Spring 2022

CHEM 235-002: Physical Chemistry II

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NJIT New Jersey Institute of Technology

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF CHEMISTRY AND ENVIRONMENTAL SCIENCE

Chemistry:
Spring 2022 Course Syllabus

NJIT Academic Integrity Code: All Students should be aware that the Department of Chemistry & Environmental Science (CES) takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

COURSE INFORMATION

Course Description: Phase equilibrium, Multi-component phase equilibrium, Electrochemical Equilibrium, Thermochemistry of Ions in Solutions, Kinetic Theory of Gases, Transport Phenomena, Chemical Kinetics, Gas Phase Reactions, Chemical Dynamics, Reactions in Liquid Phase, Photochemistry.

Number of Credits: 3

Prerequisites:

CHEM 231: with a grade of C or better.

Course-Section and Instructors

Course-Section	Instructor
CHEM 235-002, TR 10am – 10:20 am	Lijie Zhang

Office Hours: By appointment. Emails requesting a meeting should be sent to lijie.zhang@njit.edu.

Required Textbook:

Title	Physical Chemistry
Author	P. W. Atkins, J. de Paula, James Keeler
Edition	11th
Publisher	Oxford University Press
ISBN #	978-0-19-876986-6

University-wide Withdrawal Date: The last day to withdraw is Monday, April 4, 2021. It will be strictly enforced.

Learning Outcomes: At the end of the course, the student will be able to

- Sketch and interpret the phase diagrams for liquid-gas, liquid-liquid, and liquid-solid equilibria for mixtures.
- Calculate chemical equilibria in simple reactions and predict impact of temperature and pressure.
- Calculate activities of ions in solutions.
- Calculate the transfer parameters (diffusion coefficient, viscosity, thermal and electrical conductivity).
- Determine the Arrhenius parameters of a chemical reaction from the rate vs. temperature data.
- Process data for reactions of simple orders.
- Build up mechanisms of complex chemical reactions, construct corresponding systems of ODE, and use the steady-state approximation.
- Estimate rate constants of elementary chemical reactions using the Simple Collision Theory and the Transition State Theory.

Canvas: There is a course Canvas site that will include significant resources and updates of importance to this course. Please check it frequently, and also make sure to check or forward your NJIT email in order to receive important announcements. Furthermore, all the office hours and discussions will be conducted through WebEx.

POLICIES

All CES students must familiarize themselves with, and adhere to, all official university-wide student policies. CES takes these policies very seriously and enforces them strictly.

Grading Policy: The final grade in this course will be determined as follows:

Homework	20
Class Participation Solving problems in class, active role in asking and answering questions	20
Midterm Exam I	20
Midterm Exam II	20
Final Exam	20

Your final letter grade in this course will be based on the following tentative curve:

A	88-100	**C**	60-64.5
B+	78-87.9	**D**	55-59.9
B	70-77.9	**F**	< 55
C+	65-69.9		

Attendance Policy: Attendance at all classes is not mandatory but extremely encouraged due to the nature of the topic which cannot be simply learnt through "getting the notes."

Homework Policy: Homework is an expectation of the course. The homework problems set by the instructor at the end of every Thursday lecture are to be solved and uploaded for grading before the next class **(i.e. till midnight of the Sunday before the next class)**. Students will be asked to solve one problem of their choice in the following class which contributes to the grading of "class participation".

Exams: There will be two midterm exams during the semester and one final exam. Each exam covers the materials discussed during the prior lectures after the last exam. There will be a mock exam on the session prior to the main exam.

Midterm Exam I	February 22 (first 9 lectures)
Midterm Exam II	April 5 (next 8 lectures)
Final Exam Period	May 6 – May 12 (last 8 lectures)

The exams are open book/notebooks/printed slides.

Makeup Exam Policy: There will normally be **NO MAKE-UP EXAMS** during the semester. In the event that a student has a legitimate reason for missing an exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the CES Department Office/Instructor that the exam will be missed so that appropriate steps can be taken to make up the grade.

Cellular Phones: All cellular phones and other electronic devices must be switched off during all class times. Such devices are not allowed during exams or quizzes.

ADDITIONAL RESOURCES

Accommodation of Disabilities: Office of Accessibility Resources and Services (***formerly known as Disability Support Services***) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please contact Chantonette Lyles, Associate Director at the Office of Accessibility Resources and Services at 973-596-5417 or via email at lyles@njit.edu. The office is located in Fenster Hall Room 260. A Letter of Accommodation Eligibility from the Office of Accessibility Resources Services office authorizing your accommodations will be required.

For further information regarding self-identification, the submission of medical documentation and additional support services provided please visit the Accessibility Resources and Services (OARS) website at:

- http://www5.njit.edu/studentsuccess/disability-support-services/

Important Dates See: Spring 2022 Academic Calendar, Registrar

https://www5.njit.edu/registrar/spring-2022-academic-calendar/

January	18	Tuesday	First Day of Classes
January	22	Saturday	Saturday Classes Begin
January	24	Monday	Last Day to Add/Drop a Class, Last Day for 100%
January	25	Tuesday	W Grades Posted for Course Withdrawals
January	31	Monday	Last Day for 90% Refund, Full or Partial Withdrawal, No
February	14	Monday	Last Day for 50% Refund, Full Withdrawal
March	7	Monday	Last Day for 25% Refund, Full Withdrawal
March	14	Monday	Spring Recess Begins - No Classes Scheduled
March	19	Saturday	Spring Recess Ends
April	4	Monday	Last Day to Withdraw
May	3	Tuesday	Friday Classes Meet
May	3	Tuesday	Last Day of Classes
May	4	Wednesday	Reading Day 1
May	5	Thursday	Reading Day 2
May	6	Friday	Final Exams Begin
May	12	Thursday	Final Exams End
May	14	Saturday	Final Grades Due

Tentative Course Outline

Lecture	Date	Topic
1	01/18/2021	**Chapter 5.** Phase equilibria in multi-component systems. Phases. Phase diagrams. Components. Degrees of freedom. The Gibbs phase rule.
2	01/20/2021	**Chapter 5**. Liquid-vapor equilibria in binary systems. Completely miscible liquids. Ideal solutions. Pressure -composition diagrams. Temperature-composition diagrams. Real solutions. Lever rule. Fractional distillation. Azeotropes.
3	01/25/2021	**Chapter 5.** Liquid-liquid phase equilibria. Partially miscible liquids. Upper and lower critical temperature.
4	01/27/2021	**Chapter 5.** Liquid-solid phase equilibria. Partially miscible solids. Simple eutectic systems. Cooling curves. Solid compound formation. Congruently and incongruently melting compounds. Fractional crystallization.
5	02/01/2021	**Chapter 6.** Chemical equilibrium. The stoichiometric equation. The extent of reaction. The reaction Gibbs energy and the Standard Gibbs Energy of the reaction. The Gibbs energy minimum. The reaction quotient. The equilibrium constant. The equilibrium constant expressed via the Standard Gibbs Energy of the reaction.
6	02/03/2021	**Chapter 6.** Constructing the reaction quotient. Activities. Activities in the gas phase, in solution, and of pure solids and liquids. Equilibrium constant in terms of partial pressures, K_p. Equilibrium constant in terms of mole fractions, Kx. Sample equilibrium calculations.
7	02/08/2021	**Chapter 6**. The response of equilibria to temperature and pressure. The Le Chatelier Principle. The van't Hoff equation. Sample equilibrium calculations using the equilibrium constant in terms of mole fractions and partial pressures.
8	02/10/2021	**Chapter 5.** Thermodynamics of ions in solutions. Thermodynamic functions of formation of ions in solutions. The convention for H_3O^+. Activities of ions in solution. Activities of electrolytes. The mean ionic activity and the activity coefficient.
9	02/15/2021	**Chapter 5.** The Debye-Huckel limiting law. The ionic strength.
10	02/17/2021	Mock Exam
11	02/22/2021	**Midterm Exam I**
12	02/24/2021	**Chapter 6**. Equilibrium electrochemistry. Reduction and oxidation. Redox reactions. Electrochemical cell. Half-reactions and electrodes. The variety of cells. The variety of electrodes. Electrochemical cell at equilibrium. The cell potential. The Nernst equation.
13	03/01/2021	**Chapter 6**. The standard potentials. The reference electrode. The electrochemical series. Solubility constants. Thermodynamic functions from the cell potential measurements.
14	03/03/2021	**Chapter 16**. Molecules in motion. Mean free path. Collisions with walls and surfaces. Effusion.
15	03/08/2021	**Chapter 16**. Migration down gradients. Transport properties of gas. Diffusion, thermal conductivity and viscosity.
16	03/10/2021	**Chapter 16**. Molecular motion in liquids. The conductivity of electrolyte solutions. The mobilities of ions.
17	03/22/2021	**Chapter 16**. Mobility and diffusion. Conductivity of weak and strong electrolytes. The Ostwald dilution law. The Kohlrausch law.
18	03/24/2021	**Chapter 17**. The rates of chemical reactions. Elementary and complex chemical reactions. The rate law. Reactions of simple orders. The rate constant.
19	03/29/2021	**Chapter 17**. The formal chemical kinetics. First, second and third order chemical reactions. The integrated rate laws.

20	03/31/2021	Mock Exam
21	04/05/2021	**Midterm Exam II**
22	04/07/2021	**Chapter 17**. The temperature dependence of reaction rates. The Arrhenius expression. The A-factor and the activation energy. The apparent activation energy of chemical reaction.
23	04/12/2021	**Chapter 17**. Simple complex reactions. Reversible first order reaction. Approaching the equilibrium. The relationship between the forward and reverse rate constant and the equilibrium constant. Parallel first order reactions. Consecutive first order reactions. Pre-equilibrium. The steady-state approximation.
24	04/14/2021	**Chapter 17**. Application of the steady-state approximation. Unimolecular reactions. The Lindemann-Hinshelwood mechanism. Enzymatic kinetics (Chapter 23.2). The Michaelis-Menten mechanism.
25	04/19/2021	**Chapter 17**. The kinetics of complex reactions. The system of ordinary differential equations. The structure of chain reactions. Application of the steady-state approximation. The chain length. Chain initiation, propagation and termination. The rate controlling step.
26	04/21/2021	**Chapter 17**. Chain branching reactions. Chain branching explosions. The criterion of the explosion limits.
27	04/26/2021	**Chapter 18**. Molecular reaction dynamics. The collision theory. The steric factor.
28	04/28/2021	**Chapter 18**. The reaction coordinate and the transition state. The Transition State Theory. The Standard Entropy and Standard Gibbs Energy of Activation.
29	05/03/2021	**Chapter 17**. Photochemical reactions. Quantum yield.