

A. GENERAL INFORMATION:

1. Program name:	Science
2. Course title:	General Chemistry
3. Course and section numbers:	202-SN1-RE Sections 03-04
4. Ponderation (weekly class – lab – homework hours):	3-2-3
5. Credits:	2 $\frac{2}{3}$
6. Competency statement and code:	Analyze properties of matter and chemical changes (0C01) Covered Completely
7. Prerequisite:	Secondary V Chemistry
8. Semester:	Winter 2025
9. Teacher name(s), (pronouns if desired):	Lecture: Michael Lautman Laboratory: Sean Hughes
10. Office number, phone extension (email address optional):	Michael Lautman: AME-412 (Extension 5880) Sean Hughes: AME-417 (Extension 5877) MIO is best for contacting Michael and Sean
11. Teacher's availability:	Posted

B. INTRODUCTION:
Course summary:

General Chemistry is the first of the two required chemistry courses of the Science Program and is normally taken in the first semester. It is specifically designed to fulfill the requirements of objective 0C01 of the Science Program.

The course initially reviews the use of chemical language and applications of quantitative analysis of chemical systems. The course then introduces the properties of elements and periodic trends, which are fundamental to understanding the structure of matter. Finally, macroscopic properties of matter are studied, identifying relevant intermolecular forces and their effect on properties (for example phase transitions and solubility). Deductive reasoning is used to explain and to predict chemical and physical behaviour. The study of molecular structures is essential to prepare the student for further studies in chemistry and in modern biology.

The laboratory work introduces laboratory techniques and best practices in a laboratory setting.

Role and place of the course:

202-SN1-RE General Chemistry is normally taken in the program's first semester, although it may be taken in a subsequent semester. It is a prerequisite for 202-SN2-RE Chemistry of Solutions.

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 chemistry-specific knowledge, but also an integrated understanding of science. While program competencies other than OC02 will not be specifically assessed, the student should realize that many Exit Profile outcomes are being implicitly addressed and assessed in the course; by the end of the Science program, students will be able to:

1. Draw on subject-specific knowledge that allows for the consolidation and enrichment of their basic scientific culture;
2. Approach complex situations from an interdisciplinary perspective;
3. Appreciate the relationships between science, technology and society;
4. Demonstrate critical judgment and intellectual rigour;
5. Use digital technologies in a scientific context;
6. Develop a collaborative spirit and communicate; and
7. Demonstrate a nuanced understanding of human impacts on the natural world and planetary life support systems in the context of global climate and environmental disruptions.

The Teaching of the Climate and Ecological Emergency (CEE) is integrated in the Science Program. General Chemistry expands on selected topics by including fundamental aspects of the Climate and Ecological Emergency (CEE modules). Four basic aspects are emphasized by John Abbott College:

1. Causes: the factors that cause climate change and ecological degradation
2. Impacts: the range of impacts on the biophysical world and on human societies
3. Dynamics: the social forces that produce the emergency, impinge on change, and distribute the impacts unevenly
4. Actions: appropriate objectives and means for mitigating and adapting to the emergency; action contributing to the solutions

C. COURSE OBJECTIVES:

Objectives
Statement of the Competency: Analyze properties of matter and chemical changes.
Performance Criteria for the Competency as a Whole: <ul style="list-style-type: none">• Appropriate use of terminology.• Observance of mathematical and chemical formalism.• Use and conversion of appropriate units of measurement.• Consideration of environmental issues.• Demonstration of rigour in the problem-solving approach.

Elements of the Competency:

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

1. Use chemical language and symbols.
2. Carry out the quantitative analysis of chemical systems.
3. Explain the properties of the elements and how they relate to the periodic classification.
4. Explain the structure of matter according to the types of chemical bonds.
5. Explain the main macroscopic properties of matter.
6. Verify, using an experimental method, some chemical and physical properties of matter.

D. EVALUATION PLAN:

Evaluation type:	%	Tentative date:	Link to the Elements of the Competency:	✓ if part of final evaluation
Test 1	10	Week 5-6	1, 2, 6	
Test 2	10	Week 10-11	3, 6	
Test 3	10	Week 15	4, 5, 6	
Final exam	30	TBA	1, 2, 3, 4, 5, 6	✓
Laboratories	25	Weekly	6	✓
Quizzes and/or assignments	15	TBA	1, 2, 3, 4, 5, 6	
Total value:	100%			
Value of final evaluation:	55			

Additional explanation of the evaluation plan:

a) A student may drop the lowest test mark, if it is lower than the final exam mark, so that the remaining 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 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: Elements of the Competency and Corresponding Performance Criteria**1. Use chemical language and symbols.**

- 1.1. Recognize and identify the following: atom, element, compound, and molecule.
- 1.2. Recognize and identify the following: ion, cation, and anion.
- 1.3. Recognize and identify isotopes of the same element.
- 1.4. Identify by name and formula the following elements from their chemical symbols: elements 1-36, Sr, Pd, Ag, Cd, Sn, I, Xe, Ba, Pt, Au, Hg, and Pb.
- 1.5. Identify the common oxidation state (charge) of ions: elements 1-20 and 31-36.
- 1.6. Identify elements as being metals, non-metals, or metalloids.
- 1.7. Distinguish between the bonds of molecular and ionic compounds. Identify molecular and ionic compounds based on their formulae/name.
- 1.8. Write the formulae associated with the following polyatomic ions: nitrate ion, nitrite ion, sulfate ion, sulfite ion, carbonate ion, bicarbonate ion, phosphate ion, hydroxide ion, hydronium ion, acetate ion, ammonium ion, and perchlorate ion.
- 1.9. Write the chemical formula of ionic compounds, binary molecular compounds, and hydrated compounds from the name.

2. Carry out the quantitative analysis of chemical systems.

- 2.1. Define the terms mass, mole, molarity, atomic mass, molar mass, density, ppm (by mass and by volume), and ppb (by mass and by volume).
- 2.2. Convert measurements to different scales on the S.I. system: kilo, centi, milli, micro, and nano. Example: convert moles into millimoles.

- 2.3. Convert between units of the chemical quantities listed in Objective 2.1. Example: convert moles into grams.
- 2.4. Apply the rules of stoichiometry to balance chemical equations.
- 2.5. Determine the initial number of moles of reactants and the number of moles of reactants and products after a chemical reaction.
- 2.6. Identify a limiting reactant and calculate the theoretical yield of a chemical reaction.
- 2.7. Calculate the percent yield of a reaction or use a percent yield to predict the amount of product from a reaction.

3. Explain the properties of elements and how they relate to the periodic classification.

- 3.1. Describe the probabilistic model of the atom and what led to its development.
- 3.2. Explain the behaviour of electrons in the quantum-mechanical model of the atom.
- 3.3. Define the four quantum numbers n , l , m_l and m_s .
- 3.4. Recognize the shapes associated with different values of the quantum number l (s and p only)
- 3.5. Express how the quantum numbers relate to the size, shape, and orientation of an orbital, and to the spin of an electron.
- 3.6. Write the full and condensed electron configurations and their corresponding orbital box diagrams for ground-state atoms and monoatomic ions of the first four periods, respecting the Aufbau principle, Hund's rule, and the Pauli exclusion principle.
- 3.7. Identify core and valence electrons.
- 3.8. Describe orbital penetration and shielding to assess relative energies of orbitals.
- 3.9. Provide a rationale for the energy of an atomic orbital based on electron-nuclear attraction and electron-electron repulsion.
- 3.10. Distinguish between ground-state and excited-state electron configurations.
- 3.11. List common characteristics of metals, non-metals, and metalloids.
- 3.12. Recognize a set of isoelectronic species.
- 3.13. Define atomic and ionic size.
- 3.14. Define ionization energy.
- 3.15. Define electron affinity.
- 3.16. Explain trends across periods and down groups for: atomic size, ionic size, ionization energies, and electron affinities.

4. Explain the structure of matter according to the types of chemical bonds.

- 4.1. Recognize ionic compounds, molecular compounds, network covalent substances, and metals from formulae and/or drawings.
- 4.2. Define electronegativity and relate bond polarity to differences in electronegativity between bonded atoms.
- 4.3. Differentiate between ionic, polar covalent, and non-polar covalent bonds.
- 4.4. Define lattice energy.
- 4.5. Explain trends in the magnitudes of the lattice energies for ionic compounds using Coulomb's law.
- 4.6. Draw valid Lewis structures for molecular compounds, including those with exceptions to the octet rule.
- 4.7. Assign formal charges to atoms in Lewis structures.
- 4.8. Evaluate covalent bond properties (bond length, bond strength and bond order).
- 4.9. Draw resonance structures for polyatomic ions and simple molecules.
- 4.10. Estimate the enthalpy change for a reaction using bond dissociation energies.
- 4.11. Predict electron pair geometry, molecular geometry, bond angles, and molecular polarity using the valence shell electron-pair repulsion (VSEPR) model.
- 4.12. Determine the hybridization of central atoms (sp , sp^2 , and sp^3 only).
- 4.13. Explain sigma and pi bonds using the hybridization model.
- 4.14. Interpret orbital-overlap diagrams, identifying sigma and pi bonds.

5. Explain the main macroscopic properties of matter.

- 5.1.** Describe intermolecular forces (IMF) in both pure substances and in solution.
 - 5.1.1. Dispersion forces.
 - 5.1.2. Dipole-dipole forces.
 - 5.1.3. Hydrogen bonding forces.
 - 5.1.4. Ion-dipole forces.
- 5.2.** Assess the relative strength of intermolecular forces between different species (molecules, ions, or atoms).
- 5.3.** Draw the possible intermolecular forces between species (molecules, ions, and/or atoms).
- 5.4.** Compare and explain the relative melting and boiling points of pure substances based on the strength of their intermolecular forces.
- 5.5.** Assess miscibility of two substances and determine whether they might form a homogeneous mixture based on the intermolecular forces involved. (*IMF's broken in the pure substance and IMF's formed in the possible mixture.*)
- 5.6.** Assess the relative strength of the ion-dipole forces made when ionic compounds are dissolved in water.
- 5.7** Evaluate the environmental partitioning and mobility of compounds of environmental concern using intermolecular forces.

6. Verify, using an experimental method, some properties of chemical systems, and reactions.

- 6.1.** Identify the purpose (to contain or to deliver) of glassware.
- 6.2.** Obtain accurate and precise measurements with common laboratory instruments.
- 6.3.** Produce a record of work during laboratory activities.
- 6.4.** Record data from scientific instruments and glassware to the appropriate number of significant digits.
- 6.5.** Report qualitative observations related to both chemical and physical changes.
- 6.6.** Use appropriate software to process data collected, including graphical representation with a trend line.
- 6.7.** Determine if data is accurate by comparing measured values to known values.
- 6.8.** Determine how precise a data set is by making use of either a standard deviation or correlation.
- 6.9.** Identify controlled and manipulated variables associated with an experimental protocol.
- 6.10.** Collaborate effectively to share tasks within a group.
- 6.11.** Communicate results in a scientific/professional manner.
- 6.12.** Comply with laboratory rules for health, safety, and environmental protection.
- 6.13.** Analyze a life cycle for materials used and produced by an experiment (CEE).

Elements of the Competency:	Weeks	Additional Info:
	1-15	The 202-SN1-RE teaching committee will choose to incorporate one to four CEE modules during the semester.
1. Use chemical language and symbols. 2. Carry out the quantitative analysis of chemical systems.	1-5	2.4 Students will not need to predict product(s) from provided reactants. The 202-SN1-RE teaching committee may choose to incorporate the following CEE modules: A. Calculate atom economy and contrast this with percent yield as a way of evaluating the efficiency of a reaction or process. May be covered after objective 2.7 . B. Quantitatively evaluate the absolute and relative environmental impact of burning various fuels. May be covered after objective 2.7 .
3. Explain the properties of elements and how they relate to the periodic classification.	6-10	
4. Explain the structure of matter according to the types of chemical bonds. 5. Explain the main macroscopic properties of matter.	11-15	4.6. May also introduce skeleton representations of organic molecules. Radical species may be introduced. The 202-SN1-RE teaching committee may choose to incorporate the following CEE modules: C. Use molecular symmetry and dipole moment to assess whether a molecule is a potential greenhouse gas. May be covered after objective 4.11 . D. Evaluate the environmental partitioning and mobility of compounds of environmental concern using intermolecular forces. May be covered after objective 5.6 .
6. Verify, using an experimental method, some properties of chemical systems, and reactions.	1-15	Glassware: volumetric flask, volumetric pipette, Pasteur pipette, micropipette, burette, Erlenmeyer flask, beaker, and graduated cylinder. Laboratory Instruments: spectrophotometer, thermometer, pH meters, conductivity meters, and electronic balance. Techniques/skills to acquire: <ul style="list-style-type: none"> • Use and handle glassware properly. • Write a procedure. • Record work done (including results and observations). • Prepare a solution of accurate concentration.

		<ul style="list-style-type: none"> • Standardize a solution. • Titrate an analyte with a titrant. • Use a spectrometer to record an absorbance curve, a calibration curve, and determine a concentration. • Use spreadsheets. • Use a calorimeter. • Use a pH-meter. • Identify sources of errors. • Record data in appropriate tables. • Manage time efficiently. <p>Statistical Analysis:</p> <ul style="list-style-type: none"> • Preliminary evaluation of data quality. • Calculate the mean, variance, and standard deviation. • Recognize the type of error (systematic, random, or gross). • Differentiate error and uncertainty. • Express the confidence level of a measurement (statistically significant). • Determine the degrees of freedom in an experimental procedure. • Understand absolute error of an instrument, and the concept of signal to noise (limit of detection). • Identify the correct region for linear regression analysis (R^2). • Understand the importance of sample size when considering removal of outliers from average. <p>See the 202-SN1-RE Lab Manual for the complete list of experiments and their schedule.</p> <p>Objective 6.7. Physics and Biology Departments use percent deviation to compare measured values to known values. $\% \text{ deviation} = \frac{ \text{measured value} - \text{true value} }{\text{true value}} \times 100\%$ Chemistry uses percent error to compare measured values to known values. $\% \text{ error} = \frac{ \text{experimental value} - \text{theoretical value} }{\text{theoretical value}} \times 100\%$</p>
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F. REQUIRED TEXTBOOKS/MATERIALS, COURSE COSTS IN ADDITION TO TEXTS:

Title/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 instead.	\$14
Lab coat (available from the JAC Bookstore, or may be available second hand - see JAC portal)	\$25

G. BIBLIOGRAPHY (if applicable):

Suggested books, articles, videos, websites, podcasts that can supplement the course material:
Supplemental problem sets, practice final exams, and videos can be found on the Chemistry Department Website: https://departments.johnabbott.qc.ca/departments/chemistry/

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-session per week. These periods will include 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 students will be trained in their use. Some laboratory sessions may be used for workshops.

I. CHEMISTRY DEPARTMENT AND COURSE POLICIES:

Policy:	Description:
Approved 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.
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	<p>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. If a test is missed for a valid reason, an alternate test will be offered; you could instead choose to replace your missed test mark with your final exam mark.</p> <p>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).</p> <p>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.</p>

J. COLLEGE POLICIES:

Topic:	Resource:
Student rights and responsibilities (articles 3.2 and 3.3)	https://www.johnabbott.qc.ca/wp-content/uploads/2021/05/Policy-No.-7-IPESA-FINAL.pdf
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	<ul style="list-style-type: none"> • https://johnabbott.omnivox.ca/intr/webpart.gestion.consultation/3-cheating_plagiarism_-_final.pdf?IdWebPart=6b336be2-2405-444e-b1f4-7550857f6a5e&idDoc=YWY1OGM5YzQtNDcxZS00MTQ2LTk5MTEtYjE0YjNiNjc2MzJj&t=1717513517 • 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)