

CHE 454a09 – Nuclear Chemistry; Summer 2020

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Website: <http://ReggieNet.IllinoisState.edu/>
Required Texts: *Radiochemistry and Nuclear Chemistry*, 4th Edition by Gregory Choppin, et al.; Academic Press; ISBN-13: 978-0124058972; available online from Milner Library

Catalog Description: Fundamental concepts and applications of nuclear chemistry and radiochemistry, including nuclear dating, nucleosynthesis, nuclear energy, nuclear weapons, and radiation effects. Not for credit in the M.S. in Chemistry. Prerequisite: one semester of Inorganic Chemistry (CHE 250, or CHE 350, or equivalent) or consent of the instructor.

Learning Outcomes: Upon successful completion of this course the student should be able to:

1. Predict the stability of isotopes and describe their likely decay modes
2. Quantify mass-energy conversions that accompany nuclear reactions
3. Apply appropriate approximations to specific types of successive radioactive decay
4. Understand the similarities and differences between different types of radiation
5. Communicate, with specific examples, the importance and practical application of radioelements and the heavier elements
6. Understand and communicate the risks and benefits of radiation and nuclear chemistry
7. Have a plan to incorporate nuclear chemistry/science into a currently taught course

TECHNICAL SKILLS AND REQUIREMENTS AND ONLINE ETIQUETTE

To be successful in the online environment, learners will need to have a basic working knowledge of and access to computers, the internet, and various software programs, as well as good communication/netiquette and time management skills. Below is a list of the most crucial of these skills and requirements.

Technical Skills:

1. Access and navigate the internet, including downloading and reading files from websites
2. Access and navigate Illinois State's learning management system, ReggieNet
3. Access and navigate the Milner Library website, downloading and reading files from library reserves and databases
4. Use Redbird Mail, including attaching and downloading files from emails
5. Create, save and submit files in commonly used word processing program formats
6. Copy and paste text and other content on a computer

Technical Requirements:

1. Computer that you can use for extended periods of time
2. Reliable broadband internet access (cable modem, DSL, or other high speed)
3. Activated ULID account
4. Redbird Mail account, checked regularly
5. Consistently updated browser (Firefox, Safari, Chrome, Explorer)
6. Up-to-date Flash and Java plug-ins
7. Permissions and ability to install additional plug-in or class software, as needed

Online Etiquette: To help guide online interactions, ISU requires both students and faculty demonstrate appropriate netiquette, i.e. internet etiquette. That is, interacting in a positive, cooperative and supportive manner, displaying respect for the privacy and rights of others. This policy is inclusive of, but not limited to the following guidelines:

1. Keep your questions and comments relevant to the discussion topic. If another participant posts a comment or a question that is off topic, do not reply. The instructor will reply in private to the participant.

2. Be courteous and treat co-learners with respect, modeling the same standards of behavior online you would follow in a face-to-face discussion.

3. Be respectful and open to opinions and ideas that differ from yours. Being deliberately hostile and insulting online, i.e. flaming, is not appropriate under any circumstance. When responding to messages or posts made by others, address the ideas not the person.

4. All course communication should be conducted in Standard American English to ensure understanding among diverse participants.

Please note, the instructor reserves the right to remove posts that are not collegial or fail to meet online etiquette guidelines.

Online Support: Illinois State University provides [online resources for learner support](#).

GRADING

Discussion Posts: There will be a total of 4 semester discussions worth 25 points each. Readings and a prompt will be posted online for students to review. Topics will include real-life applications of nuclear chemistry.

Module Exams: There will be two 50 point exams; one after each module.

Book Review: 75 points. As part of your learning about issues relating to nuclear chemistry and radiation, you'll select one book to review, either from the provided list or another of your choice with instructor permission. As you read, you should be looking for connections to what we've learned throughout the course and to your teaching context relating to nuclear chemistry. Once you finish your reading, you will be tasked with writing a book review that focuses on two parts: a critical evaluation of the book itself and a reflection on the extent to which this text might have potential for use as a core piece of instruction for a nuclear chemistry/science unit in a course you currently teach. Your review should be 2 – 4 pages in length.

Final Curriculum Project: 125 points. Throughout the semester, you'll have the opportunity to dig deeper into nuclear chemistry and examine several ways in which the topic plays a role in our social and political world as well as in our daily lives. For the final curriculum project, your goal will be to develop a reflection in which you describe an ideal unit on nuclear chemistry as well as how that content fits within the larger scope of a course you currently teach and the science courses currently offered at your school. The reflection should be 4 - 6 pages.

Final Grades: There are a total of 400 points possible over the course of the semester. Grades will be assigned as follows: A \geq 360 points; B = 320 – 359.99 points; C = 280 – 319.99 points; D = 240 – 279.99 points; F < 240 points.

OTHER POLICY ITEMS

1. University Sanctioned Events including Athletics:
 - » As per University policy, if you are on an athletic team or involved in other university sanctioned events, you need to provide me with information (name, athletic team/event, and planned travel dates) by the end of the second week of class.
 - » As per University policy, if you think you will be missing an assignment (exam, quiz, or lab) due to travel, you need to inform **me in person at least one week in advance of the missed assignment to make accommodations**, and your coach needs to email me 48 hours in advance of you leaving town. If the coach does not contact me within that timeframe you will likely receive a zero for that assignment.
2. Any student needing to arrange a reasonable accommodation for a documented disability and/or medical/mental health condition should contact Student Access and Accommodation Services at 350 Fell Hall, (309) 438-5853, or visit the website at StudentAccess.IllinoisState.edu.
3. Illinois State University has several systems in place to assist our students in times of crisis and bereavement. If you have suffered a bereavement, you may choose to notify the Office of the Vice President for Student Affairs of your loss, (phone: (309) 438-5451, e-mail: StudentAffairs@IllinoisState.edu) and they will contact all your professors on your behalf, so you don't have to worry about it. The Dean on Duty (phone: (309) 438-2008, email: deanofstudents@illinoisstate.edu) and Student Counseling Services (phone: (309) 438-3655, email: counseling@illinoisstate.edu) are also there to help students deal with traumatic life events.
4. Any changes made to this syllabus will be announced in ReggieNet. *It is your responsibility to be active on the course website and be aware of any announcements.*
5. Students must obtain written permission from the instructor if they wish either to photograph classroom lectures or discussions or to record them using audio or video devices. This restriction includes visual materials that accompany the lecture/discussion, such as lecture slides, whiteboard notes/equations, etc. Such recordings are to be used solely for the purposes of individual or group study with other students enrolled in the class. They may not be reproduced, shared in any way (including electronically or posting in any web environment) with those not in the class. Students with disabilities who need to record classroom lectures or discussions must contact Student Access and Accommodation Services to register, request and be approved for an accommodation. Students who violate this policy may be subject to both legal sanctions for violations of copyright law and disciplinary action under the University's Code of Student Conduct.
6. Students are expected to follow the Student Code of Conduct, available [on the Dean of Students website](#).

COURSE OUTLINE

Module 1: Atomic/Nuclear Theory

Week 1 – Welcome & Introductions/Orientation

Week 1 – Isotopes & Isotopic Separation

Nuclei, Isotopes, and Isotope Separation (Ch. 3 Choppin)

Additional Reading: “Updating the Atomic Theory in General Chemistry”

Additional Reading: Spindel & Ishida (1991)

Week 2 – Nuclear Stability & Solutions for Instability

Nuclear Stability & Radioactive Decay (Ch. 4-5 Choppin)

Additional Reading: “Who’s that lying in my coffin? An imposter exposed by ^{14}C dating”

Discussion #1: Weapons Proliferation (Week 2)

Week 3 – Nucleosynthesis (Fusion)

Stellar Nucleosynthesis (Ch. 12-13 Choppin)

Additional Reading: “Populating the periodic table”

Week 4 – Nuclear Energy (Fission and Fusion)

Nuclear Power (Ch. 20 Choppin)

Discussion #2: Decommissioning Nuclear Plants (Week 4)

End of Week 4 – **Module 1 Exam - Foundations of Nuclear Chemistry**

Module 2: Radiation

Week 5 – What is Radiation?

Types of Radiation (Ch. 8 Choppin)

Strange Glow, Part One (Ch. 1-4)

Discussion #3: Dangers of Ionizing Radiation (Week 5)

Week 6 – Consequence of Radiation

Cellular Impact of Radiation (Ch. 15 Choppin)

Strange Glow, Part Two (Ch. 5-11)

Discussion #4: Radiation as a Tool of Murder (Week 6)

Week 7 – Risks and Benefits of Radiation

Strange Glow, Part Three (Ch. 12-End)

End Week 7 – **Module 2 Exam - Applications of Nuclear Chemistry**

Week 8 – **Book Review Due (may be submitted early)**

Week 8 – **Final Curriculum Project Due (not to be submitted before Aug 3)**

READING LIST

Main Textbook

Radiochemistry and Nuclear Chemistry, 4th Edition by Gregory Choppin, Jan-Olov Liljenzin, Jan Rydberg, Christian Ekberg; Academic Press; ISBN-13: 978-0124058972; available online from Milner Library

Book Review Book: somewhere between 224 and 450 pages depending on selection

Peer-reviewed Literature

Johnson, J.A. "Populating the periodic table: Nucleosynthesis of the elements" *Science* **2019**, *363*, 474-478.

Kato, T.A.; Wozniak, D.E. "Murder with radioactive polonium metal" *Forensic Sci. Rev.* **2014**, *26*, 131-138.

Kaufmann, C. "Why Nuclear Proliferation is Getting Easier" *Peace Review* **2006**, *18*, 315-324.

Schoeppner, M.; Glaser, A. "Present and future potential of krypton-85 for the detection of clandestine reprocessing plants for treaty verification" *J. Environ. Radioact.* **2016**, *162-163*, 300-309.

Ogden, L.E. "Ionizing Radiation and the Life Sciences" *BioScience* **2019**, *69*, 324-331.

Sowada, K.; Jacobsen, G.E.; Bertuch, F.; Palmer, T.; Jenkinson, A. "Who's That Lying in My Coffin? An Imposter Exposed by ¹⁴C Dating" *Radiocarbon* **2011**, *53*, 221-228.

Spindel, W.; Ishida, T. "Isotope separation" *J. Chem. Educ.* **1991**, *68*, 312-318.

Whitman, M. "Updating the atomic theory in general chemistry" *J. Chem. Educ.* **1984**, *61*, 952-956.

Potentially others as the semester goes along.