Lakeside View Global Vision
CEGEP JOHN ABBOTT COLLEGE

John Abbott Science Program 200.BO

General Chemistry II: Atomic and Molecular Structure

A. General information:

Program:	Science	
Discipline:	Chemistry	Office Hours:
Course Number:	202-NYA-05	Telephone:
Ponderation:	3-2-3	E-mail:
Credits:	$2\ ^{2}/_{3}$	Lecture:
Competency code:	00UL	Lab:
Prerequisite:	202-NYB-05	Classroom:
Semester:	Fall 2015	Laboratory room:
Instructor:		
Office:		

B. Introduction:

General Chemistry II is the second of the two required chemistry courses of the science program, and is normally taken in the second semester. It is specifically designed to fulfill the requirements of objective **00UL** of the science program. In the prerequisite course, General Chemistry I, 202-NYB-05, the student acquired a fundamental understanding of the properties of solutions and the chemical processes that occur there. At this point, the student is challenged to go beyond the macro level to develop models of atomic and molecular structure.

Beginning with a presentation of a modern model of the atom that integrates material from physics, the course continues with a study of periodic properties, the formation of chemical bonds, aspects of molecular structure, and the forces established between molecules. The study of molecular structure is designed to prepare the student for further studies in chemistry and in modern biology. At each stage in the course, emphasis will be placed on the relationship between what occurs on the atomic level and what is observed in chemical and physical processes observed in the laboratory and in everyday life. The problem-solving skills taught in this course build upon those acquired in the prerequisite course as well as affording the student experience in the use of deductive reasoning to explain and to predict chemical and physical behaviour on the basis of abstract models introduced in the course.

The laboratory work will further develop skills acquired in General Chemistry I and includes spectroscopic exploration of the chemical and physical properties of substances. It is a normal part of the laboratory to use computers to both collect and analyse data.

The Program Approach and the Exit Profile

This course is part of the **Science Program**, an interrelated sequence of courses that seeks to demonstrate not only the integrity of each science discipline, but also an integrated understanding of science as a whole. These issues will be addressed, but not specifically addressed, in this course, and the student will be assisted in understanding where this particular course fits into the Program as a whole. In addition, while program competencies other than **00UL** will not be specifically assessed, the student should realize that many **Exit Profile** outcomes are being implicitly addressed and assessed in the course; in particular: to apply a scientific method, to apply a systematic approach to problem solving, to use appropriate data procession techniques, to reason logically, to communicate effectively, to work as a member of a team, and to apply knowledge to new situations.

C. **Course Objectives:**

Statement of the Competency

To analyse chemical and physical phenomena in terms of modern atomic theory (00UL).

General Performance Criteria:

- Appropriate use of concepts, laws and principles
- Appropriate use terminology
- Adequate understanding of chemical situations encountered
- Representation of chemical and physical phenomena that is consistent with the probabilistic model
- Correct design and/or application of experimental procedures
- Adequate performance of the basic techniques of experimental chemistry
- Accuracy in calculations
- Adherence to safety and environmental protection regulations
- Submission of laboratory reports according to established norms
- Use of an interdisciplinary approach

Elements of the Competency

1. To apply the quantum mechanical model of the atom to an analysis of the **properties of the elements**.
2. To apply modern atomic theory to the analysis of **compound formation**.
3. To apply the **structural properties** of atoms and molecules to the analysis of the physical and chemical properties of various substances.
4. To **verify experimentally** several chemical and physical properties of substances.
5. To apply the laws of stoichiometry to the study of chemical phenomena. (**Note**: this element is addressed partially under element 2.1 of this course and partially under element 1.3 of 202-NYB -05).

Specific Performance Criteria:

Specific performance criteria for each of the elements of the competency are shown on page 3, with the corresponding **Intermediate Learning Objectives.** For the items in the list of learning objectives on page 3, it is understood that each is preceded by:

'The student is expected to be able to . . .'

D. Evaluation Plan:

Assessment	Ponderation*		Competencies
Unit Test I	10%	Week 6	3
Unit Test II	10%	Week 10	1, 2
Unit Test III	10%	Week 15	3
Final Exam	30%	Dec 11-22	1, 2, 3
Laboratories	25%	Weekly	4, 5
Lab Exam	5%	Week 14	4
Quizzes & assignments	15%		1, 2, 3

*Base ponderation. See following paragraphs for exceptions. The ponderation of individual laboratory experiments, quizzes and assignments are at the discretion of each teacher. Your teacher is responsible for letting you know ahead of time how much each one will be worth.

Please Note:

a) * The lowest unit test mark will be dropped if it is lower than the final exam mark, so that the remaining unit tests are worth 20% of the final grade, and the final exam is worth 40% of the final grade. Please note that this arrangement is not available for a student who is assigned a grade of zero on a unit test because of cheating.
b) To pass the laboratory portion of the course, a minimum of 60% of the total laboratory grade must be obtained. Failing this, a laboratory grade of **zero** will be given and a maximum grade of 55 will be allowed for the course.
c) Notwithstanding other class grades, if a student passes the laboratory portion of the course, a grade of 60% or more on the final exam will guarantee a pass in the course.
d) Every effort will be made to ensure **equivalence amongst the various sections** of the course. Laboratory experiments are common to all sections, common policies are used with respect to replacement of term grades with final exam marks, the requirements of lab projects are reviewed by the course committee, the standard required to pass the course is that of the common text used, and the final exam is both set and graded by all members of the course committee.

E. Course Content:

Specific Performance Criteria	***Text Ref.****	**Intermediate Learning Objectives**
1. The Elements	**Chapters**	1.1 **The Hydrogen Atom**
1.1 Description of the probability model of the hydrogen atom.	**Ch. 2** (2.2-2.4)	1.1.1 Describe Dalton's atomic theory. 1.1.2 Define the terms element, compound, atom and isotope. 1.1.3 Describe how Rutherford used alpha particles to probe the atomic structure. 1.1.4 Describe the nuclear model of the atom.
	Ch. 7 (7.2)	1.1.5 Describe the main characteristics of an electromagnetic spectrum. 1.1.6 Describe the line spectrum of hydrogen.
	(7.3-7.5)	1.1.7 Use the Rydberg equation to predict the wavelengths of the lines in the visible spectrum of hydrogen. 1.1.8 Describe the Bohr model of the hydrogen atom. 1.1.9 Understand the relevance of the Rydberg equation in terms of the Bohr model. 1.1.10 Calculate the energy changes involved for all possible electron transitions in a hydrogen atom. 1.1.11 Sketch an energy level diagram for a hydrogen atom. 1.1.12 Calculate the ionization energy of hydrogen. 1.1.13 Understand the limitations of the Bohr model.
1.2 Description of the probability model of the multielectron atom.		1.2 **The Periodic Table**
	Ch. 7 (7.4)	1.2.1 Describe wave-particle duality and apply the de Broglie equation.
	Ch. 7 (7.5)	1.2.2 Describe the quantum numbers *n*, *l*, m_l and m_s.
	(7.6)	1.2.3 Sketch boundary surface diagrams for s and p orbitals.
	(7.7)	1.2.4 Describe the Pauli exclusion principle and Hund's rule.
	Ch.8 (8.2-8.4)	1.2.5 Use the aufbau method to predict the ground state electron configurations of atoms and ions from hydrogen through to krypton, plus the representative elements.
1.3 Analysis of the periodic properties of the elements using modern theories of chemistry.		1.3 **Periodic Properties of the Elements**
	Ch. 7 (7.7)	1.3.1 Describe diamagnetism and paramagnetism. 1.3.2 Predict whether an atom or an ion is diamagnetic or paramagnetic.
	Ch.8 (8.5-8.8)	1.3.3 Describe, and predict trends in: atomic radius, ionic radius, ionization energy and electron affinity.
2. Compound Formation		
2.1 Analysis of the formation of ionic compounds from a thermodynamic perspective.		2.1 **Ionic Bond Formation**
	Ch. 4 (4.3)	2.1.1 Use solubility rules to predict the solubility of ionic compounds.
	Ch. 4(4.4-4.9)	2.1.2 Identify and write balanced chemical equations for acid/base, double replacement and single replacement reactions. 2.1.3 Write ionic equations for reactions occurring in solution.
	Ch. 9 (9.2-9.4)	2.1.4 Draw the Lewis structure for an ionic compound. 2.1.5 Describe lattice energy. 2.1.6 Use a Born Haber cycle to analyze the thermodynamic factors involved in the formation of an ionic crystal.

*** References from N. J. Tro (Canadian edition.)**

Specific Performance Criteria	***Text Ref.***	**Intermediate Learning Objectives**
2.2 Description of the formation of covalent compounds and complex ions using the valence bond model.	**Ch. 9** (9.5-9.10)	2.2 **Covalent Bond Formation**
		2.2.1 Draw valid Lewis structures for covalent compounds.
		2.2.2 Understand covalent bond properties; bond order, strength, length.
		2.2.3 Assign formal charges to atoms in Lewis structures.
		2.2.4 Describe the concept of resonance and draw the contributing structures of a resonance hybrid.
		2.2.5 Use bond dissociation energies to estimate the enthalpy change for a reaction.
		2.2.6 Describe and know the main periodic trends in the electronegativity of atoms.
		2.2.7 Relate electronegativity differences between bonded atoms to bond polarity.
2.3 Analysis of the geometry of covalent species using modern theories of chemistry.	**Ch. 10** (10.2-10.4)	2.3 **Molecular Geometry**
		2.3.1 Describe the VSEPR Model and use it to predict electron pair geometry, molecular geometry and bond angles.
	(10.4)	2.3.2 Apply VSEPR to central atoms with steric number 6 or less.
	(10.5)	2.3.3 Use the VSEPR Model to predict the molecular polarity of a structure.
	(10.6)	2.3.4 Use the hybridization model to explain sigma and pi bonds.
	(10.7)	2.3.5 Predict whether any central atom is *sp*-, sp^2- or sp^3-hybridized.
		2.3.6 Draw orbital box diagrams for central C, N and O before and after hybridization.
		2.3.7 Draw orbital overlap diagrams clearly indicating sigma and pi bonds.
	Ch. 20 (20.2, 20.3, 20.5, 20.7, exclude naming)	2.3.8 Draw 3-D representations of simple organic and inorganic molecules.
		2.3.9 Describe and identify structural isomers and stereoisomers (diastereomers and enantiomers).
		2.3.10 With the aid of molecular models determine the isomeric relationships among different structures.
3. Structural Properties		
3.1 Description of the nature and strength of the intermolecular forces in simple chemical systems.	**Ch. 11** (11.3-11.4)	3.1 **Intermolecular Forces**
		3.1.1 Describe each of the following intermolecular forces: dispersion force, dipole-dipole force, H-bonding.
3.2 Understanding of the relationship between intermolecular forces and the physical properties of substances.	(11.3)	3.2 **Intermolecular Forces and Physical Properties**
		3.2.1 Describe the effects of increasing dispersion forces on boiling and melting points.
		3.2.2 Describe the effects of dipole forces on boiling and melting points.
		3.2.3 Describe the effect of hydrogen bonding on the boiling point and melting point.
	(11.9)	3.2.4 Describe the unique physical properties of water.
		3.2.5 Describe the typical physical properties of ionic compounds.
	Ch. 12 (12.2-12.3)	3.2.6 Use a thermodynamic cycle to describe the solution process of an ionic compound and to explain the factors affecting the enthalpy of solution.

Specific Performance Criteria	Text Ref.	Intermediate Learning Objectives
		3.2.7 Describe the solubility of an ionic compound in terms of the lattice energy, enthalpy of solution and the entropy change for the solution process.
3.3 Analysis of the relationship between the structure of acids and bases and their degree of dissociation.	**Ch. 15** (15.11,15.10)	3.3 **Acid and Base Strength** 3.3.1 Rank simple acids in order of increasing or decreasing acid strength.
	(15.4, course notes)	3.3.2 Describe the importance of charge delocalization in stabilizing the conjugate base of an acid.
		3.3.3 Rank simple bases in order of increasing or decreasing base strength.
	Ch. 16 (16.4)	3.3.4 Describe how to measure the pK_a of a weak acid or the pK_b of a weak base.
4. Experimental verification 4.1 Observation of the visible emission spectrum of an element.	**Ch. 7** (7.3)	4.1 **Emission Spectra** 4.1.1 Interpret the line spectrum of elements such as hydrogen and sodium in terms of Bohr theory. 4.1.2 Use flame tests as a qualitative analysis for the presence of group IA and IIA cations in solutions.
4.2 Measurement of light absorption by compounds in solution.		4.2 **Absorption Spectra** 4.2.1 Record and interpret the absorption spectrum of a specified ion or ions. 4.2.2 With the aid of appropriate graphing techniques determine the concentration of an absorbing species in a solution of unknown concentration.
4.3 Observation of certain chemical and physical properties of aqueous solutions	**Ch. 4** (4.4-4.9) **Ch. 6** (6.6) **Ch. 12** (12.3) **Ch. 16** (16.4)	4.3 **Chemical reactions** 4.3.1 Carry out specified single and double replacement reactions in aqueous solution. 4.3.2 Use a coffee cup calorimeter to measure an enthalpy of solution or reaction. 4.3.3 To determine the pK_a of a weak acid or the pK_b of a weak base using the half-neutralization method.

F. Required Texts: Course Costs in Addition to Texts:

*Chemistry: A Molecular Approach (Canadian Ed.), Nivaldo J. Tro, Pearson Prentice Hall (approx. $150)
*Chem NYA Lab Manual, John Abbott College, Chemistry Department, Fall 2015 (approx. $5)
*MasteringChemistry access code – teacher dependent (included in the price of a new book, but may be purchased separately on-line)
**Safety glasses must be worn at all times in the laboratory.* Good quality safety glasses are available from the bookstore (about $8) or from most hardware stores. Normal prescription glasses may be worn.
*A sturdy cotton lab coat or lab apron is required (about $20 at the bookstore).
*Optional Material: A molecular model kit (approx. $25). Instructions concerning the type of kit to be purchased will be given by the instructor.

G. Bibliography:

Other Materials and Readings: Determined by the individual teacher.

H. Teaching Methods:

The course will be 75 hours, divided into Lecture and Laboratory periods, as follows:

Lectures: 45 hours.

Two 1.5-hour lectures per week, consisting of the introduction of new material, usually accompanied by the working of sample problems. In addition, preparation for upcoming laboratory sessions will be discussed during lecture time.

Laboratory Sessions: 30 hours.

One 2-hour period per week. These periods will include applications of techniques learned in General Chemistry I to solve problems related to atomic and molecular structure, in addition to practice in the basic techniques of experimental chemistry introduced in this course. The chemistry laboratories are well-equipped with computers interfaced with various instruments and students will be trained in their use. Some laboratory sessions will be used for workshops that will help the student work with molecular models and to cope with course material.

I. Departmental Policies:

a) Regular attendance is expected. If lectures are missed, it is the responsibility of the student to cover the material missed and to be aware of any announcements made concerning assignments, quizzes, tests or changes to the laboratory schedule.
b) Students must attend the laboratory session in which they are officially registered.
c) There will be no make-up tests, quizzes or laboratory periods. If you miss an evaluation session or deadline due to illness, you must notify your instructor as soon as possible. A valid medical note is required to prove absence for a medical reason. If a test is missed for a valid reason, then the final exam mark will be used as a basis for a substitute for the missed test mark. Late homework may be accepted, with or without penalty, at the discretion of individual instructors.
d) Periodically there will be workshops held during the laboratory period. Attendance is required. Quizzes or assignments may be given during these workshops.
e) **A special note concerning the use of chemicals**: this course uses chemicals as part of its normal teaching practices. If a student has experienced allergic reactions in the past due to any particular chemical or chemicals he or she must inform the instructor. In the event that an allergic reaction is experienced at the college, the student should report to Campus Security immediately (local 5226, 5231, or 514-398-7770).
f) Cell phones and computers may only be used during class for pedagogical purposes.
g) Students are expected to behave respectfully towards their classmates and teachers. In case of inappropriate behavior a student will be asked to leave the class or the lab session. If an assessment is planned for this session, a mark of zero will be given in that case.

J. College Policies:

Policy No. 7 – IPESA, Institutional Policy on the Evaluation of Student Achievement:
http://www.johnabbott.qc.ca/wp-content/uploads/2014/05/2011_IPESA_-FINAL-website_JAN_2013-updated-links.pdf

a) Changes to Evaluation Plan in Course Outline (Article 4.3)

Changes to the evaluation plan, during the semester, requires unanimous consent.

b) Mid-Semester Assessment MSA (Article 3.3)

First and second semester students will receive an MSA in accordance with College procedures.

c) Religious Holidays (Article 3.2)

Students who wish to observe religious holidays must inform their teacher in writing within the first two weeks of the semester of their intent.

d) Student Rights and Responsibilities (Article 3.2, item 19 and Article 3.3, item 7.)

It is the responsibility of students to keep all assessed material returned to them in the event of a grade review. (The deadline for a Grade Review is 4 weeks after the start of the next regular semester.)
Students have the right to receive the results of evaluation within two weeks. For evaluations at the end of the semester/course, the results must be given to the student by the grade submission deadline.

Cheating and Plagiarism (Article 8.1 & 8.2)
Cheating and plagiarism are serious infractions against academic integrity which is highly valued at the College; they are unacceptable at John Abbott College. Students are expected to conduct themselves accordingly and must be responsible for all of their actions.

Cheating
Cheating means any dishonest or deceptive practice relative to examinations, tests, quizzes, lab assignments, research papers or other forms of evaluation tasks. Cheating includes, but is not restricted to, making use of or being in possession of, unauthorized material or devices and/or obtaining or providing unauthorized assistance in writing examinations, papers or any other evaluation task and submitting the same work in more than one course without the teacher's permission. It is incumbent upon the Department through the teacher to ensure students are forewarned about unauthorized material, devices or practices that are not permitted.

Plagiarism
Plagiarism is a form of cheating. It includes the intentional copying or paraphrasing (expressing the ideas of someone else in one's own words), of another person's work or the use of another person's work or ideas without acknowledgement of its source. Plagiarism can be from any source including books, magazines, electronic or photographic media or another student's paper or work.