

Chemical Principles II
Course Number 50:160:116:01 (CHEM 116)
Section 01
RUTGERS, CAMDEN

SPRING 2024 SYLLABUS¹

I. LOGISTICS

Instructor: Dr. Kumi, george.kumi@rutgers.edu (email)²

Class Meeting Times: Monday & Wednesday at 12:30 – 1:50 PM and on Friday 12:30 – 1:30 PM

Class location: Science Lecture Hall

Instructor Office Hours: Wednesday 2.30 – 3.30 PM, Friday 1.45 – 2.45 PM

II. COURSE DESCRIPTION AND OBJECTIVES

Pre-requisites and Co-requisites for Chemical Principles II. Mathematical calculations are necessary to explore chemistry concepts. The *required* mathematics pre-requisite or co-requisite course for this course are Calculus I (50:640:121) or Calculus for Business (50:1640:130).

In addition to the *required* chemistry pre-requisite courses for this course, which are Chemical Principles I (50:160:115) and Chemical Principles I Laboratory (50:160:125), the Chemical Principles II Laboratory (Course 50:160:126) is a required co-requisite course.

If for any reason, you do not meet (e.g., have not taken or are not taking) any of the stated course pre- and co-requisite courses, please notify (by email) the course instructor within the first week of classes.

Course description. This course provides students with the foundational principles and concepts of chemistry in a manner that facilitates an understanding of the central role that chemistry plays in science and in the broader society. The approach used in this course emphasizes the overall idea that chemistry employs the molecular/atomic level viewpoint to explain and predict the properties of matter. To this end, this course delves into various aspects of the following concepts: molecular geometry and chemical bonding theories, the properties of gases, intermolecular interactions and mixtures, chemical kinetics and equilibrium, acid and base equilibrium, solubility, thermodynamics, and electrochemistry.

Course objective. The objective of this course is to develop a basic appreciation of chemistry and the way it impacts our day-to-day experiences. By the completion of this course, students will have acquired the ability to understand and interpret many everyday phenomena, such as why ‘salting’ a road prevents the formation of ice, why water bubbles when it boils, how humans breathe. They will also gain proficiency in logical deduction skills by connecting written problems and laboratory work to real life scenarios.

Student Outcomes for this Course. Chemistry describes matter and its transformation from three distinct viewpoints, namely, the macroscopic, the microscopic, and the representational viewpoints. The macroscopic viewpoint is concerned with macroscopic properties (i.e., material properties that originate from observing a collection of several components of a sample of matter as a one entity). In contrast, the microscopic domain focuses on the properties (e.g., shape, size, mass) of the individual components that make up a sample of matter (microscopic properties), and, in chemistry, these entities are atoms

¹ This document addresses the topics, rules, guidelines, and strategies relevant for this course section. Please read it carefully.

² See note about emailing the instructor at the end of this document

and/or molecules. Thus, in chemistry, the microscopic viewpoint is often referred to as the atomic-level or molecular-level description. The representational viewpoint uses specialized language (e.g., equations, symbols, stoichiometry) to characterize the components of matter and any chemical transformation these components undergo. At the end of this course, successful students (i.e., students who pass this course) will be able to use the three aforementioned viewpoints to:

1. Use known molecular bonding theories to predict certain molecular properties.
2. Describe and use the gas laws (including in stoichiometric calculations), explain/apply the ideal gas law, state the basic aspects of the kinetic theory of gases, and explain (including detailing corrections for) the non-ideality of real gases.
3. Describe the major intermolecular forces, detail how these forces affect macroscopic properties, explain the concept of dynamic equilibrium, calculate the energy changes involved in changes in state, and use LeChatelier's principle.
4. Detail the energy changes that occur during solution formation, explain the effect of temperature on solubility, use Henry's law, interconvert between various units of solutions concentration, and describe colligative properties.
5. List/explain the factors that influence the speed of a reaction, calculate (given experimental data) the relative rates of concentration changes for reactants and products of a given reaction, determine the rate of reaction and rate laws, and use integrated rate laws to determine reaction order.
6. Write/use equilibrium expressions (given a chemical reaction), employ LeChatelier's principle and the reaction quotient to interpret the state of a system with respect to equilibrium, and describe experiments to determine equilibrium constants.
7. Identify Bronsted-Lowry and Lewis acids and bases, explain the conjugate acid-base pair concept, compare the strengths of Bronsted-Lowry acids, describe the trends in the strengths of binary and oxoacids
8. Explain pH determination of strong acid and base solutions, write equilibrium constants for acids and bases, determine equilibrium concentrations of weak acid and base solutions, and describe what a buffer solution is and how it works.
9. Perform solubility calculations involving neutral salts, explain how acids affect the solubility of basic salts, and undertake selective precipitation calculations.
10. State/explain the laws of thermodynamics, describe the influences on entropy and the significance of Gibbs free energy, calculate standard free energy changes, and relate the Gibbs free energy to the position of equilibrium.
11. Describe and predict potentials of galvanic cells, use standard reduction potentials to predict spontaneous reactions, calculate standard cell potentials given standard Gibbs free energies and vice versa.

Course website. A Canvas-hosted course website has been created for this course. All students must have a Rutgers email address (RU NetID) to access the course material and information on Canvas. Go to <https://canvas.rutgers.edu> and log in. The Chemical Principles II course (Spring 2024) should be listed as one of your courses (under the 'Courses' selection) if you have a Rutgers NetID and are enrolled in this course. It is important to check this course site on a regular basis for class announcements, e.g., new assignments, updated lecture schedules.

Required Course Material:

1. **Course Text Material.** *Chemistry 2e* (ISBN-10: 1-947172-61-1, ISBN-13: 978-1-947172-61-6) by Paul Flowers, Klaus Theopold, Richard Langley and William R. Robinson (main authors), OpenStax, February 14, 2019. This is an open-access (i.e., free) text that can be downloaded for free from <https://openstax.org/details/books/chemistry-2e>. A print version of this book can also be obtained (for a cost) from the aforementioned site or from the university bookstore.
2. **Aktiv Chemistry online software.** This course section uses an online learning space, Aktiv Chemistry, to facilitate student learning and a Aktiv Chemistry site has been created for this course section. All students enrolled in this section MUST purchase (~\$35) access to (i.e., *sign up for*) this

Aktiv Chemistry course section site by going to aktiv.com and signing up to create an account for access the Aktiv Chemistry site (**Course Code: K689H8**). If you experience any issues when trying to access the Aktiv Chemistry site, please contact (e.g., via email or phone) the technical support for this software (by going to <https://aktiv.com/support>).

3. **A simple scientific calculator** (e.g., a TI-30X) **with basic functions** (e.g., cosine, sine, log); graphing calculators are not allowed for assessments (i.e., exams, quizzes)

Supplementary Course Material: (not required)

1. Chemistry: The Molecular Nature of Matter **7th Edition**, Neil D. Jespersen and Alison Hyslop, Wiley, 2015
2. Chemical Principles: The Quest for Insight **6th Edition**, Peter Atkins, Loretta Jones, and Leroy Laverman, W.H. Freeman and Company, 2013.

III. COURSE TOPICS/CONCEPTS AND TENTATIVE TIME TABLE

Week 1 – 4:

Predicting the properties of molecules

Molecular Orbital Theory.

States of matter - what is ‘a gas’? Gases and their properties, ideal gases and the gas laws, the kinetic theory of gases, real versus ideal gases, and gaseous reaction stoichiometry.

States of matter – what are ‘liquids’ and ‘solids’? Intramolecular forces and properties of liquids and solids, phase diagrams, and phase transitions.

Week 5 – 10:

Why do things dissolve? A molecular view of mixtures. The dissolution process, solubility, intermolecular forces in solutions, and colligative properties.

Reaction speed: what controls how fast chemical transformations occur? Rates of reactions, rate laws, theories of chemical kinetics, and reaction mechanisms.

Week 11 – 14:

When does a chemical transformation (i.e., reaction) ‘stop’? Chemical equilibrium, the reaction quotient and the equilibrium constant, Le Chatelier’s principle, and undertaking equilibrium calculations

Acids and Bases. Definitions of acids and bases, the pH scale, the relative strengths of acids and bases, the hydrolysis of salts, buffers, and acid-base equilibria.

Why do chemical transformations (i.e., reaction) occur at all? Spontaneity, entropy, free energy and work.

Week 15 – 16:

Chemical transformation and electrical work: batteries and more. Redox reactions, galvanic cells, batteries, fuel cells, corrosion and electrolysis.

IV. COURSE ASSESSMENTS AND ASSESSMENT POLICIES

Assignment Policies. Assignments (there will be ~12 of them over the course of the semester, i.e., about one a week) will be due at various times during the semester. All students will be allowed the opportunity to submit one ‘late assignment’ (i.e., one assignment that can be submitted late) with no point deductions and ‘no questions asked’ so long as the following stipulations are met:

1. The student contacts the instructor within 24 hours after the assignment in question is due to request that they be granted permission to submit a 'late assignment'
2. The student completes the assignment within 48 hours after permission is granted (by the instructor) to submit the assignment

Aside from the 'late assignment' described above, all assignments must be completed by the designated due date and time. There are no make-up assignments. In general, unless there is a documented official (e.g., a doctor's note, police report) extenuating circumstance (e.g., unexpected illness/injury, a personal/family emergency, or University-approved student activities) that prevents an assignment from being submitted on time, the grade for that assignment is zero. No late assignments will be accepted or graded. With appropriate supporting documentation that is submitted to the instructor, missed assignments will be considered excused (with no deadlines extensions or make-ups). The grade for an excused assignment is a student's average assignment grade for the entire course. **There are no extra credit assignments offered for this course.**

Access to Aktiv Chemistry (1 semester access), the online software program required for this course (see above) can be purchased directly from Aktiv Chemistry (aktiv.com) or via the Rutgers-Camden University bookstore.

Quiz Policies. Quizzes (there will be about ~4 of them) will also be due at various times during the semester. As with all assessments in this course, unless there is a documented official (e.g., a doctor's note, police report) extenuating circumstance (e.g., unexpected illness/injury, a personal/family emergency, or a University-approved student activity) that prevents a quiz from being completed, the grade for that quiz is zero. In general, no make-up quizzes will be administered, and no late quizzes will be accepted/graded. With appropriate supporting documentation that is submitted to the instructor, missed quizzes will be considered excused (with no deadlines extensions or make-ups). The grade for an excused quizzes is the average of that student's quiz grade for the entire course.

Exam Policy and Grading Procedures. There will be 3 exams and a comprehensive final exam. While the 3 exams are not comprehensive, these exams should be considered cumulative because of the interrelated nature of the materials covered. No make-up exams will be given without the submission of supporting documents (e.g., a doctor's note, police report) for an extenuating circumstance. Notification about a missed exam should be done as soon as is possible (any delays may factor into how accommodations are provided). *Any make-up exam must occur within a week of the missed exam; be sure to provide times that you would be available to take a make-up exam when notifying the instructor.* Whenever possible, notification about missing an exam should be received before the date of the scheduled exam and with appropriate documentation. Course grades will be assigned using the grading distribution specified in the Exams and Grades insert. **Grades will be based on these criteria alone. Please note that no score adjustments (e.g., 'curving') will be performed on any assessment or course grade.** Put differently, grading will *not* be on a curve. Thus, if every student obtains scores that merit an A grade, all students will get an A in this course. However, note that the converse is also true. Also, note that the majority of your grade is based on how well you *demonstrate* knowledge of the course material in course assessments (i.e., assignments, exams); it is not based on how much effort or time *you* personally have to put into the course (this effort will be different for different students).

Course Exam Dates (Tentative).

Exam 1	Monday February 12, 2024
Exam 2	Wednesday March 20, 2024
Exam 3	Monday April 15, 2024
Final Exam	Monday May 6, 2024

Please note that the **deadline to withdraw from any class with a W grade** is 5.00 PM ET on April 1, 2024.

Re-grading Policy. In the event that you find or suspect an error in the grading of an assessment you have the option of requesting a re-grade. Requests for re-grading must be submitted within a week after the graded material *is made available*. When requesting a re-grade, please describe the alleged error **in writing** (either via email or a note attached to the pertinent exam). Note that quizzes/exams submitted for re-grading are subject to a *full* re-grading to ensure there are no other grading errors on that assessment.

Exams and Grades	
3 Exams (15% each)	45 %
1 Final Exam	30 %
Quizzes (~4% each)	17 %
Assignments (~1% each)	8 %
Total	100 %
Attendance/Participation Bonus	2 %
Course Grade	Course percentage
A	90 – 100
B+	89 – 87
B	86 – 80
C+	79 – 77
C	76 – 70
D	69 – 60
F	< 60

V. COURSE CONDUCT

Course Attendance. As per current Rutgers University stipulations/guidelines, this is an *in-person instructional mode* course (i.e., there is no ‘remote learning option’ for this course). In accordance with university policy, student attendance is *required* at every scheduled course meeting (**both lecture and recitation**), *i.e.*, attendance is mandatory.

Attendance and participation in this course will be checked in various ways (e.g., via sign-in sheets, assessments that are handed in), so as to be able to award course points for these course-related activities. Tardiness and early exiting (i.e., leaving before class ends) may result in your being marked absent if attendance is taken during your absence. Therefore, be on time for class and do not leave the class session prior to its conclusion.

Use the Student Self-Reporting Absence system (<https://sims.rutgers.edu/ssra/>) to notify the instructor about an absence and contact the instructor directly via email; both of these processes should be done as soon as is possible (preferably by the end of the day on which a course meeting is missed). Failure to follow this course policy may result in a reduction of your course participation points for this course.

Note that reporting an absence does not automatically excuse that absence. It simply notifies the instructor about your absence. It is up to the instructor to determine how to accommodate or deal with this absence in accordance with the stated course policy described in the syllabus. Excuses considered ‘non-extenuating’ (e.g., I overslept, I forgot about class today, I had to work, traffic was a little slow) will not result in an excused absence; however, such absences should still be reported via the policy outlined above. Also note that it is University policy to excuse **without penalty** students who are absent because of **religious observances**. If possible, notify the instructor of such absences during the first week of the semester.

The University's Code of Student Conduct. It is the responsibility of each and every student to have read the *Rutgers University Code of Student Conduct*, as it specifies the obligations of any individual enrolled as a student. If you have not read it, it is suggested that you do. The standards of classroom (virtual or in-person) behavior are dictated by this code of conduct. Accordingly, students may not interfere with classroom procedures by distracting or disruptive actions (*e.g.*, talking while the instructor is talking, making distracting noises, coming late to class, allowing a cell phone to ring). Any students who engage in such prohibited acts *can* and may be penalized (*e.g.*, asked to leave the meeting for the remainder of the class period). Please avoid drifting off to other activities while logged in to course virtual meeting sessions and please turn cell phones off during these sessions to minimize distractions (if possible).

Academic Integrity. *Every student is prohibited from engaging in violations of academic integrity.* Note that every instructor is ethically bound to follow certain procedures once a student is caught, or suspected of, breaching of academic integrity (see *Rutgers University Academic Integrity Policy*). In particular, any material submitted by a student in this course for academic credit (*i.e.*, grading) must be that student's own work. Also, all students should strictly adhere to the rules governing any particular quiz or exam that is assigned.

Audio/Visual Recordings. Neither audio nor video recordings of lectures are allowed without the explicit consent of the instructor. Also, listening to any other audio or video recordings during class virtual meetings is not allowed.

Course material copyrights. Any course materials (including quizzes, lectures, and exams) are protected by copyright. You may not (and you may not grant others permission to) reproduce or distribute these course materials publicly (whether or not a fee is charged) without the copyright holder's (*i.e.*, the course instructor's) express written consent.

VI. OTHER PERTINENT COURSE INFORMATION

Rutgers University has several support services and resources that exist to facilitate *your academic success* and well-being. Details of these services and resources can be found at <https://studentaffairs.camden.rutgers.edu/student-resource-list>, and you are **highly encouraged** to visit the aforementioned website *at the beginning of the semester* so that you know what services are available to you (in case you need them at some point during the semester). A few of these services are listed below.

Accommodations for Students with Disabilities. Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: <https://ods.rutgers.edu/students/documentation-guidelines>. If the documentation supports your request for reasonable accommodations, your campus's Disability Services Office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form at <https://webapps.rutgers.edu/student-ods/forms/registration>. Please note that this is a process (*i.e.*, it takes time to review requests) and that instructors cannot make any accommodations until instructed to do so by a Letter of Accommodations. Therefore, if you need (or

even *think* you might need) accommodations, please start the process as early as you can. The Rutgers-Camden disability office website can be found at <https://success.camden.rutgers.edu/disability-services>.

Division of Student Academic Success Services. The Division of Student Academic Success (DSAS) at Rutgers-Camden (<https://success.camden.rutgers.edu>) assists students through a variety of support and services including free tutoring, supplemental instruction, and academic coaching. It will be beneficial to contact DSAS to learn more about these services and to determine if you will be able to use any of their services to enhance your learning abilities and success in this and other courses. In particular, the Center for Learning and Student Success (<https://class.camden.rutgers.edu>) provides Learning Specialists who can help you build a learning plan based on your strengths and needs. Tutors, study groups and more services are available to you at no additional cost (i.e., you have already paid for these services to be available). In addition, if English is not your first language and this causes you concern about the course, the Center for Learning and Student Success (CLASS) may be able to assist. To learn more about CLASS or to schedule an appointment, visit the CLASS website (<https://class.camden.rutgers.edu>).

Rutgers-Camden Dean of Students Office. The Dean of Students Office (<http://deanofstudents.camden.rutgers.edu/>) provides support, care, and advocacy to ensure students can thrive both academically and personally. One of the goals of this office is to limit student stress by providing resources to mitigate areas of student concern. For some students, personal, emotional, psychological, academic, or other challenges (*inside* or *outside* the classroom) may hinder their ability to succeed both in and outside of the classroom. The Dean of Students Office serves as your initial contact if you need assistance with these challenges. Thus, this office is a vital resource whenever you are unsure of how to proceed on *any* matter you feel is impairing your ability to thrive academically and personally.

Pronouns. This course affirms people of all gender expressions and gender identities. If you have a preferred gender pronoun, feel free to correct me when I am communicating with you. If you have any questions or concerns, please do not hesitate to contact me. In addition, on the Canvas course site, the Rutgers Shout-Out tool allows you to type the phonetic spelling of your name and record the pronunciation of your name in a shared audio recording for your professor and fellow students.

Title IX and the Violence Prevention & Victim Assistance Office. The office for Violence Prevention and Victim Assistance (VPVA) provides support to students who have experienced sexual violence, domestic/dating violence, stalking or any form of sex or gender discrimination. For more information about VPVA or to schedule a time to speak with an advocate visit the VPVA website (<https://vpva.camden.rutgers.edu>). To report an incident or speak with the Title IX coordinator, please visit the Title IX website (<https://respect.camden.rutgers.edu>). If you choose to disclose to me, thank you for trusting me. However, please note that I am obligated to report any disclosure to our title IX coordinator to ensure you receive the appropriate support and university response.

Time Management. This is a *challenging 4-credit* undergraduate Chemistry course. Like most challenging Chemistry courses, this course generally requires a relatively large amount of time and preparation. Indeed, it will probably involve more time than most of your other course. Be prepared for this occurrence. Though I will do everything in my power to guide and help you, what you ultimately get out of the course is often a reflection of the effort that *you* put into the course. Please remember that your grade is based on how well you demonstrate knowledge of course material - not attendance, effort, how polite you are, etc.

To adequately prepare and learn the concepts being imparted in this course, the general consensus is that **you need to be able to have at least 10 hours** (inter-dispersed throughout the week) to study/prepare for this course alone. Please make necessary adjustments in your study habits, course load, time management and work/class schedule – at the start of the semester – so that you will be geared to succeed.

Emailing the instructor. Emails are a common and effective way to communicate, and I strive to answer every student email³. Thus, please do not hesitate to email me about any course-related matter you might have; be sure these emails originate from your official Rutgers email account to prevent any unexpected technical issues. However, please also have the professional courtesy to give me at least 24 hrs to respond to any email; sending multiple emails about the same query within 24 hrs will not result in a quicker response (and is, in general, not professional). If I have not responded in the 24-hr time frame, I encourage you to assist me by emailing again to notify me that you are still awaiting a response to your initial email. Please do not consider this follow-up email to be rude or unprofessional. It may be necessary if (for some reason) your original email was not received (or mistakenly overlooked or forgotten about). In the event that I have not responded to two consecutive emails, please take the time to wait behind after the next course meeting to directly inform me about your email.

³ See <http://web.wellesley.edu/SocialComputing/Netiquette/netiquetteprofessor.html> about emailing etiquette