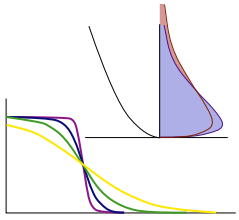

Statistical Mechanics

Syllabus

2002

1. Basic Information

Instructor Peter N. Saeta, Keck 1247, 7-3939, saeta@hmc.edu

Web Page http://saeta.physics.hmc.edu/courses/p117/

Text *Statistical and Thermal Physics*, Peter N. Saeta; the first portion has been printed and will be available in the department office for a fee of $25. This fee more than covers our cost of the binders and printing the 250 pages thus far; more installments will be distributed during the term, for which you will not be charged. See below for information about supplemental texts you may wish to consult.

Meetings MWF at 11:00, Parsons 1285. Recitation sections on Tuesdays in Thomas-Garrett; (1) at 9:35 in TG-105, (2) at 1:15 in TG-203. We will occasionally meet for recitation in the computer lab; I will keep you posted in class and by e-mail.

Office Hours The usual "open-door" policy is in force, but I intend to hold regular office hours on Monday afternoons. Please drop by early and often!

Grader Nathaniel Stern and ?

Exams The tentative exam schedule is

- an in-class midterm, Friday September 27
- a take-home midterm, given out Friday November 8, and returned Monday, November 11
- a 3-hour final exam, which I will endeavor to make available early so that you may take it when it is convenient for you up until the scheduled time, which is Wednesday December 18 at 9:00; You will be permitted a single 8-1/2" $\times$ 11" or A4 page on which you may write formulas. **It would be a good idea to prepare this sheet as you go through the term.**

2. Grade

The final grade will be weighted equally on homework and exams, with a new twist this time. The two midterms count a total of 25%, the stronger one 15% and the weaker one 10%. This determination will be made for each student individually.

Homework	Exams
30% on problem sets	10 or 15% on an in-class midterm
12.5% on a term paper	10 or 15% on a take-home midterm
7.5% on reading and participation	25% on the final examination

3. Tentative Schedule

Dates	Chapters	Topics
9/3 – 9/20	1 – 5	**Introduction to statistical mechanics**: counting, probability distributions, mechanical definitions of entropy and temperature, development of thermodynamic laws, ensembles, partition function, Boltzmann factor, canonical ensemble
9/23 – 10/8	6 – 9	**Classical and quantum statistical mechanics, gases**: phase space, particle in a box, Sackur-Tetrode equation
10/9 – 11/5	10 – ?	**Thermodynamics**: quasistatic processes, steady-state processes, heat engines, refrigerators, path dependence of work, Carnot cycle, Maxwell relations, potentials, Legendre transforms, extensivity, phase equilibrium, chemical equilibrium
11/6 – 11/13		**Diffusion and transport**: kinetic theory, detailed balance, effusion, viscosity, heat transfer
11/15 – 12/4		**Quantum gases**: fermi and bose gases, metals, thermal radiation, solids, Bose-Einstein condensation, solids, Dulong-Petit, Einstein, Debye, magnetism, semiconductors, superconductivity

I am strongly opposed to grading on a curve — a curve provides a disincentive to work together and learn from one another. Because I use an absolute scale, you have every incentive to help one another. Those doing the explaining profit from the exercise of formulating their understanding clearly for others; those receiving explanations gain hard-won insights and improved understanding. Because I firmly believe in the value of active participation in class, explaining your thoughts and ideas to others, and working together, I spend much time in class on individual, paired, and group work; participation credit is included in your final grade.

4. Reading and the Course Text

Reading assignments will be posted on the course's schedule page (saeta.physics.hmc.edu/courses/p117/schedule.html) and possibly duplicated on our WebCT page (webct.claremont.edu). Reading assignments are a very important aspect of the course; they are graded accordingly. On our WebCT site, I will monitor your discussions of the material and welcome suggestions, comments, questions, and general feedback on the text.

I will place a number of texts on reserve in the library. Of these, perhaps the most useful are the following:

Reif, F. *Fundamentals of Statistical and Thermal Physics* (McGraw-Hill, New York, 1965)

— This is an excellent and challenging book, a bit more advanced than Kittel and Kroemer. When I used this one year, many students found it difficult to read. Its real strength is the second half, which treats applications and kinetic theory. I recommend the text highly (I enjoyed it very much as an undergraduate).

Kittel, C. and H. Kroemer *Thermal Physics* (W. H. Freeman and Co., New York, 1980) — I have used this book four times, and am tired of it! Prof. Esin used it last year, so copies may be easily available. In my judgment, it does not do a particularly fine job of explaining things, it oversimplifies some subtle points, but it has a fairly concise treatment of the important topics. By and large, students found it more readable than Reif.

Callen, H. B. *Thermodynamics and an Introduction to Thermostatistics* (Wiley, New York, 1985) — This is a wonderful book that begins with and stresses thermodynamics, although it does touch on the statistical approach. Callen explains thermodynamics well, and his is my first reference for thermodynamics.

Greiner, W., L. Neise, and H. Stöcker *Thermodynamics and Statistical Mechanics* (Springer-Verlag, New York, 1995). This book has lots of nice worked examples.

Schroeder, D. V. *An Introduction to Thermal Physics* (Addison-Wesley, San Francisco, 2000) — a comparitively inexpensive recent addition to the catalog, with a great number of fine problems. Current Amazon price is about $45.

Other potentially useful books include

- Garrod, C., *Statistical Mechanics and Thermodynamics* (Oxford University Press, New York, 1995).
- Gould, H. and J. Tobochnik, *An Introduction to Computer Simulation Methods* (Addison-Wesley, Reading, 1996).
- Mandl, F., *Statistical Physics* (Wiley, New York, 1988).
- Riedi, P. C., *Thermal Physics* (Oxford University Press, New York, 1988).
- Tolman, R. C., *The Principles of Statistical Mechanics* (Oxford University Press, Oxford, 1938). A classic, available inexpensively from Dover.
- Waldram, J. R., *The Theory of Thermodynamics* (Cambrdige University Press, New York, 1991). Chapter 19 has a nice discussion of the fundamental assumptions of thermodynamics.

At a somewhat more advanced level more typical of graduate courses:

- Ma, S.-K., *Statistical Mechanics* (World Scientific, Philadelphia, 1985). Originally written in Chinese, but available in English translation.
- Landau, L. D. and E. M. Lifshitz, *Statistical Physics* (Pergamon, Oxford, 1982). Landau and Lifshitz are often not the most transparent authors on a first exposure to material, but are very elegant and provide an excellent source for review.

- Pathria, R. K., *Statistical Mechanics* (Pergamon, Oxford, 1984). A popular and accessible graduate text, with a very concise summary of introductory statistical mechanics at the outset.

5. Problem Sets

Homework is an **extremely** important part of the course. Statistical mechanics is abstract, mathematical, and challenging. Only by working problems and thinking about the concepts of the course will you arrive at a solid understanding.

I **strongly** encourage you to begin homework assignments early. You will have the same number of assignments whether you begin them the night before they are due or a week previously. By reading them over early, you allow your mind to chew on them while you are listening to lectures, walking to class, or even sleeping. You also give yourself the time to come speak with me about your questions. Feel free to send me e-mail, as well.

I encourage you to work in small groups, if you wish, provided that each member of the group participates actively. Please refrain from looking at solutions to homework problems before turning in your work.

I would like to avoid the problem of late homework. Assignments will be due on Wednesday in class. If you are unable to complete an assignment in time, please make arrangements with me ahead of time.

A great deal of research supports the notion that considerably more learning takes place when students prepare problem solutions that combine verbal explanation with mathematics. Accordingly, problem solutions will be graded for proper style as well as "the bottom line answer." Explain your solution in words and algebra; leave numbers to the end, if they are supplied. Aim to summarize in a sentence the key point of the exercise after you have completed it.

Your conduct in this course should follow the HMC Honor Code. I encourage you to discuss matters of the course, including homework assignments, with other students. However, you should not share written work in final or nearly final form. If you collaborate with other students, cite your collaborators and the work will be graded as though you worked alone. Needless to say, all exams require independent work.

We will frequently use group activities in class and in recitation. I expect considerate and active participation from everyone.