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Department of Physics and Engineering

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Office Hours: 7-8 MWF; R 1-2:30, by appt.

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**Materials** – *An Introduction to Thermal Physics* by Daniel Schroeder (2000). Access to MATLAB or similar program and a calculator.

**Description** – Fundamental concepts of thermodynamics and statistical mechanics; applications to both classical and quantum systems.

**Course Goal** – The goal of this course is to understand thermodynamics and statistical mechanics at an intermediate level. You will learn how to describe aspects of the behavior of large collections of particles and how this macroscopic behavior is connected to the laws governing the individual particles. These ideas, and associated problem solving techniques, are important in many engineering applications, material science, physics, and to understanding a wide variety of phenomena in the physical sciences.

**Learning Outcomes** – This course supports the overall learning objectives of the physics and engineering programs to: develop an understanding of the fundamental principles of physics and apply physical principles, mathematical reasoning, and computational techniques to solve real-world problems

Within these broader outcomes, in this course you will

1. Understand and quantify the energy exchange in thermal physics
2. Explain the concept of entropy and its application to many-particle systems
3. Demonstrate familiarity with a variety of practical thermodynamic systems and processes.
4. Apply the laws of thermodynamics to solve problems
5. Apply the methods of statistical mechanics (in particular the Boltzmann factor and the summation over probabilities with a partition function) to solve for equilibrium properties of simple systems.
6. Justify and explain your thinking and approach to a problem or physical situation in written or oral form
7. When appropriate for a given problem you should be able to predict your expectations of a problem (such as behavior at high or low temperature) as well as evaluate the reasonableness of your answer (such as its dependence on various quantities, units, etc.)
8. Apply computational techniques to help solve thermal physics and statistical mechanics problems.

**Homework** – Homework is exceedingly important for developing an understanding of the course material, not to mention building skills in complex physical and mathematical problem solving. Remember that it is not just a “correct solution” that is the goal, it is the process to the solution that will develop your skill as a physicist or engineer. I encourage you to work together on the homework sets, but you must participate in the process of obtaining the solution to each problem. The guideline is that you should have no trouble explaining or repeating work that you turn in. Late homework will not be accepted unless there is a documented emergency.

**Homework Grading:** I will be using the following grading rubric for your homework:

- 0: Work shows little knowledge of physics relevant to the problem.
- 1: There is clear evidence in the work that a reasonable approach to the problem was attempted, but there are errors in units, formulas, or fundamental physics.
- 2: Either a reasonable, but incorrect, approach was attempted with few other errors; or a correct approach was presented with errors in units or math.
- 3: A correct approach was presented with few errors.
- 4: A correct approach was presented with no more than one minor error. Words were used at times to clearly indicate how and why the derivation was performed.

**Preclass questions** Each class day there will be three preclass questions to answer electronically. These will be due by 9 pm the evening before class. Your responses to Preclass questions are graded on the following scale: 2=demonstrates reading/thinking; 1=room for improvement or late but before class, 0=unsatisfactory or submitted after class. For credit preclass questions must be submitted prior to class.

**Exams** – Three examinations will be given during the semester on February 18, April 2 and April 28. The final examination is scheduled for Thursday, May 7 at 7:30 am. Exams cannot be made up, unless under extreme circumstances discussed and arrangements made with the professor before the exam.

**Final Grades** – The grade you earn in this course is based on the scale shown to the right. The points you receive during the course are weighted accordingly:

- Homework/Activities: 30%
- Preclass: 5%
- Tests (3): 40%
- Final Exam: 25%

A	100 - 91.0
A-	91.0 - 89.5
B+	89.5 - 87.5
B	87.5 - 81.0
B-	81.0 - 79.5
C+	79.5 - 77.5
C	77.5 - 71.0
C-	71.0 - 69.5
D+	69.5 - 67.5
D	67.0 - 61.0
D-	61.0 - 57.0

**University Mission:** 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.

**Department Mission:** The Physics and Engineering Department at PLNU provides strong programs of study in the fields of Physics and Engineering. Our students are well prepared for graduate studies and careers in scientific and engineering fields. We emphasize a collaborative learning environment which allows students to thrive academically, build personal confidence, and develop interpersonal skills. We provide a Christian environment for students to learn values and judgment, and pursue integration of modern scientific knowledge and Christian faith.

**Attendance:** Attendance is expected at each class session. In the event of an absence you are responsible for the material covered in class and the assignments given that day. 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 <http://catalog.pointloma.edu/content.php?catoid=24&navoid=1581#Class Attendance> in the Undergraduate Academic Catalog.

**Class Enrollment**– It is the student’s responsibility to maintain his/her class schedule. Should the need arise to drop this course (personal emergencies, poor performance, etc.), the student has the responsibility to follow through (provided the drop date meets the stated calendar deadline established by the university), not the instructor. Simply ceasing to attend this course or failing to follow through to arrange for a change of registration (drop/add) may easily result in a grade of F on the official transcript.

**Final Exam** – The final exam date and time is set by the university at the beginning of the semester and may not be changed by the instructor. This schedule can be found on the university website and in the course calendar. No requests for early examinations will be approved. Only in the case that a student is required to take three exams during the same day of finals week, is an instructor authorized to consider changing the exam date and time for that particular student.

**Academic Honesty** – 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 <http://catalog.pointloma.edu/content.php?catoid=24&navoid=2136#Academic Honesty> for definitions of kinds of academic dishonesty and for further policy information.

#### **Academic Accommodations** –

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](mailto: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.

**Credit Hour** – In the interest of providing sufficient time to accomplish the stated course learning outcomes, this class meets the PLNU credit hour policy for a 3 unit class delivered over 15 weeks. Specific details about how the class meets the credit hour requirements can be provided upon request.

**Copyright Protected Materials** – 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.

## Course Calendar

	Topics	Reading	Homework
1/16	Introductions and Temperature	1.1	
1/21	Ideal Gas; Equipartition Theorem	1.2-1.3	Hmk 1
1/23	Heat and Work	1.4-1.5	
1/28	Heat Capacity and Enthalpy	1.6	Hmk 2
1/30	Microstates and Multiplicities	2.1-2.2	
2/4	The Second Law	2.3	Hmk 3
2/6	Large Systems	2.4	
2/11	Ideal Gas	2.5	Hmk 4
2/13	Entropy	2.6	
2/18	Exam 1		Hmk 5
2/20	Temperature	3.1	
2/25	Entropy and Heat	3.2	Hmk 6
2/27	Paramagnetism	3.3	
3/3	Pressure	3.4	Hmk 7
3/5	Chemical Potential	3.5-3.6	
3/10	Spring Break		
3/12	Spring Break		
3/17	Free Energy	5.1	Hmk 8
3/19	Phase Transitions	5.2	
3/24	Clausius-Clapeyron Relation	5.3	Hmk 9
3/26	Exam 2		
3/31	Heat Engines	4.1	
4/2	Refrigerators	4.2 (4.3-4.4)	
4/7	Heat Transfer I	Notes 1.1	Hmk 10
4/9	Easter Break		
4/14	Heat Transfer II	Notes 1.2	
4/16	Heat Transfer II	Notes 1.3	Hmk 11
4/21	Heat Transfer III	Notes 1.4	
4/23	Heat Transfer IV	Notes 1.5	Hmk 12
4/28	Exam 3		
4/30	Wrap Up		
5/7	Final Exam Thursday at 7:30-10:00		