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Fall 2021

CHEM 236-001: Physical Chemistry for Chemical Engineers

Kathleen Gilbert

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NJIT
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THE DEPARTMENT OF CHEMISTRY AND ENVIRONMENTAL SCIENCE

Fall 2021 Course Syllabus

CHEM 236-001 *Physical Chemistry for Chemical Engineers*
Tuesdays 10am – 12:05pm, 1 – 2:20pm
Fridays 9:15 – 11:20am

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. ***This policy applies to all in-person, online, and remote work submitted by any student, as well as any student enabling another student to cheat or plagiarize.***

CHEM 236. Physical Chemistry for Chemical Engineers. 4 credits, 5 contact hours (5;0;0).
Prerequisites: (CHEM 122 or CHEM 126) and CHEM 125A and (CHE 230 or CHE 232) with a grade C or better. This course will introduce the chemical engineering students to the concepts of order, disorder, chemical equilibrium and phase equilibrium. Credit for this course will not be given if credit for CHEM 235 has been given.

Instructor: **Kathleen Gilbert, Ph.D., P.E.**

Contact information: *Email is the best way to contact the Instructor* **gilbert@njit.edu**

Phone or leave a message at: (973) 642-7938

Office Hours: As posted in Canvas or by appointment by email. *While in-person, you are welcome to stay after class when the Instructor is available.*

> **Required Textbook:**
> **PRINT EDITION ONLY – Exams will be OPEN BOOK, our textbook only, no notes.**
> **Physical Chemistry, by Atkins, de Paula, and Keeler**
>   **11th Edition, published by Oxford University Press, ISBN: 9780198817895**

Important Information:
The Fall 2021 Chem 236 course will run in-person with NJIT-required guidelines in place. There will be required online assignments in Canvas, some of which require uploading of work for full credit.

- Bring a pencil or pen and a calculator to class to do the **worksheets** in-person
- Bring a smartphone, tablet, or computer to class to **take a photo of your worksheet and upload it** at the end of class (or directly after). Worksheets will only be collected online.

Students will be responsible for taking a photo of and uploading their work when required as part of an assignment. NO EMAILED WORK will be accepted; if you miss a deadline, you must ask the Instructor to reopen the assignment for you. Late uploads may lose credit unless a Dean of Students-approved excuse is obtained. Contact the Help Desk immediately if you have trouble uploading your assignment.

Any student who has a computer issue during an online assignment must report them to the Help Desk online at servicedesk.njit.edu, by phone to 973-596-2900, or by email to: servicedesk@njit.edu. The Instructor is unable to troubleshoot computer issues but should be copied on communications.

Learning Outcomes: *By the end of this course, you should be able to do the following:*

1. Calculate thermodynamic functions of chemical reactions (enthalpy, entropy, Gibbs energy, heat capacity) based on the tabulated data at the reference and other temperatures.

2. Sketch, interpret, and use phase diagrams for one-component systems.

3. Derive the basic thermodynamic relations and state the approximations and the applicability.

4. Calculate the thermodynamic functions of pure compounds and of components in mixtures.

5. Sketch the phase diagrams for liquid-gas, liquid-liquid, and liquid-solid equilibria for mixtures and be able to interpret them.

6. Calculate activities and activity coefficients of ions in solutions.

7. Determine equilibrium constants and reaction quotients based on reaction and/or thermodynamic data.

8. Calculate the transfer parameters (diffusion coefficient, viscosity, thermal and electrical conductivity).

9. Determine the Arrhenius parameters of a chemical reaction from the rate constant vs. temperature data.

10. Analyze data for reactions of simple orders.

11. Build up mechanisms of complex chemical reactions, construct corresponding systems of ordinary different equations, and use the steady-state or pre-equilibrium approximations.

12. Estimate rate constants of elementary chemical reactions using the Simple Collision Theory and the Transition State Theory.

Grading Policy: The overall grade for this course consists of the following:

Online Homework and Attendance	**10%**
Online Quizzes • **Respondus Lockdown Browser required** • **Lowest quiz grade dropped** • **Work must be uploaded to earn full credit**	**20%**
Midterm Exam #1 (in-person)	**20%**
Midterm Exam #2 (in-person)	**20%**
Final Exam (in-person)	**30%**

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

A	90% and above	**B**	80% to 84%	**C**	70% to 74%	**F**	59% and lower
B+	85% to 89%	**C+**	75% to 79%	**D**	60% to 69%		

Final grades are FINAL. Any discussion of possible grade issues must take place during the semester before final grades are posted.

Check your grades regularly, and email if you have a question. Students should confirm any grade issues discussed with the Instructor by email. <u>Keep a record of any emails sent to the Instructor and the Instructor's response!</u>

Attendance Policy: Attendance is mandatory and part of the final grade. If a student has a Dean of Students approved excuse for their absence, the missed assignment will either be averaged out or the student will be given a chance to make up the assignment or a substitute assignment after their excused absence is over.

<u>Lectures:</u> <u>Students are expected to read the book chapter and review any slides **before** coming to class.</u> The lectures will consist of in-depth discussion of the material, active solving of exercises, and group assignments. Exam and quiz questions are **often** more complicated than in-class examples.

Homework: There are two types of homework: online homework in Canvas and recommended problems and exercises from the book. Only the online homework counts towards the final grade. Although recommended problems and exercises will not be collected or graded, <u>they will serve as a basis for quizzes and exams, and are often more complicated than examples demonstrated in class.</u>

Online homework has a specific due date. Homework assignments will have multiple attempts available, and will not be timed or proctored. Late homework assignments will not be accepted without a Dean of Students approved excuse. NO EMAILED HOMEWORK will be accepted. HOMEWORK IS OPEN BOOK, OPEN NOTES.

Quizzes: Timed online only quizzes offered outside of class time will be given most weeks other than exam and single meeting weeks. Tentative quiz dates are posted in the Course Outline later in this syllabus. The schedule reflects the expected maximum number of quizzes, eight, but there may be as few as six. In any case, the lowest quiz grade will be dropped before calculating the final grade. *IMPORTANT: STUDENTS CAN USE THEIR ***PRINT* COPY OF ATKINS' PHYSICAL CHEMISTRY AND NOTES** FROM OUR CLASS WHEN TAKING ONLINE QUIZZES IN THE LOCKDOWN BROWSER.* No other materials nor access to other electronic devices is allowed during quizzes.

Quizzes will include fill-in and/or multiple-choice questions. Numerical fill-in questions will require work to be shown and uploaded separately from the Canvas quiz. Quiz grading errors must be brought to the attention of the Instructor as soon as possible, and manual grading will correct any automatic grading issues. ***The final answer in the Canvas quiz part must match the final answer in the submitted quiz work for each problem, or no credit will be awarded for that question for either part. You

must enter your intermediate answer and reference it in your work if you know you were on the wrong track but could not finish the problem. When in doubt, write a note for possible partial credit.***

Exams: There will be two midterm exams and one comprehensive final exam. The midterm exams are in-person only. The final exam may have both an online part and an in-person part to give students more time to show their knowledge of the material.

IMPORTANT: *STUDENTS CAN USE THEIR ***PRINT* COPY OF ATKINS' PHYSICAL CHEMISTRY ONLY** WHEN TAKING IN-PERSON OR REMOTE EXAMS.* No other materials (no notes, no papers) are allowed. No use or access of other electronic devices is allowed during exams.

The following exam dates are tentative and subject to change:

Midterm Exam #1	**F 10/8, 9:15 – 11:20am**
Midterm Exam #2	**F 11/5, 9:15 – 11:20am**
Final Exam (2.5 hrs)	**Between 12/15 and 12/21**

Midterms and the final exam will be taken in person barring a NJIT-required return to remote instruction.

The final exam will test your knowledge of all course material covered but may be weighted somewhat towards material not tested on before.

Makeup Exam Policy: There will normally be **NO MAKE-UP QUIZZES OR EXAMS** during the semester. Only excuses approved by the Dean of Students office by presenting written verifiable proof of the reason for missing the quiz or 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 and Instructor that the quiz or exam will be missed.

Cell Phones and Other Devices: **Appropriate** use of laptops, tablets, and cell phones is allowed in class. Online homework can be completed with any resources, but only the computer used to access Canvas is allowed for online quizzes and other assignments, the exception is a calculator.

Chemistry Learning Center: The Chemistry Learning Center is expected to have online tutoring.

Accommodation of Disabilities: The Office of Accessibility Resources and Services (OARS) offers long-term and temporary accommodations for students at NJIT. If you are in need of accommodations due to a disability, please contact Chantonette Lyles, Associate Director at the OARS at 973-596-5417 or via email lyles@njit.edu. For further information regarding self-identification, the submission of medical documentation and additional support services provided please visit the Office of Accessibility Resources and Services (OARS) website.

Instructor Availability: Guest lecturers or recorded material for asynchronous learning may be assigned if the Instructor is unavailable. Any last minute changes will be communicated via email or Canvas to the extent possible.

IMPORTANT DATES: (See Fall 2021 Academic Calendar to check for updates in case of snow days or other emergency situations – more likely, NJIT will pivot to online to avoid missed days):

Month	Date	Day	Event
September	1	Wednesday	First Day of Classes
September	**6**	**Monday**	**NO CLASSES – Labor Day**
September	8	Wednesday	Monday classes meet
September	8	Wednesday	Last Day to Add/Drop a Class
November	10	Wednesday	Last Day to Withdraw from a Class
November	**25**	**Thursday**	**NO CLASSES – Thanksgiving**
November	**26**	**Friday**	**NO CLASSES – Day after Thanksgiving**
December	10	Friday	Last Day of Classes
December	*13*	*Monday*	*Reading Day 1 (no classes scheduled)*
December	*14*	*Tuesday*	*Reading Day 2 (no classes scheduled)*
December	15	Wednesday	Final Exams Begin
December	21	Tuesday	Final Exams End
December	23	Saturday	Final Grades Due

CHEM 236-001 Fall 2021 Course Outline				
Class #	Date	Focus (Chapter)	Topic	Quizzes / Exams
1	F 9/3	2A	Internal Energy	
2	T 9/7	2B, 2C	Enthalpy, Thermochemistry	
3	F 9/10	2D	State functions and exact differentials	Quiz 1 on 2A - 2C
4	T 9/14	2E	Adiabatic changes	
5	F 9/17	3A	Entropy	Quiz 2 on 2D - 2E
6	T 9/21	3B, 3C	Entropy changes accompanying specific processes, The measurement of entropy	
7	F 9/24	3C, 3D	The measurement of entropy, Concentrating on the system	Quiz 3 on 3A - 3B
8	T 9/28	3D	Concentrating on the system	
9	F 10/1	4A, 4B	Phase diagrams of pure substances, Thermodynamic aspects of phase transitions	Quiz 4 on 3C - 3D
10	T 10/5	4B	Thermodynamic aspects of phase transitions	
11	F 10/8	**MIDTERM** EXAM #1	IN-PERSON EXAM, NO LECTURE.	EXAM ON CH. 2 - 4
12	T 10/12	5A	The thermodynamic description of mixtures	
13	F 10/15	5B	The properties of solutions	
14	T 10/19	5C	Phase diagrams of binary systems: liquids	Quiz 5 on 5A - 5B
15	F 10/22	5D, 5F	Phase diagrams of binary systems: solids, Activities	
16	T 10/26	6A	The equilibrium constant	Quiz 6 on 5C - 5D

CHEM 236-001 Fall 2021 Course Outline				
Class #	Date	Focus (Chapter)	Topic	Quizzes / Exams
17	F 10/29	6B	The response of equilibria to the conditions	
18	T 11/2	1B, 16A	The kinetic model, Transport properties of a perfect gas	
19	F 11/5	**MIDTERM EXAM #2**	IN-PERSON EXAM, NO LECTURE.	EXAM ON CH. 5 - 6
20	T 11/9	16B	Motion in liquids	
LAST DAY TO WITHDRAW: Wednesday, November 10, 2021				
21	F 11/12	17A	The rates of chemical reactions	Quiz 7 on 1B, 16A
22	T 11/16	17B	Integrated rate laws	
23	F 11/19	17C, 17D	Reactions approaching equilibrium, Arrhenius eq.	
24	T 11/23	17E	Reaction mechanisms	Quiz 8 on 17A - 17D
25	T 11/30	17F	Examples of reaction mechanisms	
26	F 12/3	17G	Photochemistry	
27	T 12/7		REVIEW*	
28	F 12/10		REVIEW*	
FINAL	TBD	FINAL EXAM	All of the covered material**	

* If we start to run out of time, we may use one or both of the last two sessions to cover new material, and a review session will be held outside of class hours.

**Any material that will NOT be on the final exam will be identified clearly in class.

Final notes:

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

Students are responsible to be fully aware of the information in this syllabus at all times during the semester. If you have any questions about material in this syllabus, let the Instructor know as soon as possible via email so they may be answered.

This syllabus may change based on material covered and other factors.