

JOHN ABBOTT COLLEGE SCIENCE PROGRAM 200.BO

Chemistry of the Environment and in the Marketplace

Discipline:	Chemistry	Semester:	fall 2008
Course Code:	202-DDN-05	Instructor:	Shahid Jalil
Objectives:	00UV.00UU	Office:	H-261
Ponderation:	3-2-3	Telephone:	457-6610 Loc. 5868
Credits:	2.67	Office Hours:	as posted
Prerequisite:	202-NYB-05 & 202-NYA-05		

Introduction

Chemistry of the Environment and in the Marketplace (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.

This course is designed to apply basic chemical knowledge to the understanding of certain environmental problems, and to encourage students to participate in seeking solutions to these problems.

The existence of pollution in the environment as a national and a world problem was not generally recognized until the 1960's. Since that time, as contaminants have been shown to have negative effects in so many aspects of our daily lives, the awareness of environmental problems has spread rapidly throughout society. It is clear to us now that we must be vigilant in assessing the environmental impact of all of society's activities.

The chemistry of the environment course explores a number of the current issues in environmental studies in which *chemicals* play an important part. Drawing on the procedures and methods of chemistry, physics and mathematics, students will assess the effect of chemical contaminants on biological and biochemical systems.

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 behaviour 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. These courses have been designed so that by passing any three option courses a student will have met the above requirements of the program.

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 scientific method and experimental protocol
- Justification of the method
- Critique of the credibility of the results
- Use of an interdisciplinary approach

Elements of the Competency

1. To apply laws and principles of the natural sciences to the study of air, water and soil pollution problems.
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 problems.
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. 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 be able to ... '

Standards**Objectives****Specific Performance Criteria****Intermediate Learning Objectives****1. Water and air pollution -
General Considerations****Water**

1.1 Discussion of the quality of water

1.1 Classification of Water

1.1.1 Describe the terms hard water, soft water, heavy water, distilled water and fluoridated water.

1.1.2 Describe and compare polluted vs unpolluted water

1.1.3 Describe the quality of drinking water

1.1.4 Describe a drinking water treatment process

1.2 Investigation into the primary cause of water doxygenation

1.2 Oxygen-demanding Water

1.2.1 Define the terms DO and B.O.D.

1.2.2 Describe the sources of oxygen-demanding water

1.2.3 Write appropriate equations for reactions involving aerobic conditions

1.2.4 Identify chemicals responsible for aerobic and anaerobic conditions

1.3 Analysis of the total dissolved salt in water and its effect on the environment

1.3 Salinity

1.3.1 Describe the sources of salinity

1.3.2 Describe osmosis, and the effect of salinity on the aquatic life

1.3.3 Discuss the effect of salinity on agriculture

1.3.4 Explain the relationship between salinity and crop response

1.3.5 Describe the role of de-icing salt on highways

Air

1.4 Discussion of the quality of air

1.4 General

1.4.1 Describe and compare polluted versus unpolluted air

1.4.2 List the types of air pollutants

1.5 Description of carbon monoxide as an air pollutant

1.5 Carbon monoxide

1.5.1 Describe the properties of carbon monoxide (CO)

1.5.2 Describe the sources and fate of atmospheric CO

1.5.3 Discuss the effects of CO on humans

1.5.4 Discuss the control of CO

Specific Performance Criteria**Intermediate Learning Objectives**

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| 1.6 Description of oxides of nitrogen (NO_x) as air pollutants | 1.6 <u>Oxides of nitrogen</u>
1.6.1 Explain the basic chemical reactions involving oxides of nitrogen
1.6.2 Describe the sources and fate of atmospheric NO_x
1.6.3 Describe the effects of NO_x on humans, plants and various materials
1.6.4 Discuss the control of NO_x pollution |
| 1.7 Description of hydrocarbons and photochemical oxidants in the atmosphere | 1.7 <u>Formation of smog</u>
1.7.1 Describe the sources of hydrocarbon pollution
1.7.2 Using a diagram, show the photolytic cycle of NO_2 , with smog formation
1.7.3 Describe the effects of hydrocarbons, smog and ozone on humans |
| 1.8 Discussion of oxides of sulfur | 1.8 <u>Oxides of sulfur (SO_x)</u>
1.8.1 Discuss the sources of SO_x pollution
1.8.2 Describe the effects of SO_x on plants and humans |
| 1.9 Discussion of acid rain and its effects on the environment | 1.9 <u>Acid rain</u>
1.9.1 Describe the sources of acid rain in terms of NO_x and SO_x
1.9.2 Discuss the effect of acid rain on aquatic life, soil, vegetation and various materials
1.9.3 Explain the controls used to minimize the effects of acid rain
1.9.4 Explain the buffering of natural water
1.9.5 Perform pH calculations, including those involving the 'common ion' effect and buffer solutions |
| 1.10 Analysis of the 'greenhouse' effect | 1.10 <u>Greenhouse effect (global warming)</u>
1.10.1 Explain the sources of greenhouse gases
1.10.2 Discuss the phenomenon of 'global warming'
1.10.3 Describe the actions that can be taken to minimize global warming and climate change
1.10.4 Explain the phenomenon of El Niño, La Niña and their effect on climate change |
| 1.11 Investigation into the depletion of the stratospheric ozone layer, and its effects on the environment | 1.11 <u>The ozone layer</u>
1.11.1 Describe the chemicals responsible for the depletion of the stratospheric ozone layer
1.11.2 Discuss the consequences of the destruction of the ozone layer
1.11.3 Discuss the Montreal Protocol
1.11.4 Discuss the replacement of CFC's |

Specific Performance Criteria**Intermediate Learning Objectives**

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| 1.12 Discussion of Ground Level ozone | <p>1.12 <u>Photochemical Smog</u></p> <p>1.12.1 Describe the natural cycle of nitrogen dioxide</p> <p>1.12.2 Explain the formation of a free radical</p> <p>1.12.3 Describe the mechanism of formation of methane in the atmosphere</p> <p>1.12.4 Describe the conditions for the development of photochemical smog</p> <p>1.12.5 Describe the various types of catalytic convertors</p> <p>1.12.6 Discuss alternative sources of energy (renewable, and non renewable)</p> |
| 1.13 Discussion of emission control in automobiles | <p>1.13 <u>Emission Control</u></p> <p>1.13.1 Discuss the effects of the Air/Fuel ration on exhaust composition</p> <p>1.13.2 Discuss the thermal exhaust reactor</p> <p>1.13.3 Describe and discuss the catalytic exhaust reactor</p> <p>1.13.4 Discuss various fuels used as substitutes for gasoline</p> |
| 2. <u>Specific Environmental Problems</u> | |
| 2.1 Description of radioactive materials and their effect on the environment | <p>2.1 <u>Nuclear Waste</u></p> <p>2.1.1 Describe the main sources of nuclear wastes</p> <p>2.1.2 Using a diagram, explain the transmission of radioactive fallout in the environment</p> <p>2.1.3 Describe the types of radiation and their effect on humans</p> <p>2.1.4 Discuss the operation of nuclear power plants, with special reference to the C.A.N.D.U. reactor</p> <p>2.1.5 Discuss the major environmental problems associated with the use of nuclear power</p> <p>2.1.6 Discuss the disaster at Chernobyl</p> <p>2.17 Write appropriate nuclear decay reactions of common radioisotopes</p> |
| 2.2 Discussion of mercury pollution in soil and water | <p>2.2 <u>Mercury</u></p> <p>2.2.1 Describe the chemical and physical properties of mercury and the main sources of mercury pollution</p> <p>2.2.2 Discuss the toxicity of mercury and its compounds</p> <p>2.2.3 Discuss the disaster at Minimata Bay, Japan</p> <p>2.2.4 Discuss the solutions to the mercury pollution problem</p> |
| 2.3 Analysis of lead pollution in air and water | <p>2.3 <u>Lead</u></p> <p>2.3.1 Describe the sources of lead pollution in air and water</p> <p>2.3.2 Discuss the role of lead in the diet and its behaviour in the body</p> <p>2.3.3 Describe the solutions to lead poisoning problems</p> |

Specific Performance Criteria**Intermediate Learning Objectives**

2.4	Discussion of oil pollution in freshwater and in the sea	2.4	<u>Oil Pollution</u>
		2.4.1	Describe the sources of oil pollution
		2.4.2	Discuss the biological and physical effects of oil pollution
		2.4.3	Describe the counter-measures for oil pollution
2.5	Description of waste water treatment	2.5	<u>Waste water treatment</u>
		2.5.1	Explain, using diagram, primary, secondary and tertiary treatment processes
		2.5.2	Describe reverse osmosis and the electrolysis cell
		2.5.3	Explain how dissolved organic materials and disease-causing organisms are removed from waste water
		2.5.4	Discuss some of the problems associated with modern landfills
		2.5.5	Discuss how lifestyle is related to our growing municipal solid waste problem
3.	<u>Experimental work</u>		
3.1	Qualitative and Quantitative analysis of polluted lake water	3.1	<u>Analysis of water</u>
		3.1.1	Analyse water qualitatively for different pollutants using chemical kits
		3.1.2	Analyse water quantitatively for various pollutants using chemical kits
		3.1.3	Analyse water quantitatively for heavy metals, spectrophotometrically
		3.1.4	Perform a separation of polyaromatic hydrocarbons using thin layer chromatography
		3.1.5	Perform an electrochemical remediation (electroagulation) of oily water
3.2	Determination of phosphate in a detergent	3.2	<u>Phosphates</u>
		3.2.1	Using a gravimetric technique, determine the percent in a detergent
3.3	Qualitative and quantitative analysis of soil	3.3	<u>Analysis of soil</u>
		3.3.1	Determine the pH and salinity of different soil samples
		3.3.2	Determine the presence of various chemicals in the soil using kits
		3.3.3	Determine the organic content of soil
3.4	Survey analysis of household chemicals	3.4	<u>Toxic chemicals in the home</u>
		3.4.1	Determine toxic components in household chemicals and their effects on humans
		3.4.2	Determine how to safely dispose household chemicals

Specific Performance Criteria**Intermediate Learning Objectives**

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| 3.5 | Survey analysis of household waste | 3.5 | <u>Household waste</u> |
| | | 3.5.1 | Make a comparative study of household waste in categories of paper, plastic, spoiled food, peels, glass and cans |
| | | 3.5.2 | Calculate the mass of total waste per year per household |
| 3.6 | Determination of sulfate in water | 3.6 | <u>Sulfate</u> |
| | | 3.6.1 | Using a turbidimetric method, determine the concentration of sulfate in natural water |
| 3.7 | Analysis of sea water | 3.7 | <u>Sea water</u> |
| | | 3.7.1 | Analyse sea water for Ca^{+2} and Mg^{+2} ions using EDTA |
| | | 3.7.2 | Determine the concentration of calcium and magnesium ions in sea water |
| 3.8 | Analysis of mixture of acid rain | 3.8 | <u>Acid rain</u> |
| | | 3.8.1 | Analyse a mixture of acid rain H_2SO_4 and HNO_3 |
| | | 3.8.2 | Determine the concentration, pH, and the percent of each acid in the mixture |
| 3.9 | Determination of lead in lake water | 3.9 | <u>Lead</u> |
| | | 3.9.1 | Determine the concentration of lead using ion-exchange column |
| 3.10 | Determination of lead and calcium | 3.10 | <u>Lead and calcium mixture</u> |
| | | 3.10.1 | Determine the concentration and percent of lead and calcium in a mixture |
| 3.11 | Determination of dissolved oxygen | 3.11 | <u>Dissolved oxygen</u> |
| | | 3.11.1 | Determine the concentration of dissolved oxygen in a water sample using the Winkler method |
| 4. | <u>Integration, Comprehensive Assessment and Exit Profile Goals</u> | 4. | <u>The Project</u> |
| 4.1 | Recognition of the links between science, technology and the evolution of society. | 4.1.1 | Discuss the power and the limits of science and technology in evaluating and resolving environmental problems |
| | | 4.1.2 | Discuss the implications of science and technology for the evolution of society |
| 4.2 | Development of a personal system of values. | 4.2.1 | Clearly identify and summarize two sides of an issue |
| | | 4.2.2 | Develop an opinion on an issue and the arguments to defend the position |
| | | 4.2.3 | Be aware of and understand the social and ethical implications of scientific work |

Specific Performance Criteria**Intermediate Learning Objectives**

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| 4.3 | Communicate effectively | 4.3.1 | Clarity and precision in reading and writing current environmental issues, and discussing them in class |
| 4.4 | Work as a member of a team | 4.4.1 | Significant contribution to the team |
| | | 4.4.2 | To build a water filtering device as a group of four students, and to demonstrate its use in the laboratory |

Course Information

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

Lectures: (45 hours)

Two 1.5-hour periods per week, consisting of the introduction of new material. The lectures will be illustrated by live demonstrations and audiovisual aids such as overhead projectors, movies and slides.

Laboratory sessions: (30 hours)

One 2-hour period per week. The relationship between science and technology is experienced first hand through the laboratory experiments. A number of guided inquiry oriented laboratory experiments are conducted in the laboratory and on location to verify the presence of pollutants using chemical kits and other equipment.

Textbook:

There is no specific text for this course. All necessary notes and handouts will be provided in class. The following books will be available in the library and with the instructor:

- 1) McKinney, M. Schlock, R. Environmental Science. West Publishing Co. 1996.
- 2) Manahan, Stanley E. Environmental Chemistry 6th Ed. Lewis Publishers, 1994.
- 3) Selinger, B. Chemistry in the Marketplace. Toronto: Harcourt Brace. 1994.
- 4) Chiras, D.D. Environmental Science. An action for a sustainable future. Benjamin/Cuming Publishing Inc. 1994.
- 5) Spiro, Thomas G., Stigheim, W.M. Chemistry of the Environment 2nd Ed. New Jersey: Prentice Hall, 2003.
- 6) Brennan, Scott, Withgot, Jay. Environment, Pearson, 2005.
- 7) Benjamin, Mark M. Water Chemistry, McGraw Hill, 2002.
- 8) VanLoon, Gary W. Environmental Chemistry (a global perspective). Oxford University Press, 2006.

- 9) Miller, Tyler. Environmental Science. Thomson/Cole, 2004.
- 10) Stewart, Kent K., Ebel, Richard E. Chemical Measurement in Biological Systems. Wiley Interscience, 2000.
- 11) Eby, Nelson G. Principles of Environmental Geoscience. Thomson/Cole, 2004.
- 12) Lowe, James N. Chemistry, Industry and the Environment. WCB. 1994.

Laboratory Requirements:

1. A laboratory notebook. Instructions concerning this notebook will be given by the instructor.
2. *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 - \$20). Normal prescription glasses may be worn, but *for safety reasons, the use of contact lenses is not permitted.*
3. A sturdy cotton lab coat is required.

Evaluation:

Each student will be evaluated according to the following scheme:

Two Unit Tests	25%
Final Exam	25%
Laboratory	20%
Comprehensive Assessment (Project)	5%
Quizzes	15%
Assignments	10%

Please note:

- a) If the final exam mark is greater than the average of the two Unit Tests, then the final exam mark replaces the unit Test marks: i.e. the final exam is then worth 50% of the total course grade.
- b) To pass the laboratory portion of the course, a minimum of 50% of the total laboratory grade must be obtained. Failing this, a laboratory grade of **zero** will be given and a maximum grade of 55EC will be allowed for the course.
- c) 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.

Course costs:

The major course costs are specified above. However, an instructor may require the student to purchase additional materials, such as a laboratory notebook (approx. \$10 - \$20) or course notes (approx. \$10).

Course Information

Regulations

- 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.
- 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 9-398-7770).

College Policies:

- a) **Cheating and Plagiarism:** The College has a universal policy on cheating and plagiarism, which is upheld in this course. The student is referred to the IPESA (p. 16 item 22) for further information.
- b) **Mid-semester Assessment:** All first semester students will receive a mid-semester assessment, to give them some idea of how they are progressing in the course. This assessment has no percentage value in calculating the final grade.
- c) *"It is the responsibility of all students to keep all assessed material for at least one month past the grade review deadline in the event that they would want to request a grade review. Students can learn more about their rights and responsibilities by reading the IPESA."*