COLLEGE OF LIBERAL ARTS AND SCIENCES, UIC

Chem 342, "Physical Chemistry I", 3 credit hours

I. Instructor & Course Details

Preston T. Snee

Email address: sneep@uic.edu

Office Hours: 12-1 Tu, 11-12 Wed in SES Rm. 4176

Graders

Hashini Chandrasiri. Email address: hhitih2@uic.edu. Drop-In Office Hours: Drop-In Hours location: Rm. 4123 SES.

Eun Byoel Kim. Email address: ekim217@uic.edu. Drop-In Office Hours: Drop-In Hours location: Rm. 4123 SES.

Blackboard Course Site LINK

Students are expected to log into the course site regularly to learn about any developments related to the course, upload assignments, and communicate with classmates. For all technical questions about Blackboard, email the Learning Technology Solutions team at LTS@uic.edu.

II. Course Information

Course Description and Prerequisite Statement

What is Physical Chemistry I? For this class we will explore physical phenomena in chemistry using the rather simple mathematical tools of 1st semester calculus. The purpose is to demonstrate that creating a model for a real system allows one to understand the underlying principles of the system and predict new behaviors. To this end we will explore energy in all its forms, especially as it applies to chemical-based power systems.

Course Goals and Learning Objectives

Goals and Competencies Gained, Learning Objectives, and General Education Learning Objectives:

In the first part of this course we will study gas expanding systems, such as the internal combustion engine. The Three Laws of Thermodynamics will be introduced.

For the second part we will use energetic principles to predict the products and yields of chemical reactions.

For the last part we will use the principles of energetic equilibrium to understand phase diagrams, colligative (solution) properties such as boiling point elevation, electrochemistry (batteries) and last the thermodynamics of surfaces.

Required and Recommended Course Materials

Download your textbook "Free Energy" at https://pchem.digital.uic.edu

Respect for Copyright

Please protect the copyright integrity of all course materials and content. Please do not upload course materials not created by you onto third-party websites or share content with anyone not enrolled in our course.

III. COURSE POLICIES & CLASSROOM EXPECTATIONS

Grading Policy and Point Breakdown

Problem sets: 10 of them = 100 points total
Hour exams: 100 per each of 3 exams = 300 points total
Quizzes: 50 points – we have quizzes if attendance drops.
Final: 300 points

Policy for Missed or Late Work

Exams and homeworks cannot be submitted late without permission of the instructor.

Attendance / Participation Policy

Policy: Please email me if you face an unexpected situation that may impede your attendance, participation in required class and exam sessions, or timely completion of assignments.

Other Course Policies

Academic Integrity

As a student and member of the UIC community, you are expected to adhere to the Community Standards of academic integrity, accountability, and respect. Please review the UIC Student Disciplinary Policy for additional information.

Email Expectations

Students are responsible for all information instructors send to your UIC email and Blackboard accounts. Faculty messages should be regularly monitored and read in a timely fashion.

IV. COURSE SCHEDULE

Weekly Schedule of Class Topics, Assignments, Assessments, Due Dates, and Deadlines

Monday Aug 21 2023. Description of the course, State variables. Class policies, and introduction to state variables (intensive and extensive). Reading: Chapter 1 of Free Energy
Wednesday Aug 23 2023. State Variables and the Perfect Gas Law. Introduction to real gas laws, the Virial and the van der Waals equations. Reading: Chapter 1 of Free Energy
Friday Aug 25 2023. Real Gas Laws Pt. I. An overview of the Virial and van der Waals equations for real gas behavior. Reading: Chapter 1 of Free Energy
Friday Aug 25 2023. Extra Hour 1: A review of calculus, especially as applied to thermodynamics.
Monday Aug 28 2023. Compression Factors and Residual Volumes of Real Gases. Real gas behavior as measured by the compression factor and residual volume. Reading: Chapter 1 of Free Energy
Wednesday Aug 30 2023. Path Dependence and Work. How inexact differentials (like heat and work) are path dependent, and they add together to equal internal energy which is exact. Reading: Chapter 2 of Free Energy

Friday Sep 01 2023. The Equipartition Theorem. How to calculate the number of degrees of freedom to determine the Internal Energy via the Equipartition Theorem. Reading: Chapter 2 of Free Energy
Friday Sep 01 2023. Extra Hour 2: More on Inexact Differentials and Practice Problems. Example problems on the van der Waals equation and supplemental information on inexact partial differentials.
Wednesday Sep 06 2023. Heat Capacity and Enthalpy. Introduction to Heat Capacity, at constant volume and at constant pressure. Reading: Chapter 2 of Free Energy
Friday Sep 08 2023. Enthalpy and the Legendre Transform. How Enthalpy is defined by the Legendre Transform. Reading: Chapter 3 of Free Energy
Friday Sep 08 2023. Extra Hour 3: Example Problems.
Monday Sep 11 2023. Introduction to Thermodynamic Proofs. An introduction on thermodynamic proofs, with Cp-Cv as an example. Reading: Chapter 3 of Free Energy
Wednesday Sep 13 2023. Adiabatic Transitions. Introduction to adiabatic systems and how to calculate the temperature change in an adiabatic transition. Reading: Chapter 3 of Free Energy
Friday Sep 15 2023. The Joule and Joule-Thomson Experiments. The Joule and Joule-Thomson Experiments prove that our general knowledge of thermodynamics is correct. Reading: Chapter 4 of Free Energy
Friday Sep 15 2023. Introduction to the 2nd Law. How the change in heat over temperature is an exact quantity, also known as entropy. Reading: Chapter 4 of Free Energy
Monday Sep 18 2023. Calculating Entropy and the 2nd Law. How to calculate changes in entropy, and the 2nd Law of Thermodynamics as it pertains to changes in the total entropy. Reading: Chapter 4 of Free Energy
Wednesday Sep 20 2023. Exam 1 Review.
Friday Sep 22 2023. Exam 1.
Monday Sep 25 2023. System and Exterior Entropy, and Introduction to the Carnot Cycle. The importance of exterior entropy in the calculation of total entropy. Reading: Chapter 4 of Free Energy
Wednesday Sep 27 2023. The Carnot Efficiency. The total work and efficiency of the Carnot Cycle. Reading: Chapter 4 of Free Energy
Friday Sep 29 2023. The Entropy of the Carnot Cycle and the Clausius Inequality. How the system entropy of the Carnot cycle is 0 J/K and how the 2nd Law is defined by the Clausius Inequality. Reading: Chapter 4 of Free Energy
Friday Sep 29 2023. Extra Hour 4: Derivations using Adiabatic Derivatives. Derivation examples for homework help.
Monday Oct 02 2023. The Boltzmann Formula. How to calculate adiabatic reversible derivatives and the Boltzmann formula for entropy. Reading: Chapter 4 of Free Energy
Wednesday Oct 04 2023. The Boltzmann Formula and Introduction to Helmholtz Energy. More about entropy, and the definition of Helmholtz and Gibbs Energy. Reading: Chapter 5 of Free Energy
Friday Oct 06 2023. Derivation of Helmholtz and Gibbs energy, and how to derive Maxwell relations via Euler's test. Reading: Chapter 5 of Free Energy
Monday Oct 09 2023. The Gibbs-Helmholtz Equation. How to determine the change in Gibbs Energy with temperature using the Gibbs-Helmholtz equation. Reading: Chapter 6 of Free Energy
Wednesday Oct 11 2023. The 3rd Law and Introduction to Hess's Law. The 3rd Law of Thermodynamics as defined by the Nernst Theorem. Also the 1st law of Thermo (Conservation of Energy) results in Hess's Law. Reading: Chapter 6 of Free Energy
Friday Oct 13 2023. Hess's Law and Examples. Relative energies of formation from elements in their standard states, and how Hess's Law is a re-expression of the 1st Law. Several examples are provided. Reading: Chapter 6 of Free Energy
Friday Oct 13 2023. Kirchoff's Law and the Temperature Dependence of Thermochemical Data. How to calculate Del_G, H, and S for two perfect gases mixing. Reading: Chapter 6 of Free Energy

Monday Oct 16 2023. Open Systems and Chemical Potential. How changes in energy with mass is calculated via the chemical potential. Reading: Chapter 6 of Free Energy
Wednesday Oct 18 2023. Exam 2 Review.
Friday Oct 20 2023. Exam 2.
Monday Oct 23 2023. How Mixing Lowers Chemical Potential. The first step to a chemical reaction is for the reactants to mix, which changes their chemical potential. Reading: Chapter 6 of Free Energy
Wednesday Oct 25 2023. How Chemical Reactions Reach Equilibrium. More discussion on the change of chemical potentials as a reaction occurs. Reading: Chapter 6 of Free Energy
Friday Oct 27 2023. How Chemical Reactions Reach Equilibrium Pt. 2. The dependence of chemical potential on mole fractions, equilibrium, and equilibrium constants. Reading: Chapter 6 of Free Energy
Monday Oct 30 2023. Equilibrium Constant T&P dependence and Introduction to Liquid Mixtures. The temperature and pressure dependence of equilibrium constants and introduction to solution partial volume. Reading: Chapter 7 of Free Energy
Wednesday Nov 01 2023. Mixing Thermodynamics. Mixing Thermodynamics as described by Raoult's Law for ideal solutions. Reading: Chapter 7 of Free Energy
Friday Nov 03 2023. Ideal and Ideal-Dilute Solutions. Ideal and Ideal-Dilute solutions can be described using Raoult's and Henry's Laws. Reading: Chapter 7 of Free Energy
Monday Nov 06 2023. Excess Enthalpy and Activity. How to relate non-zero excess enthalpy to the activity of the components of a solution. Reading: Chapter 7 of Free Energy
Wednesday Nov 08 2023. Colligative Properties. Colligative Properties- Boiling point elevation and freezing point depression, as well as osmotic pressure. Reading: Chapter 7 of Free Energy
Friday Nov 10 2023. Introduction to Phase Diagrams and the Gibbs Phase Rule. Reading: Chapter 8 of Free Energy
Friday Nov 10 2023. The Clausius-Claperyon Equation. The Clausius-Clapeyron Equation for defining phase diagrams. Reading: Chapter 8 of Free Energy
Monday Nov 13 2023. Multicomponent Phase Diagrams. Reading: Chapter 8 of Free Energy
Wednesday Nov 15 2023. Exam 3 Review.
Friday Nov 17 2023. Exam 3
Monday Nov 20 2023. Multicomponent Phase Diagrams Pt. 2 and Intro to the Electromotive Force. An introduction to the Nernst Equation. Reading: Chapter 9 of Free Energy
Wednesday Nov 22 2023. Battery Designs and Reduction Potentials. Anodes, Cathodes, the Daniel Cell and the Standard Hydrogen Electrode. Reading: Chapter 9 of Free Energy
Monday Nov 27 2023. Electrochemical Cell Analysis. How to calculate the voltage of an electrochemical cell. Reading: Chapter 9 of Free Energy.
Wednesday Nov 29 2023. Introduction to Surface Tension. How surface tension and area is like pressure and volume, especially as it applies to work. Reading: Chapter 9 of Free Energy
Friday Dec 01 2023. Final Exam Review Session

Disclaimer

This syllabus is intended to give the student guidance on what may be covered during the semester and will be followed as closely as possible. However, as the instructor, I reserve the right to modify, supplement, and make changes as course needs arise. I will communicate such changes in advance through in-class announcements and in writing via Blackboard Announcements.

V. ACCOMMODATIONS

Disability Accommodation Procedures

UIC is committed to full inclusion and participation of people with disabilities in all aspects of university life. If you face or anticipate disability-related barriers while at UIC, please connect with the Disability Resource Center (DRC) at drc.uic.edu, via email at drc@uic.edu, or call (312) 413-2183 to create a plan for reasonable accommodations. To receive accommodations, you will need to disclose the disability to the DRC, complete an interactive registration process with the DRC, and provide me with a Letter of Accommodation (LOA). Upon receipt of an LOA, I will gladly work with you and the DRC to implement approved accommodations.

Religious Accommodations

Following campus policy, if you wish to observe religious holidays, you must notify me by the tenth day of the semester. If the religious holiday is observed on or before the tenth day of the semester, you must notify me at least five days before you will be absent. Please submit this form by email with the subject heading: **"YOUR NAME: Requesting Religious Accommodation."**

Pregnancy Accommodations

Following campus policy, pregnant students have rights under Title IX. To request pregnancy-related accommodations, contact the Title IX Coordinator at titleix@uic.edu or 312-996-8670.

VI. CLASSROOM ENVIRONMENT

Inclusive Community

UIC values diversity and inclusion. Regardless of age, disability, ethnicity, race, gender, gender identity, sexual orientation, socioeconomic status, geographic background, religion, political ideology, language, or culture, we expect all members of this class to contribute to a respectful, welcoming, and inclusive environment for every other member of our class. If aspects of this course result in barriers to your inclusion, engagement, accurate assessment, or achievement, please notify me as soon as possible.

Name and Pronoun Use

If your name does not match the name on my class roster, please let me know as soon as possible. My pronouns are *[she/her; he/him; they/them]*. I welcome your pronouns if you would like to share them with me. For more information about pronouns, see this page: https://www.mypronouns.org/what-and-why.

Community Agreement/Classroom Conduct Policy

- Be present by turning off cell phones and removing yourself from other distractions.
- Be respectful of the learning space and community. For example, no side conversations or unnecessary disruptions.
- Use preferred names and gender pronouns.
- Assume goodwill in all interactions, even in disagreement.
- Facilitate dialogue and value the free and safe exchange of ideas.
- Try not to make assumptions, have an open mind, seek to understand, and not judge.

- Approach discussion, challenges, and different perspectives as an opportunity to "think out loud," learn something new, and understand the concepts or experiences that guide other people's thinking.
- Debate the concepts, not the person.
- Be gracious and open to change when your ideas, arguments, or positions do not work or are proven wrong.
- Be willing to work together and share helpful study strategies.
- Be mindful of one another's privacy, and do not invite outsiders into our classroom.

Content Notices and Trigger Warnings

Our classroom provides an open space for a critical and civil exchange of ideas, inclusive of a variety of perspectives and positions. Some readings and other content may expose you to ideas, subjects, or views that may challenge you, cause you discomfort, or recall past negative experiences or traumas. I intend to discuss all subjects with dignity and humanity, as well as with rigor and respect for scholarly inquiry. If you would like me to be aware of a specific topic of concern, please email or visit my Student Drop-In Hours.

VII. RESOURCES: Academic Success, Wellness, and Safety

We all need the help and the support of our UIC community. Please visit my **drop-in hours** for course consultation and other academic or research topics. For additional assistance, please contact your assigned college advisor and visit the support services available to all UIC students.

Academic Success

- UIC Tutoring Resources
- UIC Library and UIC Library Research Guides.
- Offices supporting the UIC Undergraduate Experience and Academic Programs.
- Student Guide for Information Technology
- First-at-LAS Academic Success Program, focusing on LAS first-generation students.

Wellness

- **Counseling Services**: You may seek free and confidential services from the Counseling Center at https://counseling.uic.edu/.
- Access U&I Care Program for assistance with personal hardships.
- **Campus Advocacy Network**: Under Title IX, you have the right to an education that is free from any form of gender-based violence or discrimination. To make a report, email TitleIX@uic.edu. For more information or confidential victim services and advocacy, visit UIC's Campus Advocacy Network at http://can.uic.edu/.

Safety

- UIC Safe App—PLEASE DOWNLOAD FOR YOUR SAFETY!
- UIC Safety Tips and Resources
- Night Ride

- Emergency Communications: By dialing 5-5555 from a campus phone, you can summon the Police or Fire for any on-campus emergency. You may also set up the complete number, (312) 355-5555, on speed dial on your cell phone.