STATISTICAL AND THERMAL PHYSICS

Phys 362 Spring 2026

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Office Hours:	M 10 – 11am, T 1 – 2pm, W 9 – 10am, Th 3:30 – 4:30pm, F 2 – 3pm
Class Meetings:	TTh 2:00pm – 3:15pm, WS 117
Course Website:	Phys 362 Website, Spring 2026
Required Text:	H. Gould and J. Tobochnik, *Statistical and Thermal Physics, 2^{nd} ed.,* Princeton (2021).
Prerequisites:	Phys 230, and Math 236 or Math 260

Overview

Statistical and thermal physics describe systems that contain large numbers of individual constituents. Typical examples are gases and solids, which contain large numbers of identical atoms or molecules. The goal of thermal physics is to describe these systems in terms of bulk macroscopic quantities, such as temperature and pressure. The goal of statistical physics is to relate the bulk description to microscopic descriptions of the system constituents. Averaging over microscopic properties such as kinetic energies or dipoles moments of individual molecules or atoms can yield bulk properties such as temperature or magnetization.

Statistical physics and thermodynamics have been developed to the point where a wide range for phenomena can be described using the same small set of general principles. These subjects form a cornerstone of current physics and are frequently used in condensed matter physics, atomic and molecular physics, astrophysics, chemistry and elsewhere.

Phys 362 will introduce you to the framework and techniques of statistical and thermal physics as well as illustrating its applications throughout the physical sciences.

The course covers:

1. Microscopic and macroscopic systems, thermodynamic systems and states, thermodynamic equilibrium.
2. First law of thermodynamics, energy, heat capacities, enthalpy.
3. Thermodynamic processes, entropy, heat engines.
4. Fundamental thermodynamic relation.
5. Probability, microstates/macrostates, thermodynamic ensembles.

6. Magnetic systems.
7. Classical ideal gases, Bose and Fermi gases.

Assignments

An undergraduate student should expect to spend on this course a minimum of two hours outside the classroom for every hour in the classroom. The outside hours may vary depending on the number of credit hours or type of course. More details are available from the faculty member or department office and in CMU's Curriculum Policies and Procedures Manual.

1. **Homework:** There will typically be one homework assignment per class meeting. This will be due by 5pm on the date indicated on the assignment. Late homework will be subject to a penalty of at least a 2% reduction in maximum grade for each hour that the work is late. It is in your best interests to work by yourself on the homework problems but collaboration is acceptable. You can discuss the broad outlines of problem solutions with your colleagues but must write your final solutions independently. You are also encouraged to consult me for help with homework problems.

Exams and Quizzes

1. **Class Exams:** There will be two exams during class on the following days:

   Exam 1: March 5, 2026
   Exam 2: April 16, 2026

   Exams will be closed book and closed notes although you will be able to bring a formula sheet. Calculators will be allowed.

2. **Final Exam:** There will be a final exam at **May 12, 2026**. The final will last one hour and 50 minutes and be comprehensive and closed book although a formula sheet will be allowed. Calculators will be allowed.

Grades

Individual assignments and exams will be graded using suitable scales. In general, to get full credit (100%) for a problem your solution must be correct and well justified. Partial credit will be given for incomplete or partly correct solutions. No credit (0%) will be given for problems not attempted, assignments not turned in or quizzes and exams missed without good reason.

The numerical grades for each component will be totaled and a final numerical grade will be computed according to the following distribution.

Homework	25%
Class Exams	45%
Final Exam	30%

The following final numerical scores will guarantee letter grades:

90%	A
80%	B
70%	C
60%	D

Policies

1. **Helpful Resources:** The Center for Academic Support (CAS) provides FREE tutoring and writing support across all disciplines to CMU and CMU Tech students in a variety of subject areas. Peer tutors are available to support your learning and help you with your questions. CAS o ers four di erent tutoring options to students: in-person tutoring (one-on-one), online tutoring, group tutoring, and writing help. Check out the CAS website or or email tutoring@coloradomesa.edu with any questions.

   In coordination with Educational Access Services, reasonable accommodations will be provided for qualified students with disabilities. Students should contact Educational Access Services at 970-248-1856 or Houston Hall 108 as soon as possible. Please visit Educational Access Services for additional information.

2. **Withdrawals:** There are several ways to drop this course. The deadline for dropping without penalty is **February 4, 2026.** Please consult the CMU academic calendar and catalog for more details about adding and dropping courses.

3. **Attendance:** Attendance policies are described in the Maverick Guide. You are expected to attend all the class meetings and attendance will be recorded. In case of an absence due to illness, another emergency, or a conflicting CMU-sanctioned event, you must be able to produce the *appropriate documentation from someone other than you* that attests to the conflict or absence. If you miss a class for a *documented* valid reason, turn in any assignments due within two business days after the end of the documented absence period. If you miss more than half of the class meetings in the first week of the semester, you will be dropped from the course.

   The dates of the class exams and final exam are set at the beginning of the semester and these have priority over any other events. If you have an event that conflicts with these **and** that was scheduled before the start of the semester, you must notify the instructor about this prior to **January 22, 2026**, provide documentation from someone other than you that attests to the event and I will arrange an alternative test time. If you notify the instructor about a conflict after **January 22, 2026**, the possibility of taking the test at an alternative time will depend on the nature of the conflict (e.g. illness, CMU athletic events, other emergencies). In this case you must explain the nature of the conflict to the instructor, provide documentation from someone other than you that attests to the conflict and the instructor will decide

whether the absence warrants an alternative testing time or arrangement. Alternative testing times will be decided by the instructor.

4. **Academic Integrity:** You are expected to present your own work in assignments, exams and quizzes. Fabrication of data, plagiarism, and copying from any source, particularly in closed book exams, are serious violation of academic norms. CMU has extensive policies on these matters and penalties for infringement can be severe. For more details, consult the academic integrity policies in the Maverick Guide.

   You are prohibited from using sources, of any type, which provide solutions to homework assignment or exam problems. These include AI sources that generate solutions to homework problems. Students who are discovered to have submitted any assignment or exam problem to any such service that provides solutions or have used any such service to obtain or view solutions to any assignment or exam problem will receive zero credit for that entire assignment and the instructor will submit a Report of Academic Dishonesty with the Office of Academic A airs. Additional penalties may be levied in such cases.

Objectives

1. Translate between verbal and mathematical descriptions of physical situations. Apply mathematical reasoning, using algebra, trigonometry and calculus, to analyze these situations.
2. Apply the First Law of Thermodynamics (including enthalpy and free energies) to thermodynamic situations.
3. State and use fundamental thermodynamic identities (e.g. temperature in relation to entropy and internal energy), via derivatives and di erentials.
4. Apply the First and Second Laws of Thermodynamics to analyze thermodynamic process and heat engines.
5. Determine and use probabilities to relate thermodynamic variables to internal microscopic states of systems.
6. Distinguish between and use Boltzmann, Bose-Einstein and Fermi-Dirac statistics.
7. Use the partition function to determine thermodynamic quantities.

This course contributes to the fulfillment the following program learning objectives for the BS in Physics degree. A student will have demonstrated the ability to:

1. Show fluency with the major fields of physics (classical mechanics, electromagnetism, statistical physics and quantum theory).
2. Use mathematical representations to analyze physical scenarios.

Schedule

The following schedule is tentative, except for the dates of the class exams.

Week	Dates	Topic
1	1/20– 1/22	Microscopic and macroscopic systems, thermodynamic systems (Ch 1, 2.1 – 2.5).
2	1/27 – 1/29	First law of thermodynamics, energy in thermal system, heat capacities, thermodynamic derivatives (Ch 2.6 – 2.9, 2.22).
3	2/3 – 2/5	Enthalpy, adiabatic processes, second law of thermodynamics (Ch 2.10 – 2.13).
4	2/10 – 2/12	Fundamental thermodynamic relation, heat engines (Ch 2.13, 2.15 – 2.18).
5	2/17 – 2/19	Heat engines, free energies (Ch 2.14 – 2.21).
6	2/24 – 2/26	Free energies, thermodynamic processes (Ch 2.21, 2.23).
7	3/3	Probabilities (Ch 3.1 – 3.6).
7	3/5	**Exam I**.
8	3/10 - 3/12	Microstates and macrostates (Ch 4.1 – 4.3).
–	3/17– 3/19	Spring break (no classes).
9	3/24 – 3/26	Microstates, energy flow, entropy, counting states (Ch 4.3 – 4.4).
10	3/31 – 4/2	Counting states, thermodynamic ensembles (Ch 4.4 – 4.6).
11	4/7 – 4/9	Thermodynamic ensembles, spin systems (Ch 4.5 – 4.8, 4.12, 5.1 – 5.3).
12	4/14	Ideal gases (Ch 6.1 – 6.2).
12	4/16	**Exam II**.
13	4/21 – 4/23	Oscillators, multiple particles (Ch 6.3).
14	4/28 – 4/30	Bose-Einstein and Fermi-Dirac statistics (Ch 6.3 – 6.5).
15	5/5 – 5/7	Applications of statistical physics (Ch 6.6 – 6.8).