Physics 357 – Thermal Physics - Spring 2005

Contact Info

MTTH 9-9:50. Science 255
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Description

Thermal physics involves the study of systems with lots (10^{23}) of particles. Since only a two-body problem can be solved analytically, you can imagine we will look at these systems somewhat differently from simple systems in mechanics. Rather than try to predict individual trajectories of individual particles we will consider things on a larger scale. Probability and statistics will play an important role in thinking about what can happen.

There are two general methods of dealing with such systems – a top down approach and a bottom up approach. In the top down approach (thermodynamics) one doesn't even really consider that there are particles there, and instead thinks about things in terms of quantities like temperature heat, energy, work, entropy and enthalpy. In the bottom up approach (statistical mechanics) one considers in detail the interactions between individual particles. Building up from there yields impressive predictions of bulk properties of different materials.

In this course we will cover both thermodynamics and statistical mechanics. The first part of the term will emphasize the former, while the second part of the term will emphasize the latter. Both topics have important applications in many fields, including solid-state physics, fluids, geology, chemistry, biology, astrophysics, cosmology.

The great thing about thermal physics is that in large part it's about trying to deal with reality. In introductory physics, we are constantly simplifying things. We throw out friction, call the rope massless, assume that air doesn't really get in the way, assume that whatever potential we are dealing with is quadratic, deal with only two particles, etc. We often end up modeling systems that don't really exist. With thermal physics, the connection to real systems will be more apparent than with introductory mechanics and electricity and magnetism.

Textbook

An Introduction to Thermal Physics, by Daniel Schroeder. Should be available at the bookstore. There will also be a copy on reserve in the library. Homework problems will be from this book, and we will follow it fairly closely.

Other books I will draw from include Thermal Physics, by Baierlein, Thermal Physics, by Kittel & Kroemer, Fundamentals of Statistical and Thermal Physics, by Reif, and Random Walks in Biology, by Howard Berg.

Prerequisites

Physics 246 and its associated prerequisites is required. You should be comfortable differentiating and integrating simple functions and looking up those for more complex functions. You should also be comfortable with Taylor expansions.

Problem Sets

There will be a problem set due in class on the Tuesday of each week. In terms of learning the material, the problem sets are probably the most important part of the course. I strongly suggest you start them early – it always helps to let things rattle around for a couple days if you get stuck. Make your best effort to do each problem individually. If you reach an impasse, feel free to consult your classmates for hints. However, the solution you write up should be your own.

Exams

There will be two in class exams during the term, in addition to the final. Dates for the in-class exams are to be determined, but will occur approximately 1/3 and 2/3 of the way through the term. The final is scheduled for Tuesday, May 17 from 2-4 pm.

Grading

Your grade will be determined from problem sets (25%), exams (2 mid terms – 20% and a final 30%), and in class participation (5%).

Schedule. A general outline of what we will cover follows, with references to Schroeder.

Energy and the First Law of Thermodynamics (Chapter 1)	2 weeks
Entropy and the Second Law of Thermodynamics (Chapter 2)	2 weeks
Interactions (Chapter 3)	2 weeks
Engines & Refrigerators (Chap 4.1 & 4.2)	1 week
Free Energy & Chemical Thermodynamics (Chapter 5)	2 weeks
Boltzmann Statistics (Chapter 6)	2 weeks
Quantum Statistics (Chapter 7)	2 weeks
Special Topics	1-2 weeks