CITY COLLEGES of CHICAGO
Harry S Truman
Education that Works

DEPARTMENT OF PHYSICAL SCIENCES & ENGINEERING

MASTER SYLLABUS

Chemistry 201 (General Chemistry-I)

Harry S. Truman College: Our Mission dedicates us to deliver high-quality, innovative, affordable and accessible educational opportunities and services that prepare students for a rapidly changing and diverse global economy.

Course (Discipline): Chemistry 201
Proposed IAI Code – CHM 911

1. **Title, Number, and Classification**
   Chemistry 201 (General Chemistry-I)

2. **Course Term**
   16 week Semester or 8 week summer term

3. **Credit and Contact Hours**
   Credit hours: 5
   Contact hours: 4 lecture, 4 laboratory

4. **Prerequisites**
   Eligibility for Mathematics 140 or higher and either Grade of C or better in Chemistry 121 or one year of high school chemistry, or consent of department chair

5. **Catalog Description**
   Topics include the periodic table of the elements, atomic structure, basic concepts of quantum theory, bonding, stoichiometry of compounds and reactions, thermochemistry, the gaseous state, basic concepts of the liquid and solid states, solutions, acids and bases. Writing assignments, as appropriate to the discipline, are part of the course.

6. **Students for whom the course is intended**
   Students may take this course to meet concentration or elective requirements for an associates degree, to fulfill requirements for a career occupational degree, or to prepare for other careers in the physical sciences or healthcare professions.

7. **Course Objectives**
   At the completion of this course, the successful student will be adequately prepared to take the subsequent course: General Chemistry II (Chemistry 203), and be able to do the following:

   Topics marked with (R), review, should have been covered by the student in a Basic Chemistry course.

Scientific Method

- (R) Describe the scientific method.
- (R) Define and explain the terms: law, hypothesis, and theory.

Chemical Calculations

- (R) Use exponential notation.
- (R) Do mathematical calculations involving significant figures.
- (R) Differentiate between mass and weight.
- (R) Convert from the English system to the metric system (& vise versa) common units of length, mass, volume, and temperature.
- (R) Use the metric system in calculations.

Heat and Temperature

- (R) Differentiate between heat and temperature.
- (R) Do simple calculations of heat changes using specific heat.
- Define and use the terms standard state, standard enthalpy change, molar enthalpy of formation.

Density

- (R) Solve problems using density as the relationship between mass and volume.

Properties of Matter

- (R) Use and define (describe or explain) basic chemical concepts with respect to properties of matter: physical states of matter, physical and chemical properties of matter, physical and chemical changes, the law of conservation of mass, the law of conservation of energy, the law of definite composition, classification of elements.
- (R) Distinguish between pure substances (elements and compounds) and mixtures (homogeneous and heterogeneous).
- List the names and chemical symbols of at least 48 elements.

Atomic Theory and Structure, Molecular Theory and Structure

- (R) Distinguish between ionic and molecular compounds.
- (R) Determine the number and types of atoms represented in a chemical formula.
- Use basic chemical nomenclature for inorganic compounds.
- Write the formulas of binary ionic compounds, common binary molecular compounds, and at least 12 common acids, 4 common bases, inorganic ternary compounds using 15 common polyatomic ions.
- Use oxidation numbers to distinguish oxidation states of metals in compounds.
- (R) Balance chemical equations given the formulas of the reactants and products.
- Calculate the oxidation number of each element, given the formulas of the reactants and products.
- Balance redox equations using oxidation numbers.
- (R) List the basic principles of Dalton's atomic theory and indicate how the theory has been further developed in this century.
- (R) State the basic properties of the subatomic particles: protons, neutrons, and electrons.
- (R) Describe the Rutherford atom.
- (R) Define atomic number, mass number, and isotopes.
- (R) Define the atomic mass unit and Avogadro's number.
- (R) Use the conversion factor from grams to amu in simple calculations.
- Calculate the average atomic mass from isotopic masses and percent abundances.
- (R) Apply the terms: metals, nonmetals, alkali metals, alkaline earth metals, metalloids, transition metals, noble gases, halogens, and inner transition metals to the arrangement of elements in the periodic table.
- (R) Describe the arrangement of the elements in the periodic table.
- (R) Use the periodic table to predict formulas of compounds.
- (R) Define the terms anion, cation, and polyatomic ion.

- Describe how ionic and covalent bonds are formed.
- Calculate the oxidation number of each element in a chemical formula.

Mole-Mass Calculations

- (R) Calculate the percent composition of compounds, given the formulas.
- (R) Calculate the empirical formula, given the percent composition.
- (R)Calculate the empirical formula of compound given the mass of the sample, the mass of CO_2 and mass of H_2O produced in a combustion reaction.
- (R) Distinguish between empirical and molecular formulas.
- (R) Explain the concepts of the chemical quantity, the mole, and relate it to counting of atoms and molecules.
- (R) Convert mass in grams to moles, formula units, molecules (and/or atoms) using atomic weights, formula weights, and molecular weights.
- List the basic rules which predict whether a salt is soluble in water.

Stoichiometry

- Write the balanced equations describing several examples of combustion, acid-base, precipitation, and exchange reactions. Write the equations in the molecular, total ionic and net ionic format.
- (R) Explain the information given by the balanced chemical equations.
- Perform stoichiometric calculations from a given chemical equation.
- Use calculations determine the limiting reagent, how much excess reagent is left, and the theoretical and percentage yield of each product.

Solutions

- List the properties of solutions and distinguish true solutions from heterogeneous and colloidal mixtures.
- Define solubility, percent concentration, molarity, mole fraction, and molality.
- Explain factors affecting solubility and the rate of dissolving.
- Write molecular, total ionic and net ionic equations which show that the solution is the reaction medium.
- Use percent concentration, molarity, and molality in stoichiometric calculations.

Gases

- List the basic principles of the Kinetic Molecular Theory of gases.
- (R) Describe the measurement of pressure using a barometer.
- (R) Use four kinds of pressure units in calculations and convert from one to another.
- Calculate pressure, volumes, and temperatures of gases using Boyle's law, Charles' Law, the Combined Gas Law, and Dalton's Law of Partial Pressures.
- (R) Calculate Kelvin temperatures from Centigrade and vise versa.
- (R) Define standard conditions of temperature and pressure.
- Use the Ideal Gas Law to calculate density and molecular weight of a gas.
- Use the gas laws in chemical stoichiometric calculations.
- Define and distinguish between diffusion and effusion.

Energy and Light

- Define and explain the terms electromagnetic radiation, wavelength, frequency, wave amplitude, spectrum, and nodes.
- Describe the Bohr hydrogen atom; describe the hydrogen atom in terms of simple quantum mechanics.
- Perform calculations using the equation $\lambda\nu = c$.
- Explain the source of the atomic line spectra.
- Describe the properties of light.

Molecular Orbital Theory

- Write electronic configurations of the first 50 elements; show the diagrams of their electronic structure, and indicate the spin of each electron.
- Sketch the shape of the s, p and d orbitals.
- Identify the 4 quantum numbers for any electron in an atom.
- Predict which atoms or ions are paramagnetic and which are diamagnetic using the electronic configurations.
- State the Pauli Exclusion Principle, Hund's rule, and the Aufbau principle.
- (R) Define ionization energy and be able to rank using the periodic table.
- Use ionization energy trends to predict the stability of electronic configurations and the tendency for outer shell electrons to undergo changes in order to form compounds.
- (R) Define electronegativity: show how it varies with respect to the periodic table.
- (R) Use electronegativity to estimate the polarity of bonds.
- Show the trends of atomic and ionic sizes on the periodic table.
- State the octet rule, including exclusions.
- Write Lewis electron dot structures for simple covalent compounds and polyatomic ions.
- Use double and triple bonds to show structures of molecules and ions; use resonance to describe equivalent bonds.
- Use the Valence Shell Electron Pair Repulsion theory to describe electron pairs geometry, molecular geometry, hybridization, and bond angles.
- Predict the polarity of bonds and molecules.
- Define bond order and bond dissociation energy; use bond energies to estimate reaction enthalpies.
- Calculate the formal change of an atom in a molecule or ion, and use it to predict the most reasonable resonance structures.
- Explain the difference between oxidation number and formal change.
- Explain simple valence bond theory.
- Use the concepts of orbital overlap, sigma and pi bonds, hybrid orbitals to explain the strength and orientation of covalent bonds.

Properties of Solutions

- Use molarity in calculations concerning the dilution of solutions.
- Explain at least two examples of colligative properties.
- Calculate the freezing point depression and the boiling point elevation due to the addition of a nonvolatile molecular solute to a pure solvent.

Acids and Bases

- List at least four properties each for acids and bases.
- Explain the behavior of acids and bases in terms of the Arrhenius and Brønsted/Lowry theories.
- Write equations for acids and bases showing conjugated acid/base pairs.
- List at least five common strong acids and five common strong bases.
- Given an acid, write the formula of the conjugate base, and vise versa.
- Write complete equations for at least two examples of each of the following reactions: acid + base, acid + metal, acid + metal oxide, acid + carbonate.
- Given the formula of a salt, write the formulas of the acid and the base which would react to form the salt.
- Distinguish between electrolytes and non-electrolytes, strong and weak electrolytes. List at least three examples of each.
- Define pH. Given a pH value, state whether the solution is acidic, basic, or neutral.
- Given a pH value calculate the H^+ concentration, and vise versa.
- Estimate pH and pOH values without the use of a calculator given H^+ concentration and/or OH^- concentration.
- Given a pOH value calculate the OH^- concentration, and vise versa.
- Convert from H_3O^+ concentration to pH then to pOH then to OH^- concentration.

8. Learning Outcomes

At the completion of this course, the successful student will be able to:

1. 1Solve quantitative chemistry problems and demonstrate reasoning clearly and completely. Integrate multiple ideas in the problem solving process.
2. Describe, explain and model chemical and physical processes at the molecular level in order to explain macroscopic properties.
3. Classify matter by its state and bonding behavior using the Periodic Table as a reference.
4. Apply important theories such as the Kinetic Molecular Theory of Gases or the Quantum Mechanical Theory of the Atom to the solution of general chemistry problems.
5. Perform general chemistry laboratory experiments using standard chemistry glassware and equipment and demonstrate appropriate safety procedures.
6. Record, graph, chart and interpret data obtained from experimentation and use that information to correctly identify/analyze assigned unknown substances.

9. Topical Course Outline (suggested)

Week	Topic	Reference
Week 1	**LECTURE:** Course Introduction, Basic Chemistry Review Placement Assessment **Before our class begins** please review the course objectives for Basic Chemistry. You may also want to work through this review worksheet and then go over the answers. It is very important that you memorize the names and formulas of the polyatomic ions.	online documents
	LECTURE: Matter: Its Properties and Measurement (scientific method, classification of matter, density, percent composition, significant figures)	Chapter 1
	LAB: Check-In, Lab Safety, Mystery White Powder	Download pdf
Week 2	**LECTURE:** Basic Chemistry Calculations and Concepts (nuclear atom, chemical elements, periodic table, mole/mass calculations)	Chapter 2
	LECTURE: Maintaining a Laboratory Notebook, Writing Conclusions and Reflections	
	LAB: Simple Qualitative Analysis	Download pdf
Week 3	**Quiz One: Basic Chemical Concepts** **LECTURE:** Molecules, Compounds and Chemical Equations (nomenclature, chemical composition, classifying and balancing chemical equations)	Chapters 1 & 2 Chapter 3
	LECTURE: Chemical Reactions (predicting products, activity series, solubility properties)	Chapter 4
	LAB: Single and Double Displacement Reactions	Download pdf
Week 4	**LECTURE:** Chemical Quantities (stoichiometry)	Chapter 4
	LECTURE: Problem Solving (stoichiometry)	Chapter 4
	LAB: Qualitative Analysis	Download pdf
Week 5	**LECTURE:** Acid-Base and Redox Reactions	Chapter 3 & 4
	Quiz Two: Chemical Reactions and Stoichiometry	Chapter 3 & 4
	LAB: Some Nonmetals and Their Compounds - Preparation and Properties	Download pdf

Week 6	**LECTURE:** Reactions in Aqueous Solutions (solutions, precipitation, acid-base, redox, stoichiometry, titrations)	Chapter 4
	LECTURE: Reactions in Aqueous Solutions (focus on redox)	Chapter 4
	LAB: The Alkaline Earths and the Halogens	Download pdf
Week 7	**Quiz Three: Solutions** Review for Exam	
	Exam One: Chapters 1-4 **LECTURE:** Introduction to Gas Behavior (gas pressure, simple gas laws, ideal gas law)	Ch. 1 to 4 Chapter 5
Week 8	**LECTURE:** Properties of Gases (gas stoichiometry, gas mixtures, Kinetic-Molecular Theory of Gases)	Chapter 5
	LAB: Molar Mass of a Volatile Compound	Download pdf
Week 9	**Quiz Four: Ideal Gas Law** **LECTURE:** Gas Effusion, Non-Ideal Gases, Partial Pressure	Chapter 5
	LECTURE: Thermochemistry (Heat, Calorimetry)	Chapter 6
	LAB: Introduction to Thermodynamics in the Laboratory	Download pdf
Week 10	**LECTURE:** Thermochemistry (Hess's Law, Standard Enthalpies of Formation, Fuels) **Lab notebooks are due for first evaluation.** (Rubric)	
	Quiz Five: Thermodynamics **LECTURE:** Thermodynamics	Chapter 6
Week 11	**Quiz Six: Thermodynamics: Hess's Law** **Problem Solving Practice**	Chapters 5 & 6
	Exam Two: Chapters 5-6	
Week 12	**LECTURE:** Introduction to Quantum Chemistry	Chapter 7
	LAB ACTIVITY: Simulation of the Photoelectric Effect	Download pdf
	LECTURE: Quantum Theory: Three Experiments, Quantum Numbers	Chapters 7 & 8
	LAB ACTIVITY: Atomic Spectra	Download pdf
Week 13	**LECTURE:** Periodic Properties **LAB ACTIVITY:** Graphing Ionization Energies	Download pdf
	Quiz Seven: Atomic Theory and Periodic Properties **LECTURE:** Chemical Bonding	Chapters 7 & 8 Chapters 9 & 10
	LAB ACTIVITY: Molecular Geometry and Shape	Download pdf
Week 14	**Quiz Eight: Molecular Geometry** **LECTURE:** Bond Energies	
	LECTURE: Intermolecular Forces: Phase Diagrams	Chapter 11
	LAB ACTIVITY: Heating and Cooling Curves	Download pdf
Week 15	**LECTURE:** Solutions and Their Physical Properties (solution	Chapter 12

	concentrations)	
	Exam Three: Chapter 7-12 Lab Check Out and Clean Up	
Week 16	**REVIEW** **Comprehensive Final Examination (begins at 9:30 am)** **Laboratory Notebook is DUE! All homework and extra assignments are due. This is the last day to turn in anything.**	Comprehensive
	Final Class: Student Conferences, Discussion of Final Grade	

10. Texts and Materials (suggested)

- Chemistry: A Molecular Approach 3rd Ed. by Nivaldo J. Tro, Pearson©
- Beck's bookstore has an edition of this textbook with only the chapters needed for Chemistry 201. This is useful for students who do NOT plan to take Chemistry 203.
- Mastering Chemistry
- All laboratories will be available to download from this website. There is no laboratory textbook to purchase.
- You will need a scientific calculator (includes log and trig functions) and should bring it with you to class.

11. Methods of Instruction

Lecture and Notes: Lecture notes will be in the form of PowerPoint presentations and overhead sheets. These will be posted on Blackboard and/or websites.
Group Exercise: Documents on instructions and methodologies will be provided by the instructor
Videos/CDs: The instructor will show or provide cd roms as deemed necessary.

12. Methods of Evaluation:

Your Grade will be based on:

(30%) laboratory work:which includes:
Lab notebook (10%) the laboratory notebook is collected twice for evauation. More information..
Lab activities (10%) Photoelectric Effect, Ionization Energies, Bohr Atom, Molecular Models, Heating and Cooling Curves
Determination of Unknowns (10%)
(20%) quizzes [best five of eight]
(20%) examinations [best two of three]
(5%) research paper
(5%) attendance, homework, class participation
(20%) comprehensive final exam
Extra Credit: One percent extra credit is available by doing the one book project.

Letter Grades	Percentage
A	90%
B	80%
C	70%
D	60%
F	Below 60%
*I	*Incomplete
ADW	**Administrative Withdrawal
NSW	***No Show Withdrawal

***I (Incomplete)** is a non-grade received by students who have **actively pursued** the course and are doing passing work at the end of the course, but who have not completed the course's final examination and/or other specific course assignments.

****ADW (Administrative Withdrawal)** is given to any student who is not **actively pursuing** the course objectives will be administratively withdrawn from the course at mid-term. An ADW will be given if a student does not complete at least 70% of all assignments; homework, exams, laboratories, quizzes due prior to mid-term by the mid-term date. Since make up work is NOT permitted this means that attendance is extremely important and excessive absences will most likely result in an ADW.

*****NSW (No Show Withdrawal)** is given to any student who misses the first two classes and does not discuss with me the circumstances of these absenses will be given an NSW after the second class. A student who attends the first class and then fails to attend the next two classes and fails to discuss with me the circumstances of these absences will be given an NSW. Any student who misses more than half of the classes in the first two weeks of the term will also be given an NSW if we do not discuss the circumstances of these absences. In my discussion with you I will determine if it is feasible for you to sucessfully pursue the course objectives under whatever circumstances are causing you to miss class. Your success is very important to me and I know, from years of experience, that your success depends on your commitment and ability to attend the class and participate in all activities.

Authorized Signature and File

Date: _____