

Course Information

Course: PHYS 317 Fall 2023
Thermodynamics and Statistical Mechanics

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Classes: MWF 1 – 2 Olin 264

Office Hours: TR 3 – 4 pm, F 2 – 3 pm and by appointment

Webpage: For updated information on our course, see the webpage
http://www.eg.bucknell.edu/~kvollmay/phys317_f2023/

Text: Daniel V. Schroeder, *An Introduction to Thermal Physics*,
Oxford University Press, Oxford 2021.
Option to borrow for free from department.

Objectives: We have an intuitive understanding of temperature and know that heat flows from hot to cold. Yet, to really understand what temperature is and why heat prefers to flow in one direction but not the other is very difficult, very interesting, and at the heart of this course.

In a more general sense, this course is about systems of very many particles in which case new “collective phenomena” occur. For example with a minimal change in density a gas might become a liquid. There are two approaches to large systems: the macroscopic approach (thermodynamics) and the microscopic approach (statistical mechanics). We will use both approaches following the modern description of D. Schroeder’s textbook. On the way we will encounter many applications with examples both of daily life and Noble Prize winning topics such as the Bose-Einstein condensation.

Although the math of this course is fairly simple, the concepts are not at all. I encourage you to try hard to enter deeply into the beautiful world of thermal physics.

Goals: For more general learning goals for physics, astronomy, and biophysics, see

<http://coursecatalog.bucknell.edu/collegeofartsandsciencescurricula/areasofstudy/physicsandastronomy/#goalstext>

For our course the following goals apply:

- “Be able to solve quantitative problems that require an understanding of the fundamental principles in each of the major areas of physics. Show a working knowledge of how a broad array of physical phenomena can be explained using these fundamental concepts.”
- “Use critical thinking skills to formulate and solve quantitative problems.”

or more specific I hope that you will gain:

- a deep understanding of main concepts in thermal physics (thermodynamics and statistical mechanics)
- an appreciation (passion) for the beauty of thermal physics
- quantitative problem solving skills in thermal physics (derivations and applications)

Course Structure: This course will be interactive, and therefore it will be *essential that you come prepared to class*. For each reading assignment you will have to submit a **journal entry**. The purpose of these journal entries is to encourage you to do the reading and to spend class time most effectively. Your journal entry should reflect that you have done the reading and can contain any or all of the following: a summary, comments on what part of the reading was most difficult, easy, and interesting, or general comments about the course. I encourage your feedback. These journal entries will be due 10 am on the day of the class. However, it would be extremely helpful if you could get them to me earlier, to give me time to incorporate your feedback into the lecture planning.

There will be **homework assignments** for each class both for you to be continuously involved with the class material and for me to get feedback on your understanding of the class material. Homework assignments will be due at the beginning of class. I will randomly decide for each problem (based on a tossed die!) whether I grade it (2/3 of the time) or whether you self-grade it. I will provide guidelines for the self-grading, and solution sets for each homework set. Usually I will start the class with a brief summary of the last class. Then the course material will be discussed in lecture form, and will be practiced in the form of in-class problems for which **you** will be working on the blackboard and/or a white board.

AI Usage: Whereas, I do not anticipate AI to be useful for our course, we will use the following guidelines:

- use AI only for brain storming; For the journal entries AI should not replace that you do the textbook reading and thinking about it. For homework AI should not replace that you practice problem solving. During in-class tests and the final you will not be permitted to use AI.
- whenever you use AI, you have to cite which AI(s) you used, and how. (e.g. I used GPT-3 to learn more about thermometers. or I used GPT-3 to revise the wording of my own summary. I take ultimate responsibility for the content.)
- in content AI should not go beyond 20% of your assignment contribution.
- be aware that AI often gives incorrect information in physics or math

Covid-19 & Monkeypox: To keep our classroom community safe, please stay home if you are not feeling well or are at an increased risk of carrying COVID, monkeypox, the bubonic plague, or anything else you don't want to pass along to your classmates. In this case, please contact me immediately, via email, office hours, or in your journal entry, so that we can make arrangements.

College in the Wake of a Crisis: We—as individuals, as a university, and as a nation—are in the wake of many crises. A national racial reckoning, a recent global pandemic, the undermining of women's rights, a wave of anti-LGBTQ legislation, the increase in anti-Asian hate crimes, sharpened anti-Semitism, and an uncertain economic future combine to create a time of intense stress and increased anxiety. And everyone will experience different levels of stress and anxiety at different times during the semester. As a class community, I encourage us to collectively move through the semester thoughtfully, kindly, and empathetically. I encourage us to communicate (when necessary and comfortable) with each regarding our health and well-being. And perhaps most importantly, I encourage each of us to prioritize self-care and accountability.

Grading: Since the course structure relies on you coming to class prepared, it is important that you work steadily on the reading with journal entries and homework assignments. For this reason, journal entries are due 10 am before class and will *not* be accepted late. Scoring of the journal entries will be on a 2-point scale. You will be able to drop two of your lowest journal entry scores. The journal entries count 5% towards your grade.

Homework will take a considerable amount of your time and is intended to give you plenty of practice. **No late homework will be accepted!** This is because the solution sets will already have been distributed, and because the goal is for you to be working on the problems while we are discussing the material. You will get to drop your lowest two homework grades. You are encouraged to work together on the homework. However your handed in solution set should be a reflection of **your** understanding. That also means that you should not reproduce a solution that you find on the internet. Such academic dishonesty will be taken seriously.

There will be six smaller in class tests, each for the full 50 min class period, but with content of a 20-25 min test. These six smaller tests replace the traditional three larger exams, to hopefully reduce test anxiety and to provide you with continuous feedback. There will be a cumulative final. Attendance is required.

Reading Assignments	5 %
Homework Assignments	30 %
Six Small Tests (each 8%)	48 %
Final	17 %

Accommodations: Any student who may need an accommodation based on the impact of a disability, should contact the Office of Accessibility Resources (OAR) at 570-577-1188 or OAR@bucknell.edu. The office will help coordinate reasonable accommodations for those students with documented disabilities. Please visit <https://www.bucknell.edu/Accessibility> for more information about the OAR.

Inclusive: We will strive for an inclusive classroom as described in The Bucknell University Solidarity Creed (2015)
“As a member of this community, I will respect the diversity of all individuals, including, but not limited to, their sex, gender, identity, expression, race, ethnicity, age, class, citizenship, sexual orientation, nationality, socio-economic status, religion, physical ability and mental ability,” the creed reads in part. “I will commit to educating myself about cultures, identities and experiences other than my own.”
For resources on diversity see
<https://www.bucknell.edu/life-bucknell/diversity-equity-inclusion>

Course Syllabus

dates	topic	text
Aug. 21/23/25/28/30	Intro & Energy	§1.1 – 1.7
Sept. 1	Test 1	
Sept. 4/6/8/11/13/15	Entropy	§2.1 – 2.6
Sept. 18	Test 2	
Sept. 20/22/25/27/29	Temperature/Interactions	§3.1 – 3.6
Oct. 2	Engines & Refrigerator	§4.1 & 4.2
Oct. 4	Test 3	
Oct. 6/11/13	Free Energy	§5.1, 5.2
Oct. 16/18/20	Phase Transitions	§5.3, 5.4
Oct. 23	Test 4	
Oct. 25/27/30 Nov.1/3/6	Boltzmann Statistics	§6.1 – 6.7
Nov. 8	Test 5	
Nov. 10	Ising Model	§8.2
Nov. 13/15/17	Quantum Statistics: Bosons & Fermions	§7.1 – 7.3
Nov. 27	Blackbody Radiation	§7.4
Nov. 29	Test 6	
Dec. 1/4	Bose-Einstein Cond.	§7.6
TBA	FINAL	