

CHEM 326/ENCH 326: Environmental and Green Chemistry

Winter 2021

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Optional weekly Zoom Q&A session: Wednesdays at 9:30 am Kingston time (link on onQ)

Text: Environmental Chemistry, 5th Edition, Baird and Cann, Freeman & Company.
(Solutions manual is optional, 4th Edition is acceptable)

Other Literature: (Check for availability through Stauffer Library Circulation Desk)

Environmental Chemistry, 4th Ed., *Baird and Cann*

Environmental Chemistry, 8th Ed., *Stanley Manahan*

Green Chemistry and Catalysis, *R. A. Sheldon et al.*

Green Chemistry: An Introductory Text, *M. Lancaster*

Other references will be given throughout the course.

Marking: Problem Sets 10%; Assignments 40%; Quarterly Quizzes 50% (12.5% each)

Course Outline:

1. Overview: define Environmental Chemistry and Green Chemistry; context within chemistry discipline; outline of text; review concentrations and calculations.
2. Chemistry of the Atmosphere: review of gas-phase reactions; radical reactions and thermodynamics; chlorine radicals and the ozone 'layer', CFCs and other ozone-depleting contaminants, catalysis on condensed phases; hydroxyl radical, ozone production, proton abstraction, VOCs, NO_x, and photochemical smog.
3. Greenhouse effect and global warming: i.r. absorbance spectra and greenhouse effect; major greenhouse gases - CO₂, H₂O, CH₄, N₂O, aerosols, others; predicted effects; energy sources and alternatives.
4. Chemistry of contaminants: review of organic chemicals, classes and nomenclature; principles of toxicology, mechanism and dose-response; persistence, bioaccumulation and toxicity; pesticides - chlorinated, DDT and others; dioxins and furans; partition, fugacity and long-range transport.
5. Chemical contaminants: PCBs, PBDEs and others; PAHs; estrogenic contaminants; microplastics; environmental and health effects.
6. Water: natural waters - oxygen and redox chemistry, acid/base chemistry and carbonate system; drinking water - purification, disinfection, impact of chlorine; groundwater - contaminants and remediation; wastewater - phosphate, oxygen demand, fate of organic compounds, wastewater treatment.
7. Soil and sediments: major contaminants - behaviour, fate and transport; chemical and

biological remediation methods; heavy metals, lead, arsenic

8. Introduction to Green Chemistry: history, goals and principles, economic and legislative drivers.
9. Measures and Metrics: E-factors and related measures, multi-variant assessment of impact, energy consumption.
10. Alternative Feedstocks and Reagents: biomass, waste polymers, CO₂.
11. Synthetic Methods and Strategies.
12. Solvents: solventless conditions, preferred organic solvents, water, supercritical fluids, expanded liquids, ionic liquids, and liquid polymers.

Handing in assignments

Assignments must be submitted through onQ on or before the due date. Late submissions will be given a penalty of 5% per day. Extensions will be granted only after an application for academic consideration (see below). Students seeking academic consideration must contact the Instructor **before the due date of the assignment**. For the lifecycle analysis assignment, no late assignments will be accepted after the first presentation by students.

Calculator Policy

Calculators acceptable for use during quizzes are intended to support the basic calculating functions required in this course. For this purpose, the use of the **Casio 991** series calculator is recommended and is the **only approved calculator for Applied Science and Arts and Science students**. This calculator sells for around \$25 at the Queen's Campus Bookstore, Staples and other popular suppliers of school and office supplies.

<http://www.queensu.ca/artsci/help/topics/calculator-policy>

<http://my.engineering.queensu.ca/policy/Calculator.html>

Academic Integrity

Queen's students, faculty, administrators and staff all have responsibilities for supporting and upholding the fundamental values of academic integrity. Academic integrity is constituted by the five core fundamental values of honesty, trust, fairness, respect and responsibility (see www.academicintegrity.org) and by the quality of courage. These values and qualities are central to the building, nurturing and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University. Students are responsible for familiarizing themselves with and adhering to the regulations concerning academic integrity. General information on academic integrity is available at Integrity@Queen's University (<http://www.queensu.ca/academicintegrity/home>), along with Faculty or School specific information. Departures from academic integrity include, but are not limited to, plagiarism, use of unauthorized materials, facilitation, forgery and falsification. Actions which contravene the regulation on academic integrity carry sanctions that can range from a warning, to loss of grades on an assignment, to failure of a course, to requirement to withdraw from the university.

Academic Accommodations

Queen's University is committed to achieving full accessibility for persons with disabilities. Part of this commitment includes arranging academic accommodations for students with disabilities to ensure they have an equitable opportunity to participate in all of their academic activities. If you are a student with a disability and think you may need accommodations, you are strongly encouraged to contact Student Wellness Services (SWS) and register as early as possible. For more information, including important deadlines, please visit the Student Wellness website at: <http://www.queensu.ca/studentwellness/accessibility-services/>

Academic Consideration

The Senate Policy on Academic Consideration for Students in Extenuating Circumstances ([Queensu.ca-Academic Considerations for Extenuating Circumstances Policy Final.pdf](#)) was approved in April, 2017. Queen's University is committed to providing academic consideration to students experiencing extenuating circumstances that are beyond their control and which have a direct and substantial impact on their ability to meet essential academic requirements. Each Faculty has developed a protocol to provide a consistent and equitable approach in dealing with requests for academic consideration for students facing extenuating circumstances. Arts and Science undergraduate students can find the Faculty of Arts and Science protocol and the portal where they submit a request for academic consideration at:

<https://www.queensu.ca/artsci/undergrad-students/academic-consideration-for-students>.

Applied Sciences students can find the relevant information at

<https://engineering.queensu.ca/Current-Students/absences-accommodations/academic-consideration.html>.

Accessibility Statement

Queen's is committed to an inclusive campus community with accessible goods, services, and facilities that respect the dignity and independence of persons with disabilities. To discuss accessibility please contact either Professor Brown or Professor Jessop via email, phone, or in-person at your convenience.

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