72, 74, 78, 80, 82, 84, 86, 88, 90, 91, 92, 93, 99, 100, 104, 105, 107, 112, 114, 130
13.	28, 29, 40, 42, 44, 48, 49, 50, 52, 56, 58, 60, 62, 63, 70, 72, 74, 78, 79, 80, 81, 82, 83, 84, 86, 88, 89, 90, 94, 96, 102, 104, 110, 115, 117, 122, 130
14.	34, 36, 44, 45, 46, 48, 50, 51, 52, 60, 62, 63, 64 (a, c), 66, 68a, 70, 72a, 74, 75, 77, 82, 84, 86, 88, 90, 91, 92, 94, 96, 98, 100, 102, 106, 108, 114,
15.	34, 42, 43, 44, 45, 48, 49, 52, 53, 54, 56, 60, 61, 64, 65, 66, 68, 70, 71, 72, 73, 74, 76, 80, 81, 86, 122, 134
16	21, 22, 24, 32, 34, 37, 39, 44, 50, 52, 54, 60, 62, 68, 70, 74, 75, 77, 78, 88, 92, 93, 95, 96, 101, 102, 104, 106 (a), 120, 125