

CHEM 1100- Chemistry and Materials Science for Engineers

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Lecture Meeting: Tues/Thursday 8.30-10.30: Room ACE 102

Tutorial: Friday 11.30-12.30: ACW 206

Labs: T,W, R, F from 2.30-5.30 in Rooms 217 B,C, D.

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Office Hours: Tuesdays/Thursdays 11-12.30; Fridays: 12.00-1.00

Brief Course Description: This course is designed for engineering students interested in refreshing and expanding their general chemistry background while exploring the relationship between the structure, properties and processing of matter. Important introductory concepts and principles of chemistry with a focus on practical applications in engineering and technology will be considered. Topics covered will include solution chemistry, reactivity, thermochemistry, structure and properties of materials, gas laws, chemical equilibrium, pH, pKa and polymers.

There will be a total of six labs, two of which will have an active learning exercise component involving a guided inquiry approach. These will essentially be “dry labs”. Introduction to laboratory techniques, emphasis on collection of accurate and precise data and understanding sources of experimental error will be the salient aspect of this segment of the course. Learning objectives included the exercise of safety practices in the laboratory setting and the preparation of reports with quantitative and descriptive content.

Course Evaluation:

Test 1:	15%	Feb 5th
Test 2:	15 %	March 17 th (Changed to March 31 st)
OWL:	10%	(ongoing- posted weekly)
Labs:	30%	(will meet biweekly)
Final:	30%	exam period (April 7 th onward)

Textbook: Chemistry and Materials Science for Engineers- CHEM 1100, Custom Edition, York University; ISBN-13 978-0-17-668518-8, Nelson Education Ltd. 2015. Material for this text is compiled from “Chemistry for Engineering Students”, 3rd Edition by L. S. Brown & T. A. Holme **and** “The Science of Engineering Materials”, SI edition, 6th Edition by D.A. Askeland, P.P Fulay and W. J. Wright **and** from “Materials Science and Engineering Properties, SI Edition, 1st Edition by Charles Gilmore.

Important Information for all Students:

Pass Requirements: A passing grade of 50% for the total mark assessed as part of the lecture component is required to pass the course. A passing grade for the lab component requires attendance at every lab session and obtaining a minimum lab average of 50%.

NOTE: There will be no makeup tests. If a student misses a test for a legitimate reason, they must provide suitable documentation within 72 hours of the missed test. In case of an illness, please provide an official York University Attending Physician Statement, available at

http://www.registrar.yorku.ca/pdf.php?pdf=attend_physician_statement.pdf

For these students, the weight of the missed test(s) will be shifted to the final exam.

NOTE: All students are expected to be available for the complete final exam period. Conflict with previously made travel arrangements is not an acceptable reason for missed exams.

Final grade: Faculty of Science approved letter grades

NOTE: Numerical grades are only guides for assignment of final grades. Exam and laboratory marks are made available to students; however, a final numerical mark is not disclosed to the student. There will be no extra credit assignments granted.

All Lecture material will be posted on Moodle on a weekly basis and the lecture material will parallel the text book. Where a section is not included from text, the information will be posted on Moodle along with the pertinent source for your reference. The OWL online system is worth 10% of your grade and problems will be posted again on a weekly biweekly basis.

Detailed Syllabus/Learning Objectives

Note: Some sections may not be covered. In lectures, I will indicate the specific sections covered from text. Learning objectives are given below.

Module 1 *Chapters 1 - 4*

Introduction to Chemistry and Materials Science – Review of U12 Chemistry- Numbers & Measurements in Chemistry, Stoichiometry, Balancing Chemical reactions, limiting reagents, solution chemistry-solutions and their concentrations. Understand connections between chemistry and engineering, and gain a basic introduction to materials science, structure property- processing relationship. Recognize difference in materials, their classification and identify possible applications.

These topics are covered in chapters 1-4 (**Part I**) and Chapters 1 (**Part II**) and **Part III** of the text (custom edition). Learning objectives include:

- performing simple unit conversions and numerical calculations involving numbers in scientific notation, significant figures; explaining the concept of mole, calculation of molar mass from chemical formulae, performing interconversion between mass, moles and # of molecules, calculation of mass % composition from chemical formula and determination chemical formulae from elemental analysis;
- calculation of molarity, stoichiometric calculations of reactions in solutions, writing molecular and ionic equations for solution reactions, identification of common acids, bases, equations for acid-base reactions calculate solution concentrations from titration information.
- identify a limiting reagent and calculate amount of product formed from a non stoichiometric mixture of reactants.

Module 2 *Chapter 5- Gases*

- Apply the ideal gas law to solve various problems involving P, V, n, or T and when given information of the initial and final states of a gas. Solve stoichiometry problems involving gases. Solve problems involving mixtures of gases with either the ideal gas law or Dalton's law of partial pressures. Explain the phenomena of effusion; compute effusion rates and apply Graham's law.

- Explain why real gases differ from ideal gases and how the differences lead to the van der Waals equation. Know under what conditions gases are most nearly ideal.
- **Chapter 6** Describe trace analysis and explain its role in materials testing. Understanding role of matter at microscopic level. (Some of the content is review material and will also be covered in chapter 2 –part II of the text)
- **Chapter 7** Recognize factors influencing biocompatibility of materials and explain their connection to chemical bonding. Consider role of nanoparticles for drug delivery.

Chapter 8

- Describe the difference between intra- and intermolecular forces, distinguish the different types of forces between molecules, and explain how these forces influence molecular properties.
- State the conditions that lead to hydrogen bonds, explain how hydrogen bonds differ from other types of intermolecular forces, and describe the effect of hydrogen bonds on physical properties. (section 8.4)
- Determine vapour pressure experimentally, estimate values from tables or graphs, and predict whether vapor and/or liquid is present under specific conditions.
- Understand terms that apply to phase changes of solids.
- Interpret simple phase diagrams and use phase diagrams to predict changes that occur as a substance is heated, cooled, or undergoes a change in pressure.
- Describe aspects of network covalent bonding: the conditions that lead to it, the properties of solids in which it occurs, and some examples of these solids.
- Predict relative lattice energies of ionic compounds and relate their magnitudes to the physical properties of those compounds (such as melting point and molar enthalpy of vaporization).
- Explain what a unit cell is, use its dimensions in calculations, and analyze unit cells to determine crystal coordination numbers and chemical formulas.
- Explain why crystalline solids are often imperfect. Describe the various types of defects arising in crystalline solids.

- Explain the main properties of ceramics and glasses.

Module 3 Chapters 9 - 10

- Understand and apply the concepts of heat and work in thermochemistry
- Define heat capacity and its important application in calorimetry.
- Apply the first law of thermodynamics.
- Apply Hess's law of constant heat summation.
- State the definitions of "standard state" and "standard formation reaction" and write the standard formation reaction for any substance.
- Use the Born-Fajans-Haber cycle to calculate lattice energies of ionic compounds from thermochemical, atomic, and molecular data. (Not in text, will be covered in lecture)
- Explain why entropy alone is not used to predict a spontaneous change and why free energy is needed and quantitatively predict a system's behaviour.

Module 4 Chapter 12

- Describe the condition of equilibrium in a reversible reaction.
- Recognize that equilibrium is dynamic and that at equilibrium, the forward and backward reaction rates are equal.
- Write the equilibrium constant expression in terms of concentrations, K_c , or partial pressures of gases, K_p ; and relate the value of K_p to the corresponding value of K_c or vice versa. Calculate the equilibrium constants from experimental data. Calculate equilibrium composition from initial data and equilibrium constant. Explain the response of an equilibrium system to applied stress- Le Chatelier's principle. Explain the connection between K_{eq} and ΔG .
- Solubility Equilibria. Common Ion Effect. Acids and Bases. Bronsted-Lowry Theory of Acids and Bases. Free Energy and Chemical Equilibrium.

Module 5: Materials and their Applications.

(Ch 16- sections to be outlined in lecture slides & Ch 8- Section 8-6)

- Explain difference between natural and artificial polymer.
- Explain basic polymerization reactions and the characteristics of polymer produced.
- Identify and discuss differences between polymer materials properties and their structure.

- Apply knowledge of mechanical behaviour to polymers.