SYLLABUS

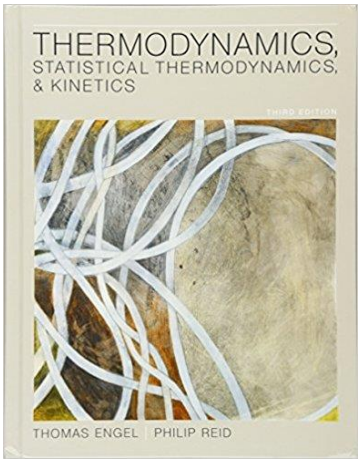
Introduction:

We usually observe and interact with chemistry and chemical systems at the macroscopic level. Over the past several centuries of history, scientists have discovered a series of laws that describe the behavior of these macroscopic systems at equilibrium. These laws and their applications comprise the field of *thermodynamics* - a fruitful subject that has enabled improvements in industrial chemistry, engines, materials, pharmaceuticals, cosmology, fuels, and other technologies that are essential to the functioning of our society. Additionally, the examination of systems out of equilibrium comprises the subject of *kinetics*. Both of these subjects also accurately describe the operation of biological systems, including the human body.

The goal of this course is to form a basis of knowledge that will enable you to engage and even contribute to the vast array of science and technology that relies of the subject of physical chemistry.

Course:	**Chemistry 3025:** Physical Chemistry I – Thermodynamics and Kinetics MWF 8:30 – 9:25 AM in Ryan Learning Center room 106 Lab Section 1: Tuesday 1:30 – 5:00 PM in Sator Hall room 208 Lab Section 2: Thursday 8:00 – 11:30 AM in Sator Hall room 208 Lab Section 3: Thursday 1:30 – 5:00 PM in Sator Hall room 208 Lab Section 4: Tuesday 8:00 – 11:30 AM in Sator Hall room 208
Instructor:	Dr. Lane Votapka Office location: Rohr Science room 322 Office hours: Mondays 1:30 – 4:00 PM, Wednesdays 1:30 – 4:00 PM, Fridays 11:00 AM – 12:30 PM and by appointment Phone: 619-849-2270 Email: lvotapka@pointloma.edu (I will be able to answer emails between 8 AM and 6 PM).
Required Materials:	*Textbook*: Thermodynamics, Statistical Thermodynamics, & Kinetics, Third Edition, Thomas Engel and Philip Reid, Pearson Education, 2013. *Online Homework*: www.masteringchemistry.com (bundled with text or purchased separately) MasteringChemistry course ID: MCVOTAPKA1414760 *Course Website*: canvas.pointloma.edu Course: CHE3025-1 SP20 – Physical Chemistry I *Clicker*: I-Clicker 2, ISBN-13: 9781429280471 *Scientific or Graphing Calculator* *Laboratory safety glasses and lab coat*: sold in lab.
Course Description:	CHE3025 (3 units) Study of classical thermodynamics as it is applied to physical and chemical systems. Includes discussion of the three laws and their application to thermochemistry, reaction energetics and chemical equilibrium. Course includes one four-hour laboratory each week. CHE3025L (1 unit) An inquiry-based laboratory that is a co-requisite for CHE 3025. Letter graded.

Learning Outcomes:



Upon completing this course you will:

1. Have improved your understanding of the laws of thermodynamics, as well as concepts including energy, enthalpy, entropy, and free energy. You will develop skills in the usage of these quantities to predict the outcomes of chemical reactions and processes.
2. Understand the microscopic explanations of the laws, physical quantities, and the behavior of chemical systems.
3. Be able to apply the macroscopic results of the laws and concepts in order to construct simplifying models to solve physical and chemical problems.
4. Have acquired the necessary skills that will be useful for future work in science or science-related fields. These skills include: problem solving, the collection, analysis, and usage of data using computer software, and the articulation and presentation of experimental and theoretical results in written and oral form.

CHEM PLO 2 (UV-vis) and BCHM PLO 3 (UV-vis) will be assessed directly by faculty laboratory instructors' observation of students' use of instruments.

Homework & Quizzes:

Homework will be essential to the learning process of this course's content; therefore, problems sets will be assigned regularly. There will be three types of assignments:

- Online homework problems: These will be assigned on MasteringChemistry. These assignments are intended to improve your problem-solving skills so you may collaborate with other students on these problems.
- Worksheets will be handed out in class and will often refer to an online video or other resource in order to practice mathematical derivations or expand understanding on a particular topic. They will be collected and graded at a later time.
- Quizzes will be held periodically in class and will mimic problems of the type that will be encountered on the exams.

I am available in office hours to help with homework and worksheet problems. All worksheets must be turned in by the beginning of class on the assigned due date. MasteringChemistry homework will typically be due just before midnight on the due date: usually every Wednesday.

Lab Reports and Presentations

There will be six experiments in total, one approximately every two weeks. Right before starting the next experiment, you will need to submit your work from the previous lab, which may include calculations, figures, a lab report, or a presentation. More details about these assignments will be described in lab rubrics and handouts.

Participation: Discussions and collaboration with your fellow student "colleagues" will be very helpful to facilitate everyone's understanding of physical chemistry. Small-group activities and problem-solving will be conducted frequently in class. Your participation score will be assigned based on engagement in in-class discussions. Participation and attendance will also be measured using clicker questions.

To minimize distractions to both yourself and others, please don't use laptops or phones in class. It would be nearly impossible to takes notes on physical chemistry using a laptop anyways.

Attendance: Regular and punctual attendance at all classes is considered essential to optimum academic achievement. If the student is absent from more than 10 percent of class meetings, the faculty member can file a written report which may result in de-enrollment. If the absences exceed 20 percent, the student may be de-enrolled without notice until the university drop date or, after that date, receive the appropriate grade for their work and participation. See Academic Policies in the Undergraduate Academic Catalog.

ADDITIONAL NOTE ABOUT LABS: The above paragraph is the official PLNU policy, but the timing of this lab course can be a bit more flexible than usual. I will periodically pass around a sign-in sheet for times to perform the lab. Everyone should plan to arrive at the beginning of the section time on the day of an experiment at the time that you signed up for. After that, since equipment is scarce, we will have to take turns using equipment, and you are free to come and go if it isn't your turn to run the experiment. If you've already performed your experiment for that week, you don't have to come in, but I will try to accommodate you during that time to answer your questions.

Grading:

Mid-term exam 1	15%
Mid-term exam 2	15%
Final exam	20%
Online Homework	15%
Quizzes	15%
Worksheets	10%
Clicker Questions	5%
Participation	5%

A	90%	C	70%
A-	88%	C-	68%
B+	86%	D+	66%
B	80%	D	60%
B-	78%	D-	58%
C+	76%	F	< 58%

PLNU Mission

To teach ~ to shape ~ to send

Point Loma Nazarene University exists to provide higher education in a vital Christian community where minds are engaged and challenged, character is modeled and formed, and service is an expression of faith. Being of Wesleyan heritage, we strive to be a learning community where grace is foundational, truth is pursued, and holiness is a way of life.

Course Credit Hour Information

In the interest of providing sufficient time to accomplish the state Course Learning Outcomes, this class meets the PLNU credit hour policy for a 3 unit class delivered over 16 weeks. Specific details about how the class meets the credit hour requirement can be provided upon request.

Final Examination Policy

Successful completion of this class requires taking the final examination on its scheduled day. The final examination schedule is posted on the Class Schedules site. No requests for early examinations or alternative days will be approved.

PLNU copyright policy

Point Loma Nazarene University, as a non-profit educational institution, is entitled by law to use materials protected by the US Copyright Act for classroom education. Any use of those materials outside the class may violate the law.

PLNU Academic Honesty Policy

Students should demonstrate academic honesty by doing original work and by giving appropriate credit to the ideas of others. Academic dishonesty is the act of presenting information, ideas, and/or concepts as one's own when in reality they are the results of another person's creativity and effort. A faculty member who believes a situation involving academic dishonesty has been detected may assign a failing grade for that assignment or examination, or, depending on the seriousness of the offense, for the course. Faculty should follow and students may appeal using the procedure in the university Catalog. See Academic Policies for definitions of kinds of academic dishonesty and for further policy information.

PLNU Academic Accommodations policy

While all students are expected to meet the minimum standards for completion of this course as established by the instructor, students with disabilities may require academic adjustments, modifications or auxiliary aids/services. At Point Loma Nazarene University (PLNU), these students are requested to register with the Disability Resource Center (DRC), located in the Bond Academic Center. (DRC@pointloma.edu or 619-849-2486). The DRC's policies and procedures for assisting such students in the development of an appropriate academic adjustment plan (AP) allows PLNU to comply with Section 504 of the Rehabilitation Act and the Americans with Disabilities Act. Section 504 (a) prohibits discrimination against students with special needs and guarantees all qualified students equal access to and benefits of PLNU programs and activities. After the student files the required documentation, the DRC, in conjunction with the student, will develop an AP to meet that student's specific learning needs.

The DRC will thereafter email the student's AP to all faculty who teach courses in which the student is enrolled each semester. The AP must be implemented in all such courses.

If students do not wish to avail themselves of some or all of the elements of their AP in a particular course, it is the responsibility of those students to notify their professor in that course. PLNU highly recommends that DRC students speak with their professors during the first two weeks of each semester about the applicability of their AP in that particular course and/or if they do not desire to take advantage of some or all of the elements of their AP in that course.

Class Schedule –Tentative--:

Sessions	**Topics**	**Readings**
Jan 14, 15	Introduction: Fundamental Concepts of Thermodynamics	Chapter 1, sections 1.1-1.5
Jan 16	Calculus "boot camp" session (Time and location TBA)	
Jan 17, 22, 24, 27	Heat, Work, Internal Energy, Enthalpy, and the First Law of Thermodynamics	Chapter 2, sections 2.1-2.11
Jan 20	Holiday: Martin Luther King Jr. Day	
Jan 29, 31 Feb 3, 5	The Importance of State Functions: Internal Energy and Enthalpy	Chapter 3, sections 3.1-3.7
Feb 7, 10	Thermochemistry	Chapter 4, sections 4.1-4.5
Feb 12, 14, 17, 19, 21	Entropy and the Second and Third Laws of Thermodynamics	Chapter 5, sections 5.1-5.10, 5.12
Feb 24	**Midterm Exam 1 (Chapters 1-5)**	
Feb 26, 28 March 2, 4	Chemical Equilibrium	Chapter 6, sections 6.1-6.14
Mar 6	The Properties of Real Gases	Chapter 7, sections 7.1-7.5
Mar 9-13	Holiday: Spring Break	
Mar 16, 18	Phase Diagrams and Stability of Solids, Liquids, and Gases	Chapter 8, sections 8.1-8.6
Mar 20, 25	Ideal and Real Solutions	Chapter 9, sections 9.1-9.3, 9.6-9.7, 9.10
Mar 23	ACS Meeting: No class	
Mar 27	Electrolyte Solutions	Chapter 10, sections 10.1-10.5
Mar 30 Apr 1	Electrochemical Cells, Batteries, and Fuel Cells	Chapter 11, sections 11.1-11.12
Apr 2, 7	**ACS Midterm Exam 2 (Chapters 1-11)**	**In your lab section**
Apr 3	Overview of Statistical Mechanics	No reading
Apr 6, 8	Kinetic Theory of Gases	Chapter 16, sections 16.1-16.7
Apr 9-13	Holiday: Easter Recess	
Apr 15, 17	Transport Phenomena	Chapter 17, sections 17.1-17.6, 17.8
Apr 20, 22, 24	Elementary Chemical Kinetics	Chapter 18, sections 18.1-18.10, 18.13, 18.15
Apr 27, 29 May 1	Complex Reaction Mechanisms	Chapter 19, sections 19.1-19.2, 19.4-19.8
May 4 (Monday)	**Comprehensive Final Exam** **7:30 – 10:00 AM in Ryan Learning Center 106**	

Lab Schedule –Tentative--:

Dates	**Week #**	**Experiment**
Jan. 16	1	Calculus Boot Camp – Thursday, Jan 16 at time and location TBA
Jan 21, 23	2	1: Van der Waals Isotherms Computational Experiment
Jan 28, 30 & Feb 4, 6 & 11, 13 & Feb 18, 20	3, 4, 5, & 6	2: The Joule-Thomson Coefficient
Jan 28, 30 & Feb 4, 6 & 11, 13 & Feb 18, 20	3, 4, 5, & 6	3: Bomb Calorimetry: Heat of Formation
Feb 25, 27 Mar 3, 5 & 17, 19	7, 8, 9, & 10	4: Gas Phase Reaction: Dissociation of N_2O_4
Feb 25, 27 Mar 3, 5 & 17, 19	7, 8, 9, & 10	5: Heat Capacity Ratio of Gases
Apr 2, 7	**11**	**ACS Thermodynamics Midterm Exam during lab session**
Mar 26, 31 Apr 14, 16 & 21, 23	11, 12, 13, & 14	6: Reaction Kinetics: The Bromination of Acetone
Apr 28, 30	15	Special Topic: The Making of the Atomic Bomb