JOHN ABBOTT CEGEP/COLLEGE

COURSE OUTLINE

A. GENERAL INFORMATION:

1. Program name:	Science
2. Course title:	**General Chemistry II: Atomic and Molecular Structure**
3. Course and section number(s):	202-NYA-05
4. Ponderation (weekly class – lab/fieldwork – homework hours):	3-2-3
5. Credits:	$2^2/_3$
6. Competency statement and code:	To analyse chemical and physical phenomena in terms of modern atomic theory (00UL) (covered completely)
7. Prerequisite:	202-NYB-05
8. Semester:	Fall 2022
9. Teacher name(s), (pronouns if desired):	
10. Office number, phone extension (email address optional):	
11. Teacher's availability:	

B. INTRODUCTION:

Land Acknowledgement: *At John Abbott College we acknowledge that we are on unceded Indigenous lands of the traditional territory of both the Kanien'kehá:ka, "Mohawk," and the Anishinabeg, "Algonquin," peoples.*

We are grateful for the opportunity to gather here and we thank the many generations of people who have taken care of this land and these waters. Tiohtiá:ke, Montreal, is historically known as a gathering place for diverse First Nations; thus, we recognize and deeply appreciate the historic and ongoing Indigenous connections to and presence on these lands and waters. We also recognize the contributions Métis, Inuit, and other Indigenous peoples have made in shaping and strengthening our communities.*

Together, as a diverse college community, we commit to building a sincere relationship with Indigenous peoples based on respect, dignity, trust, and cooperation, in the process of advancing truth and reconciliation

Course summary: 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, Chemistry of Solutions (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. Each stage in the will emphasize 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, and afford the student experience in the using 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 Chemistry of Solutions 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.

Role and place of the course: 202-NYA-05 is normally taken in the program's second semester, although it may be done in a subsequent semester. It is a prerequisite for all science program option courses offered by the chemistry department.

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. 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:

Objectives: To analyse chemical and physical phenomena in terms of modern atomic theory
1. Apply the quantum mechanical model of the atom to an analysis of the **properties of the elements.**
2. Apply modern atomic theory to the analysis of **compound formation.**
3. Apply the **structural properties** of atoms and molecules to the analysis of the physical and chemical properties of various substances.
4. **Verify experimentally** several chemical and physical properties of substances.
5. 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).

Upon successful completion of this course, students will be able to:

- Make appropriate use of concepts, laws and principles.
- Use terminology appropriately.
- Show adequate understanding of chemical situations encountered.
- Represent chemical and physical phenomena in ways that are consistent with the probabilistic model.
- Correctly design and/or apply experimental procedures.
- Adequate perform the basic techniques of experimental chemistry.
- Perform calculations accurately.
- Adhere to safety and environmental protection regulations.
- Submit laboratory reports according to established norms.
- Use an interdisciplinary approach.

D. EVALUATION PLAN (include all components of the evaluation and their weights – IPESA Article 6):

Evaluation type:	**%**	**Tentative date:**	**Link to competencies/objectives/ competency elements:**	**√ if part of final evaluation**
Unit test 1	10	Week 5-6	1	
Unit test 2	10	Week 10-11	2,5	
Unit test 3	10	Week 14-15	3	
Final exam	30	Mid-December	1, 2, 3, 5	**√**
Laboratories	25	Almost weekly	4	**√**
Quizzes and/or assignments	15	Instructor's discretion	1, 2, 3, 5	
Total value:	100%			
Value of final evaluation:	55			

Please Note:

a) A student may drop the lowest unit test mark, 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. This is not available for a student 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 standard required to pass the course is that of the common text used, and the final exam is both agreed upon by all members of the course committee and graded from a common marking scheme.

E. COURSE CONTENT:

** Text references are from Flowers et al., 2nd Edition (2019)*

*** Content marked with an ** may not be covered in detail in the textbook. Additional notes will be provided by your instructor*

Topics:	Text reference(s)*	Additional Info:
<u>Unit 1. The Elements</u> 1.1 Description of the probability model of the hydrogen atom.	**Chapters** **Ch. 1, 2** (1.2, 2.1-2.2)	1.1 **<u>The Hydrogen Atom</u>** 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, Thompson and Millikan elucidated the atomic structure. 1.1.4 Describe the nuclear model of the atom. 1.1.5 Describe the main characteristics of an electromagnetic spectrum. 1.1.6 Describe the line spectrum of hydrogen. 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.	**Ch. 6** (6.1-6.2) **Ch. 6** (6.3-6.4)	1.2 **<u>The Periodic Table</u>** 1.2.1 Describe wave-particle duality and apply the de Broglie equation. 1.2.2 Describe the quantum numbers n, l, m_l and m_s. 1.2.3 Sketch orbital surfaces for *s* and *p* orbitals. 1.2.4 Describe the Pauli exclusion principle and Hund's rule. 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.	**Ch.8** (8.4) **Ch.6** (6.5)	1.3 **<u>Periodic Properties of the Elements</u>** 1.3.1 Describe diamagnetism and paramagnetism. 1.3.2 Predict whether an atom or an ion is diamagnetic or paramagnetic. 1.3.3 Describe, and predict trends in: atomic radius, ionic radius, ionization energy and electron affinity.

<u>Unit 2. Compound Formation</u> 2.1 Analysis of the formation of ionic compounds from a thermodynamic perspective.	**Ch. 7** (7.1, 7.3, 7.5)	2.1 **<u>Ionic Bond Formation</u>** 2.1.1 Describe lattice energy. 2.1.2 Use a Born Haber cycle to analyze the thermodynamic factors involved in the formation of an ionic crystal.
2.2 Description of the formation of covalent compounds and complex ions using the valence bond model.	**Ch. 7** (7.2, 7.3-7.5)	2.2 **<u>Covalent Bond Formation</u>** 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. 7** (7.6) **Ch.8** (8.1-8.3) **Ch. 20** (20.1, 20.3, exclude naming)	2.3 **<u>Molecular Geometry</u>** 2.3.1 Describe the VSEPR Model and use it to predict electron pair geometry, molecular geometry and bond angles. 2.3.2 Apply VSEPR to central atoms with steric number 6 or less. 2.3.3 Use the VSEPR Model to predict the molecular polarity of a structure. 2.3.4 Use the hybridization model to explain sigma and pi bonds. 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 (σ) and pi (π) bonds. 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.

Unit 3. Structural Properties 3.1 Description of the nature and strength of the intermolecular forces in simple chemical systems.	**Ch. 10** (10.1)	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.	(10.3) (10.2) **Ch. 7** (7.1)	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. 3.2.4 Describe the unique physical properties of water. 3.2.5 Describe the typical physical properties of ionic compounds. 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.** 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. 14** (14.3) (course notes) (14.6-14.7)	3.3 **Acid and Base Strength** 3.3.1 Rank simple acids in order of increasing or decreasing acid strength. 3.3.2 Describe the importance of charge delocalization in stabilizing the conjugate base of an acid. 3.3.3 Describe how to measure the pK_a of a weak acid
4. Experimental verification 4.1 Observation of the visible emission spectrum of an element.	**Ch. 6** (6.1)	4.1 **Emission Spectra** 4.1.1 Interpret the line spectrum of elements in terms of Bohr theory. 4.1.2 Use flame tests as a qualitative analysis for the presence of group 1 and 2 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 chemical species.

		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. 5** (5.2) **Ch. 14** (14.7)	4.3 **Chemical reactions** 4.3.1 Use a coffee cup calorimeter to measure an enthalpy of solution or reaction. 4.3.2 To determine the pK_a of a weak acid using the half-neutralization method.**

F. REQUIRED TEXTBOOKS/MATERIALS, COURSE COSTS IN ADDITION TO TEXTS:

Item:	Estimated cost ($):
Flowers, P., K. Theopold, R. Langley, W. R. Robinson, *Chemistry 2e*, OpenStax (Rice University). Freely available at https://openstax.org/details/books/chemistry-2e.	Free (digital copy)
Safety glasses (available from the JAC bookstore or from most hardware stores). Normal prescription glasses may be worn.	$10
Cotton lab coat (available from the JAC Bookstore, or may be available second hand- see JAC portal)	$25
Molecular model kit (optional)	$35

G. BIBLIOGRAPHY

Not applicable

H. INSTRUCTIONAL METHODS:

Methods used in teaching the course:
The course will be 75 hours, divided into lecture (classroom) and laboratory periods, as follows: **Lectures:** 45 hours Two 1.5-hour sessions 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 Chemistry of Solutions (202-NYB-05) to solve problems related to atomic and molecular structure, practice of the basic techniques of experimental chemistry introduced in this course, and practice in designing and carrying out strategies to investigate chemical systems. The chemistry laboratories are well-equipped with computers interfaced with various instruments and you will be trained in their use. Some laboratory sessions will be used for workshops that will help you work with molecular models and to cope with course material.

I. PROGRAM, DEPARTMENTAL/DISIPLINE, AND COURSE/SECTION POLICIES:

Policy:	Description:
Department attendance policy (Policy 6).	Students are expected to attend all lecture and laboratory sessions. Students are responsible for all assigned work, lecture material and other course related material announced or assigned during class. Attendance for laboratory periods is mandatory. Missing a lab period without a valid reason will result in a grade of zero being assigned to any work assigned during that period. *However,* ***please do not come to campus if you are showing any COVID-19-related symptoms unless you have tested negative.*** *Be assured that we will arrange make up work or some alternative.*
Policy to ensure that issues relating to late submission, or resubmission, of work to be dealt with in an equitable manner (Policy 7).	All assigned work is to be submitted on time. Late submission may be accepted, with or without penalty, at the discretion of individual instructors.
Policy dealing with the expectations of classroom behaviour, including use of cell phones, laptops and other technology (Policy 13).	Use of personal electronic devices is permitted in the classroom or laboratory with teacher's permission.
Other expectations.	1. If you miss an evaluation session or deadline due to illness or other valid reason, 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 can be used as a basis for a substitute for the missed test mark. 2. 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 6911, or 9-514-457-6911). 3. Students are expected to behave respectfully towards their classmates and teachers. In case of inappropriate behaviour 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:

Topic:	Resource:
Student rights and responsibilities (articles 3.2 and 3.3)	Policy 7:IPESA - Institutional Policy on the Evaluation of Student Achievement (version: June 12, 2019)
Changes to evaluation plan in the course outline (article 5.3)	
Religious holidays (articles 3.2.13 and 4.1)	
Cheating and plagiarism (articles 9.1 and 9.2)	
Cheating and plagiarism academic procedure and other resources	Academic Integrity: Cheating and Plagiarism Procedure (version: October 22, 2021) • **You need to log into Omnivox to access the above document** • **For PowerPoint on cheating and plagiarism** refer to the JAC Portal: My JAC Communities / Academic Council / Curriculum Validation Committee (CVC) / Course Outlines – Reference Documents / Academic Integrity • **For link to interactive tutorial on how to cite sources correctly**: http://citeit.ccdmd.qc.ca
Code of conduct	Policy 13: Policy on Student Conduct and Discipline Procedures (version: September 21, 2021)

K. PROVISO:

- Attendance: Due to the ongoing pandemic health issues, attendance policies may need to be adjusted by your teacher. The normal attendance expectations are outlined above (Section I) and your teacher will inform you of any modifications as needed. Please note that attendance continues to be extremely important for your learning, but your teacher may need to define it in different terms based on the way your course is delivered during the semester.

- Please note that course outlines may be modified if health authorities change the access allowed on-site. This includes the possibility of changing between in-person and online formats.