Physics 369, Thermodynamics and Statistical Mechanics, Fall 2015

Section: Unique #55685, Meets MWF, 9-10 AM, RLM 7.104

Pre-requisite: Credit or registration for Phys. 373. I will enforce this requirement. See me for approval if you have taken an equivalent course elsewhere. You must have a good understanding of multi-variable calculus and of elementary quantum physics to be properly prepared for this course.

Instructor: Dan Heinzen; Office: RLM 10.324; Phone: 471-3960;
e-mail: heinzen@physics.utexas.edu ; Office Hours: M 3-4, or by appointment.

Grader: Tao Wang; e-mail: taowong@utexas.edu ; Grader Office Hour: by appointment.

Text: Daniel V. Schroeder, *An Introduction to Thermal Physics* (Addison-Wesley, 2000), and supplementary course notes posted on Canvas.

Canvas: Lecture notes, recitation section notes, handouts, homework solutions, and grades will be posted on Canvas.

Homework: Assigned approximately once per week. You may work together on the homework. However, each student must hand in his or her own solution, and must contribute substantially to the solution of any problem he or she hands in. Some homework assignments will require numerical solutions, which you will need to provide using Excel, Mathematica, or some other programming environment. Homework assignments will all be worth the same point value even though their difficulty level and length will vary. Homework will be accepted one lecture late with a penalty of 10%. No homework will be accepted after that, except as discussed below. Your lowest homework grade will be dropped in the calculation of your final course grade.

If the workload on the grader is excessive due to the large enrollment of this course, we may need to base homework grades on partial grading of assignments.

Recitation sessions: Recitation sessions will be scheduled on an as-needed basis. These will be used to review material, do additional practice problems, and/or as homework help sessions. Attendance at these sections is optional.

Tests: There will be three in-class tests. Your lowest test score will be dropped in the calculation of the final grade.

Final: There will be a comprehensive final exam during the scheduled exam time for this class.

Make-up tests and homework: You may *not* skip tests or hand in late homework without [(i) a legitimate reason (illness, family emergency, etc.) (ii) appropriate documentation (*e.g.* doctor's note), and (iii) advance permission from me, if it is reasonably possible for you to make such a request] OR [because of observance of a religious holy day (see below)]. If you satisfy *all three* of requirements (i)-(iii) or the religious exception, you will be allowed to turn in the homework late, or take a make-up test. Otherwise your score for that homework or test will be zero.

Course grade: Homework 26%, Highest two test scores 20% each, and Final Exam 34%. Course grades will be determined strictly from your calculated weighted average score using the above weight factors. If differences between the average scores of tests are large, I may scale the scores to make their averages more similar. I do not use fixed grade breakpoints. I will provide some guidance during the semester of *approximate* grade breakpoints. You will *not* be able to earn a grade based only on your Final Exam score.

Disabilities: Students with disabilities may request appropriate academic accommodations from the Division of Diversity and Community Engagement, Services for Students with Disabilities, 512-471-6259, http://www.utexas.edu/diversity/ddce/ssd/

Religious observance: Students are entitled to a make-up exam or to turn in late work if this is needed for observance of a religious holy day. Students who want to exercise this right must inform me of the observance 14 days in advance.

University Honor Code: The core values of the University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

Test schedule:

Test 1: Weds., Sept. 30

Test 2: Fri., Oct. 30

Test 3: Weds., Dec. 2

Course Outline

Tentative. Content and schedule may be revised as course proceeds.

Date(s)	Activity	Topic
Aug. 26-31		Heat and temperature. Thermal expansion. Empirical temperature scales. Caloric vs. kinetic theory of heat. Heat capacity. Development of atomic theory. Avogadro constant. Absolute zero of temperature.
Sept. 4	HW 1 due	
Sept. 7	Labor day holiday	
Sept. 2-9		Ideal gas law. Joule and the "mechanical equivalent of heat." Internal energy. First law of thermodynamics. Compression work. Enthalpy. Dulong-Petit rule. Equipartition. Ideal gas heat capacity. Adiabatic and isothermal compressions of an ideal gas. Compressibility. Equations of state.
Sept. 11	HW 2 due	
Sept. 11-16		Random processes. Distribution functions. Poissonian statistics. The random walk. Stirling's approximation. Gaussian distribution. Kinetic theory. Maxwell-Boltzmann distribution. Effusion.
Sept. 18	HW 3 due	
Sept. 18-23		Transport phenomena. Fluctuations. Langevin equation. Brownian Motion.
Sept. 25	HW 4 due	
Sept. 30	In-class test 1	
Sept. 25, 28 Oct. 2		Multiplicity function. Examples: two-state system, Einstein solid. Thermodynamic limit. Coupled large systems. Ideal gas. Entropy.
Oct. 5	HW 5 due	
Oct. 5-9		Second law of thermodynamics. Ideal gas entropy. Entropy of mixing. Gibbs' paradox.
Oct. 12	HW 6 due	
Oct. 12-16		Definition of temperature in statistical mechanics. Entropy and heat. Third Law. Paramagentism. Mechanical equilibrium and pressure. Thermodynamic identity. Diffusive equilibrium and chemical potential. Heat engines. Carnot cycle. Carnot's theorem. Refrigerators.

Date	Activity	Topic
Oct. 19	HW 7 due	
Oct. 19-23		SI definition of temperature. Real heat engines and refrigerators. Free energy. Thermodynamic potentials. Electrochemical cells. Thermodynamic equilibrium. Phase equilibrium.
Oct. 26	HW 8 due	
Oct. 30	In-class test 2	
Oct. 26, 28 Nov. 2		Phase transitions. Clausius-Clapeyron relation. Van der Waals model.
Nov. 3	Last drop day	Last day to drop class with Dean's approval except for "urgent and substantiated non-academic reasons"
Nov. 4	HW 9 due	
Nov. 4-9		Boltzmann factor. Partition function and free energy. Statistical mechanics calculations with the canonical ensemble. Examples: Paramagnet, rigid rotor, etc. Continuous degrees of freedom. Equipartition theorem.
Nov. 11	HW 10 due	
Nov. 11-16		Plane wave states. Ideal gas. Maxwell-Boltzmann Distribution. Resolution of Gibbs' paradox. Molecular gases. Ortho- and para-hydrogen.
Nov. 18	HW 11 due	
Nov. 18-23		Grand canonical ensemble. Gibbs factor. Fermi and Bose statistics. Degenerate Fermi gas.
Nov. 26-28	Thanksgiving	Thanksgiving holidays
Nov. 25	HW 12 due	
Nov. 25-Dec. 4		Blackbody radiation. Debye theory. Bose-Einstein condensation.
Dec. 2	In-class Test 3	
Dec. 4	Last class day	