

SC/CHEM1500 4.0 INTRODUCTION TO CHEMISTRY

An introductory course in chemistry for students needing an adequate preparation for SC/CHEM 1000 3.0 and SC/CHEM 1001 3.0. Topics include basic atomic theory, stoichiometry, the periodic table, chemical bonding, acids and bases, oxidation-reduction and organic chemistry. Each student is counseled to enroll either in this course or in SC/CHEM 1000 3.0 depending on previous chemistry experience.

Simultaneous enrolment in CHEM 1509 0.00 is compulsory.

Course Format: three lecture hours per week, three lab hours every second week (6 lab experiments over the term) and two tutorial hours every second week (alternating with the labs, 4 tutorials over the term through the enrolment in CHEM1509).

Professor: Valeria Tsoukanova (office: Petrie Bldg. 342; e-mail: valeriat@yorku.ca)

Schedule: lectures – Monday, Wednesday, Friday 11:30 – 12:30

tutorials – Wednesday Oct.8th, Oct.15th, Nov.19th and Dec.3rd
(time and location will be announced via e-mail and course website)

labs – run throughout the week (time and location will be provided with the lab manual by the Lab Coordinator)

Lab Coordinator: Carolyn Hempstead (office: CB 360, e-mail: carolynh@yorku.ca)

Textbook: Petrucci R. H., Herring F. G., Madura J. D., Bissonnette C. *General Chemistry: Principles and Modern Applications*. Custom Edition for York University CHEM1000/1001/1500, 2nd ed.: Pearson Canada Inc., Toronto, 2011.

Grading Scheme:

- Test #1 (Oct.17th) – 20% of the Final Grade
- Test #2 (Nov.21st) – 20% of the Final Grade
- Exam (date to be announced) – 50% of the Final Grade
- Lab work – 10% of the Final Grade

SC/CHEM1500 SYLLABUS

Lecture 1: Chemistry Science

Matter, its composition and properties. Atoms, molecules, crystals. Chemical elements, compounds and substances. States of matter, phase.

Reading: Textbook chapters 1-2 and 1-3.

Lecture 2: Chemistry Methods

Pure substances and mixtures. Mixture separation methods. Evaporation and crystallization. Filtration and magnetic separation. Sublimation and deposition. Chemical decomposition.

Reading: Textbook chapters 1-2 and 1-3.

Lecture 3: Chemistry Measurements

Units of measurements. Mass, volume, density. Temperature: Celsius, Fahrenheit and Kelvin scale.

Reading: Textbook chapters 1-4 and 1-5.

Lecture 4: Uncertainties in Measurements

Systematic and random error. Accuracy and precision. Significant figures. Error analysis.

Reading: Textbook chapters 1-5, 1-6 and 1-7.

Lecture 5: Percent Composition

Percent composition. Composition of mixtures. Solutions. Percent composition of an aqueous solution.

Reading: Textbook chapter 1-5.

Lecture 6: Fundamental Laws of Chemistry

Decomposition and combustion. The Law of Conservation of Mass. The Law of Constant Composition. Dalton's atomic theory. The Law of Multiple Proportions.

Reading: Textbook chapter 2-1.

Lecture 7: Atom and the Atomic Theory

The nuclear atom. Fundamental particles in atoms. Chemical elements and isotopes.

Reading: Textbook chapters 2-3, 2-4 and 2-5.

Lecture 8: Atoms, Isotopes, Ions

Isotopic mass, atomic mass and mass number. Chemical properties of isotopes. Ions.

Reading: Textbook chapters 2-4 and 2-5.

Lecture 9: Elements and Periodic Table

Periodic table of the elements. Periods and groups. Main groups and transition series. Metals, nonmetals and semimetals. The concept of mole. The Avogadro constant and molar mass.

Reading: Textbook chapters 2-6, 2-7 and 2-8.

Lecture 10: The Concept of Mole

Atomic mass and molar mass. Number of moles and number of atoms.

Reading: Textbook chapter 2-8.

Lecture 11: Chemical Compounds (part I)

Molecular and ionic compounds. Covalent and ionic bonds. Chemical formulas: empirical, molecular and structural formulas. Molecular models.

Reading: Textbook chapter 3-1.

Lecture 12: Chemical Compounds (part II)

Formula unit. Cations and anions. Intramolecular and intermolecular forces. Network covalent solids.

Reading: Textbook chapters 3-1, 3-2, 12-1 and 12-5.

Lecture 13: Mass and Mole of a Compound

Mass of a compound: molecular mass and formula mass. "Molecular" elements. Allotropes. Mole of a compound, molar mass, number of molecules and number of ions.

Reading: Textbook chapter 3-2.

Lecture 14: Composition of Chemical Compounds

The mass percent of an element in a compound. Chemical formulas and percent composition of compounds.

Reading: Textbook chapter 3-3.

Lecture 15: Oxidation State

Oxidation state. Oxidation states for metals, nonmetals and semimetals in pure elements and compounds. Polyatomic ions.

Reading: Textbook chapter 3-4.

Lecture 16: Assigning Oxidation States

Oxidation states of metals and nonmetals in a compound. Typical oxidation state numbers for metals, nonmetals and semimetals. Oxidation state periodicity.

Reading: Textbook chapter 3-4.

Lecture 17: Writing Names and Formulas for Chemical Compounds

Organic and inorganic compounds. Binary inorganic compounds. Electronegativity.

Reading: Textbook chapters 3-5 and 3-6.

Lecture 18: Chemical Compounds of Greater Complexity

Ternary compounds. Oxoacids and oxoanions. Salts of oxoacids. Hydrates.

Reading: Textbook chapter 3-6.

Lecture 19: Names and Formulas of Organic Compounds

Composition of organic compounds and nomenclature. Hydrocarbons. Isomerism.

Reading: Textbook chapters 3-7 and 26-1.

Lecture 20: Functional Groups in Organic Compounds

Functional groups in the hydrocarbon framework. Alcohols, aldehydes, ketones and carboxylic acids.

Reading: Textbook chapters 3-7 and 26-7.

Lecture 21: Chemical Reactions

Evidence of a chemical reaction. Chemical equation. Balancing chemical equations. The mechanism and rate of reaction. Catalyzed reactions.

Reading: Textbook chapters 4-1 and 14-11.

Lecture 22: Stoichiometry of Chemical Reactions

Stoichiometric coefficients and stoichiometric factors. Calculating the amount of substances involved in a chemical reaction.

Reading: Textbook chapter 4-2.

Lecture 23: Molarity of a Reactant Solution

Solutes and solvents. Composition of solutions: solute concentration. Molarity.

Reading: Textbook chapter 4-3.

Lecture 24: Some Properties of Solutions

Dilute, concentrated, saturated and supersaturated solutions. Solution dilution. Solubility.

Reading: Textbook chapters 4-3, 13-1 and 13-3.

Lecture 25: Stoichiometry of Reactions in Solutions

Stoichiometric proportions. Excess of a reactant. Limiting reactant. Yield of a reaction.

Reading: Textbook chapters 4-4 and 4-5.

Lecture 26: Reaction Yield

Reversible, consecutive and simultaneous reactions. Reaction intermediates and by-products. Calculating the yield: theoretical, actual and percent yield.

Reading: Textbook chapter 4-5.

Lecture 27: Chemical Reactions in Aqueous Solutions

Nature of aqueous solutions: electrolyte and nonelectrolytes. Hydronium ion. Species concentration.

Reading: Textbook chapter 5-1.

Lecture 28: Precipitation Reactions

Reactions between cations and anions in aqueous solutions. Precipitate. Spectator ions. Net ionic equations. Predicting precipitation reactions.

Reading: Textbook chapter 5-2.

Lecture 29: Acids and Bases

Strong and weak acids and bases. Dissociation. Ionization.

Reading: Textbook chapter 5-3.

Lecture 30: Neutralization Reactions

Reactions between acids and bases. Predicting neutralization reactions. Acidic and basic properties of water. Self-ionization of water.

Reading: Textbook chapters 5-3 and 16-3.

Lecture 31: The pH Scale

The pH scale. Molarity, pH and species concentrations in acidic and basic solutions. Predicting neutralization reactions and the pH of solutions after reaction.

Reading: Textbook chapters 5-3, 16-3, 16-4 and 16-5.

Lecture 32: pH of Acidic and Basic Solutions

pH and pOH. Degree of ionization. Percent of ionization.

Reading: Textbook chapters 5-3, 16-4 and 16-5.

Lecture 33: Oxidation-Reduction Reactions (part I)

Oxidation, reduction, changes in oxidation state. Redox pairs and half-reactions. Reductant and oxidant. Oxidizers and reducers.

Reading: Textbook chapters 5-4 and 5-6.

Lecture 34: Oxidation-Reduction Reactions (part II)

Redox equations. Balancing redox equations in acidic and basic solutions.

Reading: Textbook chapter 5-5.

SC/CHEM1500 TUTORIALS

Tutorial 1.

Units of measurements and significant figures. Temperature scales. Density. Atomic number, mass number, and isotopes. Atomic masses. The Avogadro constant and the mole.

Practice: Exercises for textbook chapters 1 and 2.

Tutorial 2.

Chemical formulas and composition of compounds. Oxidation states. Nomenclature. Molar mass, number of molecules and ions.

Practice: Exercises for textbook chapter 3.

Tutorial 3.

Writing and Balancing Chemical Equations. Stoichiometry of Chemical Reactions. Determining the limiting reagent. Theoretical, actual and percent yield.

Practice: Exercises for textbook chapter 4.

Tutorial 4.

Ion concentrations in aqueous solutions. Precipitation, neutralization and redox reactions. Titrations.

Practice: Exercises for textbook chapter 5.

SC/CHEM1500 LABS

Experiment 1: The Law of Constant Composition and Separation of Mixtures.

Experiment 2: Elements, Compounds, Reactions.

Experiment 3: Acids and Bases.

Experiment 4: Quantitative Analysis.

Experiment 5: Molecular Dimensions.

Experiment 6: Simple Organic Reactions.