CHEM 360 Environmental Chemistry
Fall 2017

Instructor: Dr. Alexei Khalizov
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Office hours: Monday 2:30 – 3:30 am or by appointment

Lectures on Monday and Wednesday, 1:00 – 2:25 pm, TIER 113

Course description: Chemistry of the environment with emphasis on the atmosphere. Included are an introduction to the composition and chemistry of the natural and polluted atmosphere, thermodynamics and kinetics of atmospheric reactions, indoor and outdoor air pollution, air quality and its impact on human health, air quality regulations, and climate change. Examples of specific environmental issues covered in this course are the global stratospheric ozone depletion and Polar ozone holes, classical and photochemical smog, acid rain, and climate warming.

Prerequisites: CHEM 126 or CHEM 122, or CHEM 124 with a grade of C or better. CHEM 360 is a prerequisite for CHEM 361.

Required textbook: *Atmospheric Chemistry (From the Surface to the Stratosphere)* by Grant Ritchie, ISBN: 978-1-78634-176-1

Supplementary textbook (not required, but highly recommended): *Elements of Environmental Chemistry* by Ronald A. Hites, 2nd Edition (available electronically via NJIT library website at http://librarius.njit.edu/vwebv/holdingsInfo?bibId=423296).

General Chemistry reference materials (not required): (a) ACS General Chemistry Study Guide (http://uwm.edu/acs-exams/instructors/ordering-information/); (b) a good freshman General Chemistry textbook, such as *Chemistry: a Molecular Approach* by N.J. Tro (any edition)

Course outline

1. **Introduction**: environment; course logistics; Earth as a closed system (lithosphere, atmosphere, and hydrosphere); life and ecosystem; global biogeochemical cycles
   MZJ 2.3; RAH 1.2

2. **Review of fundamental concepts #1:** concentration units for gas mixtures and aqueous solutions; unit conversions; peer reviewed journal articles and literature search
   MZJ 1.6, 3.4; RAH 1

3. **Earth's atmosphere**: major and minor constituents; atmospheric structure; energy balance; global circulation; sources, sinks, transport, and lifetimes of chemicals
   MZJ 3.5-3.6, 3.1-3.4; 6.1-6.5; RAH 3.1

4. **Review of fundamental concepts #2:** atoms and molecules; structure and reactivity; thermochemistry; equilibria; reaction rates; pH of strong and weak acids; photochemistry; heterogeneous reactions

   MZJ 1.1, 1.3-1.5, RAH 2.3, 3.2, 5.1, Appendix A

5. **Atmospheric aerosols:** physical properties and chemical composition; sources and sinks; interaction with sunlight; aerosol-cloud interaction

   MZJ 5, 7

6. **Climate change:** radiative balance; greenhouse gases; signs of climate change; radiative forcing; global warming and its impacts

   MZJ 12, 13; RAH 4

7. **Stratospheric chemistry – ozone chemistry:** Chapman model of stratospheric ozone; catalytic ozone destruction; global stratospheric ozone reduction; Montreal protocol; Antarctic ozone hole

   MZJ 11; RAH 3.4, 3.5

8. **Tropospheric chemistry:** the hydroxyl radical; oxidation of methane and carbon monoxide; the role of nitrogen oxides and organic compounds in the formation of tropospheric ozone and secondary organic aerosols; oxidation of sulfur dioxide; nighttime chemistry

   MZJ 4.2, 4.3; RAH 3.6

9. **Air quality:** indoor and outdoor air pollution; classical and photochemical smog; primary and secondary pollutants; criteria pollutants; monitoring of air pollutants; health impacts of air pollution; air pollution regulations; acid rain

   MZJ 4.1, 8.1, 9, 10; RAH 3.6, 5.1, 5.2

Requirements: bring to every class scientific or engineering calculator; phones must be turned off or switched to vibration mode; if you receive an urgent call, step out of the classroom while using the phone (this is a privilege, do not overuse it).

Grading:

Mid-term exam (~6 weeks)[1,2]	25%
Final Exam (cumulative)[1,2]	30%
Quizzes/Homework[1,2,3]	30%
Class project (summary and presentation)[4]	10%
Attendance	5%
Total:[5]	100%

[1] Make up exams and quizzes may be arranged only for university-approved excuses.
[2] Only scientific, but not advanced graphing calculators are allowed during exams and quizzes (e.g., TI-30 or TI-34, but not TI-84 or TI-Nspire)

[3] Each 30-min quiz is paired with a homework assignment. The grade for each quiz is counted towards the total quiz grade **only** if the associated homework assignment is turned in on time. The quiz with the lowest grade will not be counted towards total.
[4] The class project may be based on (a) scientific article from a peer-reviewed journal, (b) your research project (e.g., independent study), or (c) development of a demonstration for CHEM360/361. The article ***must cover one of the topics from this course*** and ***cannot be a magazine article or a review***. Students will work individually and must present the original journal article of their choice, a one-paragraph summary of their research project, or a one-paragraph demonstration proposal (including the source, if available) for approval by the instructor by **September 26**. Presentations (10 min) will begin on **October 10** and will continue throughout the semester (~2-3 presentations each week). The summary will be due on **November 14** (1 page, single-spaced, submitted electronically, will be checked for plagiarism using Turnitin).
[5] Under no circumstances will students be given the opportunity to complete extra-credit assignments to bolster their final grades.

Notes: You are encouraged to discuss with me any difficulties you may encounter during the course. Please do not let the problem linger, contact me as early as possible!

Academic integrity: the NJIT honor code will be upheld and any violations will be brought to the immediate attention of the Dean of Students (http://www.njit.edu/academics/pdf/academic-integrity-code.pdf)

Course outcomes: by the end of this course, students will be able to

- calculate concentrations and mixing ratios of pollutants using different units
- describe the concepts of global cycles, sources and sinks, and lifetimes of pollutants
- calculate lifetimes and removal rates of pollutants
- identify primary and secondary pollutants
- name criteria pollutants and justify their selection by the EPA
- calculate pH of rainwater under natural and polluted conditions
- describe pollution control methods, regulations, and policies
- assess impacts of air pollution on the environment, human health, and climate
- explain the major differences between the successive layers of the earth's atmosphere
- describe and explain the major photochemical reactions taking place in the stratosphere
- list the photochemical reactions leading to the ozone depletion
- list the chemical reactions forming photochemical smog
- describe the greenhouse effect and its connection to global warming
- explain the phenomena behind the formation of acid rain

Disclaimer: the course content can be adjusted by the instructor during the semester as necessary