Introductory Chemistry

Web Site: https://www.amherst.edu/academiclife/departments/courses/1011F/CHEM/CHEM-11-1011F

Instructors:

Sheila Jaswal	Karena McKinney	Richmond Ampiah-Bonney
504 Merrill	517 Merrill	431 Merrill
phone ext. 5153	phone ext. 5137	phone ext. 2148
office hrs: Mon. 8 – 10pm	**office hrs: Mon. & Fri. 11 – 12**	**office hrs: Tues. 3 – 5pm**
sjaswal@amherst.edu	**kamckinney@amherst.edu**	**rampiahbonney@amherst.edu**

Lecture TA: Casey Silver (csilver12@amherst.edu) will provide additional support to the students in this class by attending lectures and offering regular evening review sessions Tuesdays from 8 – 10 PM in Merrill 315 and, on quiz weeks only, Sundays from 3 - 5 PM in Merrill 315. Other extra help or pre-test review sessions will be offered as needed.

Textbook: Steven S. Zumdahl, **Chemical Principles, 6th ed.** (Houghton Mifflin Co., Boston, MA, 2001). This edition of Zumdahl will be used in Chem 11 and Chem 12. It is available from Amherst Books and copies are on reserve in the Science Library.

Lectures: All students will meet together for lectures in Merrill Lecture Room 2 on Monday, Wednesday, and Friday at 10:00 A.M. Please remember that you are participants during these hours. You are expected to attend every lecture. A passive attitude towards the material hinders your achievement of the goals of this course. Thus your attendance and willingness to enter into class discussions are an important factor in the evaluation of your work and assignment of your grade in Chemistry 11.

Monday Discussion Meetings: We will meet in smaller groups on Monday afternoon at 1, 2, or 3 o'clock. These meetings will be used to work problems in small groups, give quizzes and answer any questions that you may have regarding lectures, lab work, reading assignments and homework. Note that since we will follow the Monday class schedule on the first day our class meets (Wednesday, September 8), we will have discussion **TODAY**!

Section 1 Discussion:	Monday, 1:00 PM.	Merrill 401
Section 2 Discussion:	Monday, 2:00 PM.	Merrill 401
Section 3 Discussion:	Monday, 2:00 PM.	Merrill 403
Section 4 Discussion:	Monday, 1:00 PM.	Merrill 403
Section 5 Discussion:	Monday, 3:00 PM.	Merrill 401

Laboratories: There will be no lab meetings this week. Laboratory meetings will start on Tuesday, September 14th (the second week of class).

Section 1 Lab:	Tuesday, 8:00 AM	Merrill 425
Section 2 Lab:	Tuesday, 2:00 PM	Merrill 425
Section 3 Lab:	Wednesday, 2:00 PM	Merrill 425
Section 4 Lab:	Thursday, 2:00 PM	Merrill 425
Section 5 Lab:	Friday, 1:00 PM	Merrill 425

You must attend the laboratory session for which you are registered. Prior preparation for the weekly laboratory session is important for gaining an appreciation of the experimental method and of the

relationship between laboratory experimentation and theoretical principles. The answers to pre-lab questions must be turned in at the beginning of the laboratory period for each new experiment. Each laboratory session will begin with a brief pre-lab discussion to introduce the concepts and technical details of the experiments to be done, and thus on-time arrival in the laboratory is essential. Lab reports, many of which are written up in class, will be handed in for each experiment. Since laboratory experience is essential to one's education in chemistry, no student can expect to receive a passing grade in the course unless all laboratory work is completed and handed in.

Laboratory Materials:

1. Laboratory Manual: You will receive a laboratory manual with experiment descriptions and instructions and a laboratory notebook with duplicate graph-ruled pages. These will be distributed in lab the first week. Please do not lose them! You will be charged $12.36 on your term bill for the notebook.
2. Safety goggles are essential in the lab. You will be issued a set at the time you check into the lab. You are responsible for wearing lab goggles **at all times**. Proper laboratory attire is required at all times; sneakers, jeans, and T-shirts are good representative laboratory attire. Sandals, flip-flops, and Croc-type shoes are not acceptable footwear in the laboratory. Exposed feet, legs, hips, abdomens, or backs are also not appropriate.

The chemistry stockroom, in Merrill 400, is run by Dr. Kristi Ohr.

Course Materials: Class handouts will normally be found at the rear of Merrill 2, where you enter. Handouts will also be posted on the course website. Extra copies of these handouts are kept in the Chemistry office, Merrill 507. The department office is open Monday through Friday from 8:00 A.M. until 4:00 P.M. Ms. Stillerman will be able to help you find what you need. Handouts, homework assignments and practice exams with answers will be available electronically on the course website. Note that after the first week, homework assignments will NOT be handed out in class but instead will be posted on the course website.

Exams and Quizzes: There will be two two-hour evening exams. A third three-hour exam, which is cumulative, will be scheduled during the final examination period. There will be five quizzes, each worth 25 points. The lowest quiz grade will be dropped. The sum of the remaining quizzes is worth the same as one exam. The quizzes will last 25 minutes, and will be given at the beginning of the discussion meeting. Review sessions will be scheduled before each exam.

The quiz and exam schedule is as follows:

Quiz 1:	Monday, Sept. 20
Quiz 2:	Monday, Oct. 4
Exam 1:	Thursday, Oct. 14, 7:00 pm, Merrill 1
Quiz 3:	Monday, Oct. 25
Quiz 4:	Monday, Nov. 8
Exam 2:	Thursday, Nov. 18, 7:00 pm, Merrill 1
Quiz 5:	Monday, Dec. 6
Exam 3:	Finals week

Problem Sets: Each week you will be given an assignment consisting of a number of problems from your text and, usually, a challenge problem. The challenge problems are designed to be similar to those you can expect on the exams. They are usually written by us and are not from the book. Look at these as an opportunity to learn to answer the type of questions you will be given on the exams and quizzes. As a

new assignment will be given out each week, you will find it important to start them as soon as possible and hand them in on time. Assignments will include the week's reading, which will then be broken down into individual reading assignments for each lecture. Typically, homework will be posted on Blackboard on Wednesday and be due the following Wednesday at the beginning of class. Answers will be posted on Blackboard the Friday after the problem sets are turned in. Your problem sets will be reviewed by the staff, graded and returned in a timely manner. Problem sets will be graded on a 5 point scale as follows: >80% correct = 5, 60%-80% correct = 4, 40%- 60% correct = 3, not handed in = 0. Late problem sets will not be graded and will be awarded a maximum of 2 points at the discretion of the instructors.

Class Participation: Active learning in a large lecture setting like ours is best supported by encouraging pre-class preparation, in-class engagement, and frequent post-class feedback on student understanding. We have therefore put in place some mechanisms that formalize these strategies by assigning reading for each lecture and taking 2 minutes to assess comprehension at the end of each class.

Readings from your textbook will form the basis for your learning in Chemistry 11. Our goal in lecture is to clarify challenging concepts from the reading and to help you become adept in using these concepts. Lectures will not be a regurgitation of material from the textbook. Therefore, it is extremely important that you read and digest the material assigned from your textbook BEFORE each lecture. We will then use the reading as a starting point for our day's work. In order to facilitate this process, reading will be assigned before each lecture, and you will be asked to formulate and record a question on the reading. During class, keep your question in mind, and if your question isn't addressed, ask it!

We will end lecture 2 minutes before the end of class, and you will be asked to summarize the main point of that day's lecture, and to tell us what you remain confused about. You should come to each lecture with your question on the reading recorded on a sheet of paper, with your name, section number, and the date at the top. At the end of class, add your brief summary of the lecture's main point, and at least one question you still have about the material. We will collect these at the end of the lecture and use them to assess the assimilation of concepts by the class and address any mass confusion in the next lecture. Here is an example:

Johnny Neutron, Section 1 9/10/10

1. Reading: *For Dalton's Law of Multiple Proportions, does it matter which of the two elements you define to be the first or second or can you arbitrarily choose?*
2. Lecture Summary: *Careful measurements of masses of components of compounds and series of compounds with the same components allowed Dalton to propose the existence of atoms.*
3. Lecture Question: *What was so important about Avogadro's hypothesis?*

Each sheet you turn in will be recorded and count towards the class participation portion of your overall grade. To earn full credit, you must turn in at least one of these check sheets per week. However, you may turn in more if you like. Keep in mind that this is not just a gimmick to make sure you are keeping up with the reading. It is one of several ways that we gauge the 'temperature' and overall understanding of the class so that we may adjust our teaching to best serve your needs. Your feedback is extremely valuable to us as teachers. In addition to points awarded for completing the check-up sheets, some class participation points are also awarded at the discretion of the instructors.

Discussion Blog: We will also create and maintain a discussion blog on the course website. You may post any course-related questions on the blog, and we and the TAs will endeavor to answer them. In

addition, you are welcome to answer questions posed by your classmates. The goal of the blog is to foster ongoing discussion about the concepts we are learning in class. It is optional, but the more of you that actively participate, the better it works. You are also free to send questions to any one of us via email and we will answer you directly. If we think the question is of general interest, we may post it (anonymously) to the discussion blog and answer it there as well. For both email and blog questions, please note that we may not be available to answer questions at night or on weekends. On the other hand, if you have a burning question after hours, the blog is a good resource to check as your question may have already been answered.

Grading: Your final grade will be determined as follows:

Each exam: 17.5% (including the cumulative final exam)
Quiz total: 17.5% (remember, the lowest is dropped)
Problem sets: 15%
Lab reports: 10%
Class participation: 5%

Classroom Expectations: Cell phones are to be turned off and put away during lecture, discussion, and lab. Laptop use is permitted only by permission of the instructors.

Intellectual Responsibility: Students enrolled in Chemistry 11 are expected to abide by the Amherst College Statement of Intellectual Responsibility (http://www.amherst.edu/academiclife/dean_faculty/fph/policies/sir). Particular attention should be paid to the statement, "…the College considers it a violation of intellectual responsibility to submit work that is not one's own or otherwise to subvert the conditions under which academic work is performed by oneself or by others." The specific implications of this statement for Chemistry 11 are:

1. Laboratory Work: Experiments are done with a partner, and you are encouraged to discuss experimental design and interpretation with your classmates. However, the data you record and the written reports you submit, including answers to the questions posed in the laboratory manual, must be your own. You will not receive credit for a lab report identical to that of your lab partner or another student. Copying of the lab procedure or other students' lab reports, or using data that does not appear in your own lab notebook, constitutes a violation of the statement of intellectual responsibility. If you have collaborated in obtaining data or discussed the results of an experiment, you must acknowledge the collaboration in the report, generally by listing the name(s) of your lab partner(s) in your laboratory notebook and on any written report. Similarly, if you have used data other than your own, the source of the data should be indicated.
2. Problem Sets: You are encouraged to discuss the problems with your classmates. However, when your discussions are over, you are expected to be able to work through all problems by yourself. Thus, the work that is submitted should represent your mastery of the problems. You will not receive credit for a problem set identical to that of another student.
3. Exams and Quizzes: Giving or receiving assistance of any kind during an exam or quiz is dishonest. All work submitted must be your own. This applies to both regularly-scheduled and make-up exams, and to any subsequent discussion concerning the exams.

Any student who violates the Statement of Intellectual Responsibility, particularly as it applies to this course, will be asked to leave the course and will be given a failing grade.

Chem 11 Resources

Studying: Past experience has indicated that students are prone to underestimate the amount of study time needed to master the concepts and problem-solving skills taught in this course. Although each student needs to find the strategy that best suits him or her, we find that, in addition to regular class attendance and participation, 1 to 2 hours of serious study per day are necessary. Some of the following practices have been found to be helpful:

1. Review your lecture notes shortly after each lecture. Write down questions to be asked in Monday discussion session or in office hours.
2. Do the reading assigned for each lecture. Write down your questions as you read. Turn in at least one question at the beginning of the next lecture. Save your unanswered questions for discussion or office hours.
3. Start the problem sets early. Write down questions to be asked later. Do not work at a problem to the point of frustration; if you are stuck, go to office hours or a help session and ask for assistance.
4. Form study groups to discuss the lectures and problems. Working in a group is a proven way to solve problems and improve your understanding. After meeting with a group, be sure that you are able to do the problems yourself. Remember that the work you turn in must be your own.
5. Short periods of regular study are more effective than cramming. Set up a study schedule and stick to it. A schedule requires discipline on your part, but it is still easier than scrambling to catch up.

Office Hours: Office hours are provided on the first page of this information sheet. These are times we have set aside specifically to answer your questions about Chemistry 11 or any academic issue. If these times are not convenient for you, you can contact one of us to make an appointment. *Do take advantage of office hours. It shows that you are interested in doing well and it helps us to gauge how the course is going.*

E-mail and the Web: You can e-mail questions to any one of us or post questions on the discussion blog. We will answer within a day or so, although sometimes we do not check e-mail at night or on weekends. Check the web site for announcements, handouts, assignments, solutions, and other important information.

Books: Answers to the blue-numbered exercises in the Zumdahl textbook (which usually are not assigned) can be found in the back of the book (pp. A41–A74). Copies of Kelter's *Study Guide* for the textbook (6^{th} ed.) are on reserve in Keefe Science Library.

Lecture and Problem Set Assistance: The lecture TA, Casey Silver (csilver12@amherst.edu), will be providing additional support to the students in this class by offering regular weekly review sessions Tuesdays from 8 – 10 PM in Merrill 315 and, on quiz weeks only, Sundays from 3 - 5 PM in Merrill 315. Additional help or pre-test review sessions will be offered as needed.

The Quantitative Center: The Quantitative Center is a resource available to all students in quantitative courses. The Q-Center is located in Merrill 202. You can get more information at the Q-Center web site (http://www.amherst.edu/~qcenter), by phone (x 8331), or by e-mail (qcenter@amherst.edu). Samantha Ostrowski, the Q-Center fellow, will be holding regular drop-in hours for Chem 11 students Monday through Friday, 2:00-4:00 pm. Feel free to drop in and ask any questions you have on lecture material, problem sets, or labs during this time.

Peer Tutoring: Peer tutoring is available free of charge through the Q-Center. The approval of the instructor is required. If you encounter serious difficulty in the course and think you need a peer tutor, please see one of your professors.

These resources can help only if you make use of them. We will do everything we can to help you learn, but the final responsibility for your education is yours.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8:00		Lab 1 (RAB) Merrill 425					
8:30							
9:00							
9:30							
10:00	Lecture Merrill 2		Lecture Merrill 2		Lecture Merrill 2		
10:30							
11:00	Office Hours (KAM) Merrill 517				Office Hours (KAM) Merrill 517		
11:30							
12:00							
12:30							
13:00	Disc 1&3 401				Lab 5 (KAM) Merrill 425		
13:30							
14:00	Disc 2&4 401 403	Lab 2 (KAM) Merrill 425	Lab 3 (SSJ) Merrill 425	Lab 4 (SSJ) Merrill 425			
14:30	Q-Ctr Drop-in Hours Mer 202	Q-Ctr Drop-in Hrs Mer 202	Q-Ctr Drop-in Hours Mer 202	Q-Ctr Drop-in Hours Mer 202	Q-Ctr Drop-in Hours Mer 202		
15:00	Disc 5 Merrill 401	Office Hours (RAB) Merrill 523					TA Review Session (Quiz weeks only) Casey Silver Merrill 315
15:30							
16:00							
16:30							
17:00							
17:30							
18:00							
18:30							
19:00							
19:30							
20:00	Office Hours (SSJ) Merrill 504	TA Review Session Casey Silver Merrill 315					
20:30							
21:00							
21:30							

Topics Covered

Our goal in this course is to understand what 'chemicals', and in fact matter in general, are made of. This knowledge allows us to develop a systematic description of the chemical behavior of matter. We will start with the premise that atoms are the fundamental unit of matter. This leads to many questions that will drive our inquiry this semester. Some of these are:

How do we know that there are atoms?

What are the implications of the existence of atoms?

How does the atomic view help us to explain macroscopically-observable behavior such as transformations (reactions) of substances?

How big is an atom?

What are atoms made of?

What distinguishes atoms of different elements? ("Demystifying the periodic table")

Why do atoms of different elements undergo different types of reactions or form different types of molecules?

What holds atoms together to form molecules?

How does the molecular view help us to explain macroscopically-observable physical properties of substances, such as whether they are solid, liquid, or gas at room temperature, or whether they dissolve in water?

We obtain the answers to these questions through experimentation and observation, which in turn give rise to theories of atomic and molecular structure. The specific topics we will cover include:

<u>Atomic Architecture</u>

I. Atomic Theory and Stoichiometry (Zumdahl, Chapters 2 – 4)

After a brief introduction to the Origin of the Elements, we will explore the first systematic periodic table, where the elements are organized by mass and chemical properties. Early ideas that atoms differed when their masses differed led to great efforts to devise a relative mass scale for atoms. We will discuss these ideas as well as modern methods of mass spectrometry, which allow us to measure the masses of atoms and molecules directly. We will also discuss how early experiments uncovered some of the fundamental properties of electrons, and how Rutherford's discovery of the atomic nucleus led to the characterization of the proton. With the discovery of neutrons by Chadwick, the modern periodic table can be understood as being organized by atomic number, or the number of protons in the nucleus, and not by mass.

Tools for Understanding Chemical Formulas and Reactions: Mass Spectroscopy, Molecular Bookkeeping or Stoichiometry: percent composition, mole fractions, gravimetric precipitations, balancing equations.

II. Gases: The Simplest Collection of Atoms (Zumdahl, Chapter 5)

We will discuss a gaseous system's macroscopic properties of pressure, volume and temperature and the relationship between them, known as the ideal gas law. This leads to development of a model, the kinetic molecular theory of gases, which starts with a microscopic picture of a moving gas particle and is then extended to a system of particles. The pressure of the

system is related to the average velocity of the particles, which can be measured by the temperature of the gas. The energy of an idealized system of gaseous particles is found to depend only on the temperature of the gas, and not on its identity. Real gas corrections are introduced.

Tools for Equations of State: Introduction of a new "absolute" temperature scale known as Kelvin; Charles', Boyles' and Raoult's Laws, the ideal gas law, Dalton's Law of Partial Pressures.

Tools for Kinetic Molecular Theory of Gases: System Properties and Statistics of large systems, Boltzmann velocity distributions, Collision rates, Laws of Effusion and Diffusion.

III. The Quantum Mechanical Atom (Zumdahl, Chapter 12)

As we delve more deeply into chemical phenomena, we will come to realize that the simple picture of the atom we have used thus far fails to explain some observed behavior. We must therefore develop a more sophisticated understanding of atomic structure. We will start by thinking about how light exhibits both wave-like and particle-like properties, which we will observe experimentally. The wave nature of light is manifested in diffraction. The particle theory can also be demonstrated experimentally, for example in the wavelength and intensity dependence of the photoelectric effect. By studying emission of light from pure atomic gases, we can see the phenomena that led Bohr to develop his Model of Atomic Structure. We will come to realize the same wave-particle duality exhibited by light is also displayed by electrons, and we will use the ideas of de Broglie, Schrödinger, and Heisenberg to propose a quantum mechanical model for atomic structure with electrons organized in probabilistic "orbitals". Armed with this interpretation, we go back and explore orbital energies, ground and excited state electron configurations, and how these are manifested in terms of Periodic Properties.

Tools for Understanding Atomic Structure: Absorption and Emission Spectroscopy of Atoms, Energy Level Diagrams, Wave Functions

Tools for Understanding Electron Configurations of the Elements: Pauli Exclusion Principle, Hund's Rule, Aufbau principle

<u>Molecular Architecture</u>

I. Bonding (Zumdahl, Chapters 13 – 14)

Atoms form molecules when the valence electrons on one atom interact with the valence electrons on another atom in such a way as to lower the total energy of the system. Depending on the energies, these molecular assemblies can range from stable, long-lived covalent species to transient van der Waals complexes. In this section, we explore guidelines for predicting the shape, size, and polarity of these molecules based on the periodic properties of the elements. We also explore some molecular properties such as bond length, bond strength, and dipoles.

Tools for Understanding Bonding: Lewis Structures, VSEPR, Hybridization, Resonance

Tools for Understanding Higher Order Assembly: Periodic Properties, Energy Level Diagrams, Spectroscopy, Redox potentials

<u>Optional Topics</u>

We will complete the course with a discussion of one or more optional topics that present real-world evidence of the phenomena discussed thus far.