PHYSICS 321: Thermal Physics

University of Tennessee, Knoxville - Spring 2022

Credit Hours:	Three
Class Time:	MWF 1:00 PM – 1:50 PM.
Class Location:	Nielsen Physics Building, Room 306.
Instructor:	Dr. Steven Johnston, Associate Professor. Department of Physics and Astronomy. He, Him, His.
Office:	203 South College.
Website:	http://www.phys.utk.edu/johnston-group/index.html
Mail Stop:	Department of Physics and Astronomy, Main Office.
Office Phone:	(865) 974-7837
Office Hours:	Wed. 2:00 PM – 3:30 PM. If you are unable to come to office hours, please email me and set an appointment at an alternative time.
E-mail:	sjohn145@utk.edu or via the Canvas message system.

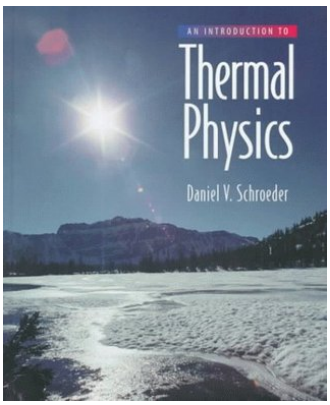
Course Description & Learning Goals

Thermal physics is the study of heat in macroscopic systems containing (very) large numbers of particles. As an entry-level course of thermal physics for undergraduate students, this course covers concepts of temperature and heat, laws of thermodynamics, and their foundation in statistical mechanics. We will also discuss applications to physical, chemical, and biological problems based on thermodynamics and statistical mechanics. By the end of the course, you should be able to:

1. describe concepts of temperature, heat, and entropy;
2. understand the laws of thermodynamics and apply them to systems in equilibrium;
3. connect microscopic physics to macroscopic behavior of a large number of particles;
4. use thermodynamics and statistical mechanics to understand physical, chemical, and biological processes such as phase transitions; And,
5. understand the basics of quantum statistics and distinguish between and apply Bose-Einstein and Fermi-Dirac statistics.

Prerequisites: The formal prerequisites for this course are one of PHYS 136, PHYS 138, or PHYS 232. The second half of the course will deal with the statistical foundation of thermodynamics and will require some concepts from quantum mechanics, at the level of PHYS 250. I will also introduce and discuss these concepts as needed.

Textbook: The primary book for the course is: *An Introduction to Thermal Physics* by Daniel V. Schroeder, Oxford University Press. It is available in hardcover (ISBN 978–0–19–289554–7), paperback (ISBN 978–0–19–289555–4), and e-book formats.



The *known* typos and corrections to the Oxford edition can be found here: https://physics.weber.edu/thermal/corrections.html.

The following textbooks can also supplement the course text:

1. *Fundamentals of Statistical and Thermal Physics* by Frederick Reif.

2. *An Introduction to Thermodynamics and Statistical Mechanics* by Keith Stowe
3. *Thermal Physics* by Charles Kittel and Herbert Kroemer. (This book is very good but also out of print and very hard to find. The library may have a copy.)

Grading: Learning outcomes will be evaluated through students' performance on homework assignments and exams. Students are responsible for reading the material before lectures, doing homework assignments, and keeping up as we go along.

Grading Distribution		Letter Grade Conversion							
Homework	40%			83-86%	B+	73-76%	C+	63-66%	D+
Quizzes	10%	$\geq 90\%$	A	80-82%	B	70-72%	C	60-62%	D
Midterm Exam	20%	87-89%	A-	77-79%	B-	67-69%	C-	57-59%	D-
Final Exam	30%							$< 57\%$	F

Assignments: I will assign homework problem sets at regular intervals throughout the year, based on the material covered in the class. There will be approximately 5-7 problem sets in total.

The problem sets will help reinforce the concepts covered in class, and they are a crucial component of the course. You will be required to provide clear solutions that demonstrate your understanding and thought process. If you provide answers without any accompanying work, you will earn a grade of zero, even if the answer is correct. Homework assignments will be due at the start of class on the indicated due dates. (If we move online during the semester, electronic copies must be submitted via Canvas by the due date.) You may submit late homework but with a 20% penalty per 24 hours after the due date unless you have made prior arrangements with me.

Quizzes: There will be four short quizzes given in class on Fridays. Questions will be based on physical concepts discussed in classes.

Quiz Dates:

Feb. 18th Mar. 11th April 8th May 2

Midterm: We will have an in-class written midterm half-way through the semester, which will cover chapters 1-4 of the textbook. A one-page, hand-written formula sheet will be allowed for both exams. (Students are allowed to use both sides of the page.) Contact the instructor *in advance* if makeup is needed.

Midterm Date: March 25th (The Friday following spring break).

Final Exam: The final exam will be held during the final exam period and will cover chapters 5-7 of the textbook. A one-page, hand-written formula sheet will be allowed for both exams. (Students are allowed to use both sides of the page.)

Final Exam Date: Wednesday, May 18th, 3:30 PM – 6:00 PM.

Appeals: You are welcome to discuss any issues you might have with the grading of an exam or assignment; however, you must raise the objections with me no later than one week after I have returned the graded material.

List of Topics and Course Timeline

We will be covering chapters 1-7 of the textbook. The tentative timeline for the course is

Chapter 1. Energy in Thermal Physics	Weeks 1 & 2
Chapter 2. The Second Law	Weeks 3 & 4
Chapter 3. Interactions and Implications	Weeks 5 & 6
Chapter 4. Engines and Refrigerators	Week 7
Midterm Exam (covering chapters 1-4)	
Chapter 5. Free Energy and Chemical Thermodynamics	Weeks 8 & 9
Chapter 6. Boltzmann Statistics	Weeks 11 & 12
Chapter 7. Quantum Statistics	Weeks 13 & 14
Final Exam (covering chapters 5-7)	

Other Important Information and Policy Matters

Group Work Policy: I encourage students to work together and discuss the homework with each other. Such discussions are one of the most effective ways of assimilating the material and often how one operates in a work or research setting. But the work you turn in must be written up by you and not be a copy of your peers' work or some other source such as solutions found on the Internet. Any homework assignment that is a direct copy of another person's work without attribution will count as plagiarism and be dealt with accordingly. Do not take advantage of the work of other people, and do not let anybody benefit from yours.

Email and Communication About Class:

I will primarily communicate either in class or via the Canvas system. Please ensure that your canvas notifications are enabled. Please adhere to the following practices when contacting me via email:

1. Use your UTK email address when contacting me about the course. This practice will ensure (a) that your email does not go to my spam folder and (b) all communication is appropriately archived.
2. Please put "PHYS321" in the subject line of all course-related emails, which will help me identify your emails and respond accordingly.
3. Please allow for up to a 24-hour delay in responding to emails; I will try to minimize such delays but do not count on an immediate response.
4. Before emailing me with questions about the course, please ensure that the information is not already provided in the course syllabus or on Canvas.

Students Accommodations: If you require course adaptations or accommodations because of a documented disability, please contact the Office of Disability Services at 2227 Dunford Hall (telephone/TTY 865-974-6087; e-mail ods@utk.edu) to ensure that you are registered for services. *University Policy forbids me from making special accommodations without a letter from the Office of Disability Services.*

Academic Honesty & Integrity: By taking this course, you agree to the following statement: "An essential feature of the University of Tennessee, Knoxville is a commitment to maintaining an atmosphere of intellectual integrity and academic honesty. As a student of the university, I pledge that I will neither knowingly give nor receive any inappropriate assistance in academic work, thus affirming my own personal commitment to honor and integrity."

All work submitted by a student is expected to represent his/her work. Students are expected to complete their homework without assistance from others. Students are expected to perform all work in conformance with the University policies regarding Academic Honesty. *I will pursue any cases of academic dishonesty that arise during the course.*

University Civility Statement: Civility is genuine respect and regard for others: politeness, consideration, tact, good manners, graciousness, friendliness, affability, amiability and courteousness. Civility enhances academic freedom and integrity and is a prerequisite to the free exchange of ideas and knowledge in the learning community. Our community consists of students, faculty, staff, alumni, and campus visitors. Community members affect each other's well-being and have a shared interest in creating and sustaining an environment where all community members and their points of view are valued and respected. Affirming the value of each member of the university community, the campus asks that all its members adhere to the principles of civility and community adopted by the campus: http://civility.utk.edu/.