Lakeside View Global Vision
CEGEP JOHN ABBOTT COLLEGE

Chemistry of the Environment

Discipline:	Chemistry	Semester:
Course Code:	202 -DDN-05	Instructor:
Competency Code:	00UV	Office:
Ponderation:	3-2-3	Tel:
Credits:	2.67	Office Hours:
Prerequisites:	202-NYB-05 & 202-NYA-05 (Chemistry)	

Lectures:

Labs:

John Abbott College is located on unceded Indigenous lands, the traditional territory of both the Kanien'kehá:ka ("Mohawk") and the Omàmiwinini ("Algonquin") peoples.

Note on terminology: Parts of this document are written in the active voice. "I" or "me" refers to the course instructor, Ed Hudson. "You" refers to a student enrolled in the course.

B: Introduction

Chemistry of the Environment (for science students) is an option course in the science program. It is specifically designed to partially fulfill the requirements of objective 00UV and is normally taken by science students after they have completed at least two semesters of the program.

Chemistry provides a rich set of tools with which to understand our fascinating living and non-living environment, including the nature and behavior of substances in the atmosphere, natural waters, the solid earth and organisms, and how substances move between these. At the same time, human activities are altering the environment, globally and at unprecedented speed, in ways that often negatively affect human societies and ecosystems. A related concern is the overuse and depletion of finite natural resources. Thus altered or contaminated environments and undisturbed environments which preceded them must be studied in tandem.

This course explores selected current issues in environmental studies using the framework and methods of chemistry, and with reference to the chemical compounds and processes involved. Tools or insights from physics, mathematics, biology, earth sciences and economics are also invoked. You will assess the condition of natural or modified environments, and the effect of naturally occurring substances and contaminants on environmental and biological systems. You are encouraged to use these insights to propose and evaluate solutions to environmental problems, and to critically evaluate the environmental impacts of choices which individuals or societies might make.

This course can contribute to the Environmental Studies certificate. For more information, talk to the teacher or contact the certificate coordinator at envirostudies@johnabbott.qc.ca

Comprehensive Assessment and Integration in the Science Program

The Ministry of Education requires every student to pass a program Comprehensive Assessment and a program integrating activity (Exit Profile Competency 14: "to apply what has been learned to new situations" and Ministry objective 00UU: "to apply acquired knowledge to one or more subjects in the sciences"). The Ministry introduced these requirements because it recognized the importance of connecting the various components within each program.

The various competencies to be addressed in the Science Program are outlined in the outcomes and standards of the Science Program Exit Profile and are listed below. They are divided into two groups: those competencies that are taught and assessed in virtually every course in the program, and those that will be the primary focus of the option courses.

The following competencies are taught and assessed in most courses of the program:

3. To apply the scientific method.
4. To apply a systematic approach to problem solving.
5. To use appropriate data processing techniques.
6. To reason with rigour, i.e., with precision.
8. To learn in an autonomous manner.
13. To display attitudes and behavior compatible with the scientific spirit and method.
14. To apply what has been learned to new situations.

The following competencies will be the special focus of the option courses of the program:

7. To communicate effectively.
9. To work as a member of a team.
10. To recognize the links between science, technology and the evolution of society.
11. To develop a personal system of values.
12. To put into context the emergence and development of scientific concepts.

Rather than impose a major exam or paper at the end of the Science Program, or requiring a single course to fulfill these requirements, John Abbott College has integrated the fulfillment of these requirements into the option courses taken late in the program.

Some option courses in the Science program at JAC, including 202-DDN-05, offer the opportunity to complete the Comprehensive Assessment. Passing the Comprehensive Assessment in any one of these courses will fulfill the Comprehensive Assessment requirements for obtaining a Science D. E. C. at JAC.

C: Course Objectives

OBJECTIVES **STANDARDS**

Statement of the Competency:

To explore in a systematic manner a number of current issues in environmental chemistry.(00UV)

General Performance Criteria:

- Appropriate choice of concepts, laws and principles
- Rigorous application of the concepts, laws and principles
- Appropriate use of terminology
- Adequate mathematical or graphical representation
- Coherence, rigour and justification of the problem-solving methods
- Respect for the scientific method and experimental protocol
- Justification of the method
- Critique of the credibility of the results
- Use of an interdisciplinary approach (00UU)

Elements of the Competency:

1. To apply the laws and principles of natural sciences to the study of the air, water and soil environment and their pollution.

2. To apply scientific procedures and methods to the resolution of some environmental problems.

3. To apply experimental techniques of the natural sciences to analyse environmental samples.

4. To undertake an interdisciplinary project that integrates current learning and which demonstrates competence in three specific goals of the exit profile at the advanced level (00UU).

Specific Performance Criteria:

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

'The student is expected to .....'

D: Evaluation Plan

Assessment	*Ponderation**	*Elements of the Competency*
Three (3) tests (all equal weight) Tentative dates Oct 3, Nov 7, Dec 5	25 %	1, 2
Final Exam	25%	1, 2, 3
Laboratory work	20%	3
Comprehensive Assessment Project Tentative date December 3	15 %	4
Quizzes and assignments	15%	1, 2

*Base ponderation. You will be informed ahead of time what each individual laboratory experiment, quiz and assignments is worth.

- You may drop the lowest of the three test marks, if it is lower than the final exam mark, so that the remaining tests are worth 16% of the final grade, and the final exam is worth 34% of the final grade. This is not available if you are assigned a grade of zero on a test because of cheating.
- 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.
- If you pass the laboratory portion of the course, a grade of 60% or more on the final exam will guarantee a pass in the course.
- The final evaluation for this course is comprised of the Final Exam (25%), the Laboratories (20%) and the Comprehensive Assessment Project (15%).

E: Required Texts and Course Costs

There is no set textbook for this course. All necessary worksheets and handouts, including the laboratory manual, will either be handed out in class or made available on Omnivox (Léa). You will be responsible for printing course materials (class and laboratory) if necessary- though direct use of the digital versions is often appropriate. Other useful resources are listed in Section G (Bibliography)

Other Course Costs

Course costs are mainly associated with the laboratory sessions.

1. *Safety glasses must be worn at all times in the laboratory*. Good quality safety glasses are available from the bookstore or from most hardware stores (approx. $10). You may wear normal prescription glasses.
2. A sturdy cotton lab coat is required (approx. $20).
3. A dedicated laboratory notebook (approx. $5) is required. You will receive instructions concerning this notebook during the first two days of the course.

F: Course Content

Tentative number of classes for each section is indicated in square brackets. The soil chemistry component is heavily dependent on weather, an outside guest, and lab activities. The number of classes for that topic includes lab sessions.

1. The Global Environment and the Tools of Environmental Chemistry [6]

1.1 Environmental compartments	1.1.1 Describe and link components (both abiotic and biotic) of the global environment and identify material flows between them.
1.2 Biogeochemical cycles	1.2.1 Explain the environmental and redox cycling of selected elements, including carbon and nitrogen.
1.3 Sampling & chemical analysis [a]	1.3.1 Identify and distinguish steps and components of a chemical analysis as these relate to environmental samples. 1.3.2 Calculate basic statistical descriptors of environmental quantities 1.3.3 Discuss and appreciate the limitations of a given environmental sampling protocol.[a]
1.4 Modelling & Fermi estimation	1.4.1 Indentify the components in an environmental model and their interactions. 1.4.2 Discuss the strengths and limitations of environmental modelling as a decision-making tool. 1.4.3 Determine the data needed to calculate environmentally relevant quantities, and articulate a strategy to perform the calculation.[b]

[a] *This topic will be addressed throughout the course as it arises in the context of each environmental compartment*

[b] *Taught primarily as a workshop*

2. The atmosphere and climate: composition, processes and anthropogenic changes [10]

2.1 Atmospheric properties and composition	2.1.1 Describe the large-scale structure and chemical composition of the atmosphere. 2.1.2 Appreciate the role of free radicals in atmospheric processes and anticipate how radicals will behave in simple gas-phase reactions.
2.2 Tropospheric chemistry: pollutants resulting from combustion, smog	2.2.1 Describe the sources of selected urban air pollutants including oxides of nitrogen (NO_x), volatile organic compounds (VOCs), tropospheric (ground level) ozone (O_3) and particulate matter (PM). 2.2.2 Explain the basic chemical reactions involved in photochemical smog formation. 2.2.3 Discuss the health effects of selected atmospheric pollutants 2.2.4 Describe measures to control photochemical and particulate air pollution.
2.3 Stratospheric chemistry: ozone formation and depletion	2.3.1 Describe naturally occurring source and sink processes for stratospheric ozone. 2.3.2 Identify and describe the compounds and reactions responsible for stratospheric ozone depletion. 2.3.3 Discuss the consequences of stratospheric ozone depletion. 2.3.4 Discuss control & replacement of ozone-depleting compounds.

2.4 Acid deposition	2.4.1 Describe the sources of acidifying pollutants and their control. 2.4.2 Discuss the effects of acid rain on environments and biota.
2.5 Climate change	2.5.1 Describe what climate is and what determines climate on a planet-wide scale. 2.5.2 Explain how the greenhouse effect operates. 2.5.3 Describe the sources and relative importance of major greenhouse gases, and trends in their concentrations. 2.5.4 Describe lines of experimental evidence for climate change and the components of climate models. 2.5.5 Discuss the evidence that human activity is causing climate change, and what the consequences of climate change will or may be. 2.5.6 Describe and evaluate actions (current and potential) to mitigate or respond to human-induced climate change.

3. The Hydrosphere- natural and modified waters and dissolved substances [9]

3.1 Composition of natural and treated waters	3.1.1 Compare and contrast the composition of fresh and sea water. 3.1.2 Distinguish between hard and soft water. 3.1.3 Describe the quality and treatment of drinking water. 3.1.4 Describe the treatment of wastewater.
3.2 Redox chemistry of natural waters; (de)oxygenation and eutrophication	3.2.1 Define the oxic status of natural and polluted waters 3.2.2 Explain and predict how the oxic status of waters influences the oxidation state of elements in the environment. 3.2.3 Describe and calculate biological oxygen demand. 3.2.4 Identify and describe the chemicals and processes responsible for oxygen depletion in aquatic environments.
3.3 Toxic and redox-active metals and organic pollutants	3.3.1 Explain dose, response and accumulation in the context of (potentially) toxic substances. 3.3.2 Describe the sources, environmental behaviour, and ecosystem and health effects of selected metals in aquatic systems (including sediments) and in humans. 3.3.3 Describe and draw the structures of selected organic pollutants and predict some of their properties. 3.3.4 Describe the sources, health effects and environmental behaviour of selected organic pollutants. 3.3.5 Explain why toxic metals and organic pollutants concentrate in certain compartments of the environment and the human body. 3.3.6 Identify emerging organic contaminants (PPCPs) and explain why they are a concern.

4. Soils- structure, composition and properties [3]

4.1 Soil structure and properties	4.1.1 Compare and describe the physical nature and chemical composition of selected soils. 4.1.2 Describe and determine selected physical and chemical properties of soils and relate these to soil ecosystem services, especially plant growth.
4.2 Threats to soils	2.1 Discuss selected threats to soils.

6. Sustainability and Green Chemistry [2]

6.1 Sustainability and Life Cycle Analysis	6.1.1 Define Sustainability.[c] 6.1.2 Assess on what grounds a process or activity might be considered sustainable.[c] 6.1.3 Identify and explain the stages in a product's life cycle.
6.2 Green Chemistry	6.2.1 Describe the principles of green chemistry and apply them in assessing how 'green' a manufacturing process is. 6.2.2 Contrast percentage yield and atom economy as approaches for evaluating a synthetic process. 6.2.3 Calculate the atom economy of a chemical reaction.

[c] *These ideas will also be introduced and reinforced in other parts of the course.*

G: Bibliography

The following books are likely to be helpful. They are available either in the JAC library, on loan from me, or on the web. The three bulleted titles are comprehensive texts on environmental chemistry and are on reserve in the library. *I encourage you to use them*. The other titles deal with more specific topics. I also encourage you to share other sources (print or web-based) which you may have found.

● Baird, C., Cann, M., *Environmental Chemistry*, 5th ed., WH Freeman, New York, 2012, 776 pp.*

● Spiro, T.G., Purvis-Roberts, K.L., Stigliani, W.M., *Chemistry of the Environment*, 3rd ed, University Science Books, Mill Valley, CA, 2012, 615 pp.*

● VanLoon, G.W., Duffy, S.J., *Environmental Chemistry: a global perspective*, 3rd ed., Oxford University Press, 2011, 545 pp.*

Andrews, J.E., Brimblecombe, P., Jickells, T.D., Liss, P.S., Reid, B., *An Introduction to Environmental Chemistry*, 2nd ed, Blackwell Science, Oxford, 2004, 296 pages. Available on the web: goo.gl/2SV8y7

Eash, N.S., Sauer, T.J., O'Dell, D., Odoi, E., *Soil Science Simplified,* John Wiley, 2015, 260 pp.*

Harte, J., *Consider a Spherical Cow- A course in Environmental Problem Solving*, University Science Books, Mill Valley, CA, 1988, 283 pp.*

Hobbs, P.V., *Introduction to Atmospheric Chemistry*, Cambridge Univ. Press, Cambridge, 2000, 262 pp.

Houghton, J., *Global Warming-The Complete Briefing*, 5th ed., Cambridge University Press, Cambridge, 2015, 380 pp.*

Lancaster, M., *Green chemistry: an introductory text,* RSC Publishing, Cambridge, 2010, 340 pp.*

Libes, S. M., *An Introduction to Marine Biogeochemistry*, John Wiley, New York, 1992, 734 pp.

Weil, R.R., Brady, N.C. *The Nature and Properties of Soils,* Pearson/Prentice Hall, Upper Saddle River, NJ. [Approx. 1000 pp.; any recent edition is worthwhile]

*Available at the JAC Library.

The MacDonald campus (McGill) library, a five-minute walk from our classroom, is also an excellent resource, especially for soil chemistry.

H: Teaching Methods

The course will be 75 hours, divided into classroom and laboratory periods. There will two 1.5-hour classroom periods per week, for the introduction of new material and practicing and problem-solving based on new and on previously learned material. Preparation for upcoming laboratory sessions may also be discussed during class time, and we expect to welcome several guest speakers during the term.

There will be one 2-hour laboratory period per week. Laboratory sessions may be used for workshops or field work. Several sessions involve going outside- please prepare/dress accordingly.

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 is no guarantee that make-up tests, quizzes or laboratory periods will be available. 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 may be used as a basis for a substitute for the missed test mark. Late homework policy will be determined by individual teachers.

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(s), (s)he 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 9-514-398-7777).

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 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:

Policy No. 7- IPESA, Institutional Policy on the Evaluation of Student Achievement
http://departments.johnabbott.qc.ca/wp-content/uploads/2017/08/Policy-7-IPESA.pdf

a) **Changes to Evaluation Plan in Course Outline** (Article 5.3).
All changes to evaluation plan in the course outline must have documented unanimous consent from the regularly attending students affected by the change(s) before submission.

b) **Evaluation** (Article 6)
Teachers should evaluate and enter grades for a sufficient number of assessments in Gradebook in order that the College may advise DEC students of their progress by mid semester as per the ACADEMIC PROCEDURE: Academic Progress by Mid Semester.

c) **Religious Holidays** (Article 3.2)
Students who wish to miss classes in order to observe religious holidays must inform their teacher of their intent, in writing, within the first two weeks of the semester.

d) **Student Rights and Responsibilities** (Article 3.2 and Article 3.3)
It is the responsibility of students to keep a copy of all assessed material returned to them and/or all digital work submitted to the teacher for at least four (4) weeks past the grade submission deadline (See current Academic Calendar) in the event that they request a Final Grade Review (Refer to Article 8)
Students have the right to receive graded evaluations, for regular day division courses, within two weeks after the due date or exam/test date, except in extenuating circumstances. A maximum of three (3) weeks may apply in certain circumstances (ex. major essays) if approved by the department and stated on the course outline

e) **Cheating and Plagiarism** (Article 9)
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.

College definition of 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.

College definition of plagiarism:
Plagiarism is a form of cheating. It includes 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.

K. Further note on cheating and plagiarism

Cheating and plagiarism are taken very seriously. Any instance (even a first instance) of cheating or plagiarism ***will*** result in failure on the assessment and ***will*** be reported to the college. "I didn't know" does not constitute a defence or excuse.

You will be provided with tools and examples (including in the laboratory manual, the *JAC Science Style Guide*, and an exercise during class time) for documenting sources and ideas in your work. Please do not be shy about asking me for further advice or guidance.