Santa Clara University
Department of Chemistry and Biochemistry
General Chemistry II

Lecture Syllabus — Summer 2016
Chemistry 12

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Prerequisites: Chemistry 11 with a grade of C- or better. You should have a **working** knowledge of topics covered in Chemistry 11 as well as basic algebra; you will be using logs very frequently this quarter so make sure to review the use of common and natural logs.

Course: Chemistry 12 is the second quarter of a three quarter sequence in general and analytical chemistry. Topics covered this quarter will include: properties of solids, liquids and gases; intermolecular forces; properties of solutions; chemical kinetics; general aspects of equilibria; properties of acids and bases; aqueous equilibria; and a few selected special topics. Special emphasis, in both lecture and laboratory, will be placed on the application of chemical principles. We will cover these topics at a very brisk pace; it is therefore essential that you do your very best to not fall behind. If any subject covered in lecture is unclear, please see me ASAP!

Learning Objectives: The primary objective of the general chemistry sequence is to give you a solid foundation in both theoretical and descriptive chemistry. Special emphasis will be placed on development of problem solving skills as well as on the application of basic chemical concepts. We will accomplish this goal using a variety of activities. These will include lectures, laboratory experiments, problem solving, examinations, and A LOT of individual effort outside of the classroom. It is IMPERATIVE that you do as many of the end-of-chapter problems as possible.

The laboratory portion of the course will provide you with the opportunity to develop skills necessary for scientific discovery (e.g., critical thinking and observation skills, ability to handle chemical reagents and instruments safely). The laboratory experiments this quarter will include those designed to introduce you to topics not covered in lecture (enrichment) as well as those designed to reinforce or introduce some of the topics discussed in lecture.

College of Arts and Sciences Performance Standards in the Sciences:
This course is a prerequisite for Chemistry 13 (General Chemistry III). In order to satisfy the prerequisite and be eligible to enroll in Chemistry 13 you **MUST** complete Chemistry 12 with a grade of **C- or better**. If you do not meet the performance standard as stated, it is your responsibility to not enroll, or to withdraw from pre-enrollment, for the next course in the sequence. If you do enroll for a course for which you do not qualify, you are subject to Administrative Withdrawal on the first day of class.

Disability Accommodation Policy:
To request academic accommodations for a disability, students must contact Disabilities Resources (DR) located in Benson Memorial Center, Room 216, (408) 554-4109; TTY (408) 554-5445. Students must provide documentation of a disability to Disabilities Resources prior to receiving accommodations. You will need to provide me with your signed paperwork from DR at least 24 hours in advance of an exam in order for me to arrange the accommodations.

Required Textbooks and Supplies:

(**1**) **Chemistry: The Central Science**, 13th ed. with the "red" solutions manual
T. Brown, G. LeMay, B. Bursten, C. Murphy, P. Woodward (Prentice Hall:New Jersey, 2015).

(**2**) **Laboratory Manual for General Chemistry II (Summer 2015 ed.)**,
SCU Department of Chemistry and Biochemistry. This is available at the bookstore.

(**3**) A bound **notebook** is required for laboratory.

(4) Chemical splash goggles, lab coat and appropriate laboratory attire are **REQUIRED**.

Electronic Devices (allowed and prohibited):

(1) An electronic calculator is essential for this course. An appropriate calculator for use during in-class graded exercises is the **TI-30X** or **TI-30Xa** (with or without solar power) by Texas Instruments. This calculator is inexpensive ($10-$20) and has all of the basic features needed for completing in-class graded exercises. You may use this calculator or one with similar features however you must limit your calculator selection to one that is nonprogrammable or you will need to clear the memory of your calculator, in my presence, prior to using it for any in class graded exercises. The use of more sophisticated electronic devices on any in-class graded exercise is **prohibited**.

(2) The use of any electronic communication devices (cameras, cell phones, iPods, etc.) during any in-class graded exercise is **prohibited** and may result in the loss of all credit for the graded exercise in question or, in extreme cases, failure in the course. All such devices must be turned off and stored in your backpack during any graded exercise.

(3) I kindly ask that you refrain from using any electronic communication devices during lecture. "Texting" a friend or playing computer games during lecture may seem innocent but it can distract fellow students from the lecture and thus have a negative impact on the learning environment. Students found engaging in this behavior will be asked to leave the classroom.

Academic Dishonesty: Academic dishonesty includes looking at another student's test during an exam, allowing another student to copy your work, use of unauthorized materials (e.g., lecture notes, crib sheets, textbooks, prohibited electronic devices) during an exam, copying lab reports from other students, recording/submitting laboratory data that was not actually observed ("dry lab"), and plagiarizing the works of others. **CHEATING IN ANY FORM WILL NOT BE TOLERATED AND MAY RESULT IN FAILURE OF THE ENTIRE COURSE.**

Lecture Procedures:
There will be no graded homework turned in this quarter however it is vital that you regularly test your knowledge of the course concepts by doing homework problems; lectures provide the introduction to concepts, but the real learning happens when you struggle with new and challenging problems on your own. You are **STRONGLY ENCOURAGED** to do as many of the in-chapter and end-of-chapter problems as time permits; a list of recommended end-of-chapter problems may be found in this syllabus. Text problems, in altered form, may appear on exams. PLEASE NOTE THAT THE FIRST DAY OF CLASS IS JULY 4TH—WE WILL HAVE CLASS THAT DAY; MAKE SURE TO GO TO THE BOOKSTORE TO GET YOUR TEXT AND OTHER MATERIALS BEFORE THE FIRST DAY OF CLASSES AS THE BOOKSTORE WILL LIKELY BE CLOSED FOR THE 4TH OF JULY.

There will be 2 short quizzes, given at the beginning of the class period each Wednesday during the first two weeks of the term, 2 midterms and a final exam this term; the tentative schedule for examinations is given below. Please note that exams will be given only during the scheduled exam period. It is your responsibility to make sure that you are present and ON TIME for each exam.

Tentative Exam Schedule :

Quizzes (2):	Wednesday July 6 and 13
Midterms (2):	Friday, July 8 and Friday, July 15
Final exam:	Final Exam, Friday, July 22

Grading: 1000 total points for the quarter will be tentatively distributed as follows:

Exercise	**points per**	**total points**	**% of grade**
Quizzes (2)	50	100	10.0
Midterm #1	300	300	30.0
Midterm #2	300	300	30.0
Final	300	300	30.0

The actual letter grade for the course will be assigned using the total scores as a guide, but it remains a subjective decision of the instructor based on general evaluation of the class as a whole.

Laboratory Procedures:
You must successfully complete and pass the laboratory section of the course in order to pass the class. Carefully review the schedule for the laboratory section provided in the Laboratory Manual. As required by the Department of Chemistry and Biochemistry, laboratory attendance is mandatory. The Chemistry 12 laboratory will be graded on a modified pass/no pass basis. Students must show proficiency in the laboratory portion of the course and fulfill the minimum attendance requirement as indicated below:

(1) In order to be eligible for a course grade of D- or higher you must not accumulate more than one unapproved absence or two total absences (for any reason excused or not) from lab. In rare cases make-up labs may be possible but this is left to the discretion of your individual laboratory instructor.

(2) In order to be eligible to earn a course grade of C- or higher you must earn an average minimum score of 75% (150 points) on all lab procedures and tasks. Traditionally we have found that most students earn fairly high average scores in lab (usually around 85% of the total or higher).

(3) The final course grade in Chemistry 12 will be determined by your accumulated points in lecture only since lab is pass/no pass. However, as an added incentive to do your very best in lab, points will be added to or deducted from your lecture total according to the following schedule:

a. **Add** one point to your lecture score for every lab point you earn above 180. Thus if your lab score is 190, you would get 10 points added to your lecture score.

b. **Deduct** one point from your lecture for every lab point you earn below 160. Thus if your lab score is 155, you would get 5 points deducted from your lecture score.

c. **Deduct *ten*** points from your lecture total if you have an unexcused absence from lab.

Tentative Lecture Schedule: *Listed below for each chapter are the major topics we will cover for each chapter as well as the approximate # of lecture hours we will spend on each chapter and textbook section numbers associated with these topics. Topics in parenthesis will be covered in less depth or covered as guided assigned reading:*

Ch. 10 Gases: Gas laws; Dalton's law; volumes of gases in chemical reactions; kinetic molecular theory; deviations from ideality (approx. 2-3 hrs); Sec 10.1, 10.2, 10.4, 10.5, 10.6, 10.7, (10.9)

Ch. 11/12 Intermolecular forces; solids and liquids; changes of state; vapor pressure; (approx. 3 hrs); Sec11.1, 11.2, (11.3), 11.4, 11.5, 12.1

Ch. 13 Concentration conventions for solutions, solution thermodynamics, ideal and non-ideal solutions, colligative properties, electrolyte solutions (approx. 5 hrs); Sec 13.1, 13. 2, 13. 3, 13. 4, 13. 5, (13. 6)

Ch. 14 Kinetics: rate laws, half-lives, mechanisms, Arrhenius theory, catalysis (approx. 4-5 hrs); Sec 14.1, 14. 2, 14. 3, 14. 4, 14. 5, 14. 6, 14. 7.

Ch. 21 Radioactive decay rates ad detection of radioactivity (approx. 1 hour); Sec (21.1), 21.4, 21.5.

Ch. 15 Chemical equilibrium, Kc, Le Châtelier's principle; common-ion effect (approx. 4-5 hrs); Sec 15. 1, 15. 2 (we will not cover Kp); 15. 3, 15. 4, 15. 5, 15. 6, 15. 7.

Ch. 16 Aqueous equilibria part I: Acid-base equilibria (definitions, impact of structure on acid strength, pH scale and pK, pH calculations for acids, bases, and salt solutions) (approx. 3-4 hrs); 16. 1, 16. 2, 16. 3, 16. 4, 16. 5, 16. 6. 16. 7, 16. 8, 16. 9, 16. 10, (16. 11)

Suggested Problems: Problems marked with an asterisk (*) are more challenging; don't be too upset if you can't do all of them. The answers to the "black" problems are posted in the glass cases in the breezeway outside of the DS200 building. Answers to "red" problems are in your textbook with full solutions in the "red solutions manual". Remember that the following list should be regarded as a starting point for doing problems (you are encouraged to do as many of the end of chapter problems as possible!).
Chapter 10: 5, 17a, 21, 25, 29, 31, 37a, 39, 41, 43, 47, 55, 57, 59, 63, 67, 73, 75, 77, 91, 119a, 121

Chapter 11: 9, 15, 17, 19, 21, 23, 25, 27, 33, 35, 39, 41, *43, 45, 49, 51

Chapter 12: 9, 11

Chapter 13: 7, 12, 13, 15, 23, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 61, 63, 71, 73, 77, 81, *83, 91,

Chapter 14: 17, 23a-b, 27, 29, 31, 33, 35, *37, 43, 51, 65, 67, 71, *73, 75, 81, 91, 99 (**Chapter 21**: 37)

Chapter 15: 15, 17, 27, 33, 35, 37, 41, 43, 45, 51, *55, 57, 6,1 63, 67

Chapter 16: 11, 13, 15, 17, 19, 21, 23, 25b, 27, 29, 31, 33, 35, 37, 41, 43, 45, 47, 49b, 51, 53, 55, 57, 59, 61, 63, 67, 69a, 71, 73, 75, 77, 79, 81, 83, *85, 87, 93, 106, 10

Basic Learning Goals for the Lecture:

1. Goal: Acquire an understanding of the behavior of gases
Objectives:
a. Be able to compare distinguishing characteristics of gases with those of liquids and solids
b. Be able to describe gas pressure, how it is measured and the units used to express it.
c. Be able to relate utilize the ideal gas equation and express the state of a gas in terms of its volume, pressure, temperature and molar quantity.
d. Understand the kinetic-molecular theory of gases and how the average kinetic energy of a gas relates to its absolute temperature
e. Understand how real gases deviate from ideal behavior.

2. Goal: Understand how intermolecular forces influence the behavior of molecules
Objectives:
a. Describe how intermolecular forces between neutral molecules depend on their molecular polarity, size, and shape.
b. Describe the major classes of intermolecular forces that exist between neutral molecules.
c. Understand how many of the properties of solids and liquids (such as boiling point, melting point, surface tension, viscosity) are influenced by the intermolecular forces present in the substances
d. Be able to diagram the various enthalpy changes that accompany the heating or cooling of a substance including enthalpy changes that accompany phase changes.
e. Understand the concept of a dynamic equilibrium, specifically as it relates to the concept of vapor pressure.
f. Be able to characterize solids according to the type of attractive forces between the units in the solid

3. Goal: Develop an understanding of the physical properties of solutions, comparing them with the properties of their components.
Objectives:
a. Describe what happens to a substance, at the molecular level, when it dissolves in a solvent to form a solution.
b. Understand the concept of solubility and the enthalpy changes that accompany the formation of a solution.
c. Appreciate the role of intermolecular forces on the solution process ("like dissolves like").
d. Be able to describe the concentration of a solute in a solution in terms of mass percentage, molarity, mole fraction, and molality.
e. Understand the concept of a colligative property and be able to quantify the extent to which a nonvolatile solute alters vapor pressure, boiling point, freezing point and osmotic pressure of a solution.
f. Understand the difference between a heterogeneous mixture, a colloidal dispersion, and true solution.

4. Goal: Acquire a familiarity with the branch of chemistry concerned with the rate at which a reaction proceeds (chemical kinetics)
Objectives:
a. Describe the four experimental variables that affect reaction rates and understand, within the framework of kinetic-molecular theory, how these factors (concentration, physical state of reactants, temperature and presence or absence of a catalyst) influence reactions rates.
b. Be able to use initial rate data to write a rate law for a given reaction.
c. Be able to manipulate rate laws, as well as the integrated form of the rate law for a first and a second order reaction, to quantify the relationship between reactant or product concentration and time.
d. Be familiar with the concept of a half-life.
e. Be able to utilize basic concepts from the kinetic molecular theory to account for temperature effects on reaction rates (at the molecular level); understand the concepts of activation energy and frequency factor as they relate to the Arrehenius equation.

f. Be familiar with the terms elementary steps, rate determining step, molecularity, and reaction mechanisms.
g. Be able to describe the characteristics of homogeneous and heterogeneous catalysts and explain how they are able to enhance reaction rates.

5. Goal: Understand the concept of a dynamic equilibrium and the factors that determine the relative concentrations of reactants and products present at equilibrium
Objectives:
a. Be able to define the concept of a dynamic equilibrium and to write an equilibrium constant expression for homogeneous and heterogeneous equilibria.
b. Be able to calculate the value of an equilibirum constant from equilibrium concentrations of reactants and products.
c. Be able to use equilibrium constants to predict the equilibrium concentration of reactants and products and to determine the direction in which a reaction must proceed in order to achieve equilibrium.
d. Be able to apply the basic concepts of Le Chatelier's principle to predict how a system at equilibrium will respond to changes in concentration, pressure, volume or temperature.

6. Goal: Examine the behavior of acids and bases in terms of their structure, bonding, and the chemical equilibria in which they participate
Objectives:
a. Be able to define an acid or a base using both the Arrhenius and the Brønsted-Lowry definitions for these substances.
b. Understand the concept of a conjugate acid-base pair.
c. Understand the process of autoionization for water and be able to explain how the equilibrium constant for this process (Kw) defines the relationship between hydronium ion and hydroxide ion in aqueous solution.
d. Be able to use the pH scale to describe the relative acidity or basicity of a solution.
e. Know the names and chemical formulas for the common strong acids and strong bases; understand the difference between a strong acid and a weak acid.
f. Be able to use the acid dissociation constant, Ka, to quantify the extent to which a weak acid will ionize in water and be able to use this information to predict the pH of an aqueous solution of the weak acid.
g. Be able to use the base protonation constant, Kb, to quantify the extent to which a weak base will become protonated in water and be able to use this information to predict the pH of an aqueous solution of a weak base.
h. Understand the mathematical relationship that exists between the Ka and Kb for a conjugate acid/base pair and understand how this may be used to predict the pH of an aqueous solution of a salt.
i. Have an appreciation for how the strength of an acid is influenced by important structural features (such as the size and/or electronegativity of key atoms, the tendency of products to exist as resonance forms, etc.)
j. Be familiar with the Lewis definitions of acids and bases.