

Thermal Physics, Spring 2006

	Monday	Wednesday	Friday
January	9 Thermal Equilibrium Section 1.1	11 Ideal Gas, Equipartition 1.2, 1.3	13 Heat and Work 1.4, 1.5
	16 M. L. King Day	18 Heat Capacities 1.6	20 Enthalpy finish 1.6
	23 Microstates and Multiplicities 2.1, 2.2	25 The Second Law 2.3	27 Large Systems 2.4
February	30 Ideal Gas 2.5	1 Review Session and Test (through section 2.4)	3 Entropy 2.6
	6 Temperature 3.1	8 Entropy and Heat 3.2	10 Paramagnetism 3.3
	13 Pressure 3.4	15 Chemical Potential 3.5, 3.6	17 Heat Engines 4.1
	20 Presidents Day	22 Refrigerators 4.2, browse 4.3-4.4	24 Free Energy 5.1
	27 Review Session and Test (through chapter 4)	1 More about Free Energy 5.2	3 Phase Transformations 5.3
March	6 Clausius-Clapeyron Relation 5.3	8 The Boltzmann Factor 6.1	10 Average Values 6.2
	13	15 Spring Break	17
	20 The Equipartition Theorem 6.3	22 The Maxwell Speed Distribution 6.4	24 More about Partition Functions 6.5, 6.6
	27 Ideal Gas Revisited 6.7	29 Review Session and Test (through section 6.6)	31 The Gibbs Factor 7.1
	3 Bosons and Fermions 7.2	5 Degenerate Fermi Gases 7.3	7 Almost-Degenerate Fermi Gases finish 7.3
April	10 Photon Gas 7.4	12 Blackbody Radiation finish 7.4	14 Debye Theory of Solids 7.5
	17 Bose-Einstein Condensation 7.6	19 More about BEC finish 7.6	21 Review Session and Test (through chapter 7)
	24 Additional Topics work on projects	26 Additional Topics work on projects	28 Additional Topics work on projects
	1	3	4 Project Presentations Thursday, 9:30 - 11:30
May			

Physics 3180 General Information

Instructor: Dr. Daniel Schroeder

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Office hours: Daily from 9:00 until 9:50. I'll often be here earlier, and I'll usually be available in the afternoons, after 1:00 or 2:00. To ensure that I'll be here at one of these times, you could make an appointment. If I'm not in my office, please check SL 221.

Textbook: Schroeder, *An Introduction to Thermal Physics* (Addison-Wesley, 2000). Everything I know about thermal physics is in this book, so we'll follow it pretty closely. Reading assignments are indicated by section number on the schedule. If this book isn't working for you for some reason, you might take a look at Mandl, *Statistical Physics* (Wiley, 1988). You may also wish to consult the thermodynamics chapters in your introductory physics textbook.

Course Description. Please read the preface to your textbook and browse the table of contents to get a general idea of what the course is about. We'll cover most of the book but skip Section 1.7, the second half of Chapter 5, and all of Chapter 8.

Problem sets will be assigned roughly once a week, and due by 4:00 p.m. on the days indicated on the syllabus ("PS1" for the first problem set, and so on). Late problem sets will not be accepted. Your homework grade will be based on only your 10 highest problem set scores (out of 12), so you may miss two problem sets without penalty. This policy should give you enough flexibility to deal with most scheduled absences, illnesses, family emergencies, term papers, unexpected romances, and the like; exceptions will be granted only in the case of extended illness or other dire emergency. Official homework solutions will be posted after the due date.

I *strongly* encourage you to talk with your classmates as you work on the problem sets. This gives you an opportunity to learn from each other, to prevent careless errors, to practice putting ideas into words, and to work in an environment more like the "real world". Don't think of the homework as a "test" of what you can do on your own—it is rather an opportunity for you to *learn*, and most of us learn better from other people than from a book. It is unethical, however, to simply copy someone else's work or to borrow an idea that you don't understand yourself. Never look at another person's written solution before finishing your own.

Tests (four of them) will be closed-book, given in the Science testing center (SL 228) with a 90-minute time limit. You will have a two-day window within which to take each test: the date indicated on the course schedule and the following school day. You may use a calculator on tests to do arithmetic, but not to store information. There will be no comprehensive final exam.

No make-up tests will be given without *advance* permission.

Projects. As you read the textbook you'll notice that it contains dozens of interesting problems that are too long to assign as regular homework. Fortunately, at the end of the

semester you'll have a chance to work at least one of these problems. For your final project you will choose (from a list that I'll provide) either a single long problem or a group of two or more closely related problems. You will then work out the solution, write up your solution as a short paper, and make a very brief (five-minute) presentation to the class on the results. The presentations will take place during our scheduled final-exam time (Thursday, May 4, 9:30 – 11:30 a.m.), and the papers will be due at the same time. I'll provide more details on project topics and logistics by the middle of the semester.

Grades will be computed according to the following weights, where you get to choose within the various ranges:

problem sets (highest 10)	30–50%
tests (4 weighted equally)	40–60%
project	10–20%

Here's how it'll work: On or before February 10 (which is after you'll have gotten your first test back), you will tell me in writing (or by email) how you would like each of the three components to contribute to your final grade, subject to the constraints given above and that the weights of the three components add up to 100%. If I don't hear from you by February 10, I'll use the weights 40%, 50%, and 10%, respectively.

I'll expect your choice of project topic to be commensurate with the weight you've chosen to give the project in your final grade. (Again, details will be forthcoming.)

In deciding borderline grades I will also consider class attendance and participation. (It is the *effort* at participation that matters; how much knowledge you demonstrate makes no difference at all.)

Academic dishonesty, though rare, occasionally does occur in physics classes, so the following policies are necessary. Inappropriate collaboration on homework will result in a zero grade for that problem set on the first occurrence and failure in the course thereafter. Dishonesty of any sort on a test, if clearly documented, will result in automatic failure in the course. In serious cases, evidence of dishonesty may also be presented to the appropriate hearing committee for possible further sanctions.

Hints and Suggestions

Thermal physics differs somewhat from other branches of physics not only in its subject matter (very large systems), but also in its logical structure. There are no grand differential equations (like Maxwell's equations or the Schrödinger equation) that encompass the entire subject. Instead, there are only a few small equations, most of them definitions, together with a bag of tricks for solving a huge variety of problems. Once the basic concepts are defined, almost everything follows from pure logic.

Because the logic of thermal physics is more important than any particular equations, you should concentrate on the logic, more than the equations, as you study. You'll need to understand, and be able to reproduce, most of the "derivations"; otherwise you will find it difficult to apply the ideas to new systems that are different from those we discuss in class. (The number of possible applications is so enormous that we'll have time for only a small fraction of them.)

Since the ideas of thermal physics are closely linked to each other, the material of this course will be highly sequential. It is therefore crucial that you not fall behind. Class attendance is not required, but is strongly recommended. If you don't understand something I say in class, ask immediately—don't just write it down and hope that you'll figure it out later. Most important of all, do the homework on schedule; don't put it off until the last minute (or later).

Extensive research in recent years has shown that the students who do best in physics (and other subjects) are those who involve themselves *actively* in the learning process. This involvement can take many forms: writing lots of questions in the margins of the book; asking questions in class or during my office hours or by email; discussing physics with classmates; inventing your own examples; writing careful English explanations in homework assignments. Try to do things like these as often as possible!

A Final Word . . .

Physics is not so much a collection of facts as a *way* of looking at the world. My hope is that this course will not only teach you many of the *ideas* of thermal physics, but will also improve your *skills* in careful thinking, problem solving, and precise communication. In this course you will gain lots of experience with qualitative explanations, rough numerical estimates, and careful quantitative problem solving. When you understand a phenomenon on all of these levels, and can describe it clearly to others, you are “thinking like a physicist” (as we like to say). Even if you eventually forget every fact learned in this course, these skills will serve you well for the rest of your life.