Thermal Physics
PHY B52 - Winter 2023

LEC 01	Wednesday	9:00 am - 11:00 am	MW 110
TUT 01	Wednesday	12:00 pm - 2:00 pm	IC 302
TUT 02	Wednesday	3:00 pm - 5:00 pm	AA 208

Instructor: Johann Bayer **Email:** jbayer@utsc.utoronto.ca
Office: SW 503A
Phone Number: 416-287-7327 **Course Website:** q.utoronto.ca

Office Hours (Tentative)

Tuesday	9:30 am - 11:30 am
Tuesday	12:30 pm - 1:30 pm
Thursday	9:30 am - 11:30 am

Course Description, Learning Outcomes, and Requisites

The course will start with the idea of thermal equilibrium; an extension to the concepts of energy, heat, and work; and the definitions of temperature and entropy. We will continue with a study of mechanical and chemical equilibrium; the laws of thermodynamics; and examples and applications to heat engines, refrigerators, free energy, and chemical thermodynamics. We will conclude the course with an introduction to the statistical concepts which underlie macroscopic thermodynamics and provide the bridge between the microscopic and macroscopic pictures, using quantum ideal gases as our example.

By the end of the course students will be able to:

- Identify and define the basic vocabulary used in Thermodynamics and Statistical Mechanics.
- Recognize the connections and differences between the microscopic and macroscopic descriptions of thermodynamic systems composed of large numbers of particles.
- Use the Laws of Thermodynamics to derive the key macroscopic properties of the two-state paramagnet, the ideal gas, and the Einstein solid, starting from a microscopic statistical description.
- Apply the fundamental principles of thermal physics and solve problems and conceptual questions involving ideal and real thermodynamical processes.
- Develop and implement problem-solving strategies useful in the analysis of examples and questions related to the description, behaviour, and evolution of thermodynamic systems.
- Identify the main ideas and core physical principles in Thermal Physics, and demonstrate their knowledge through deliberate time management and reflective judgement of the questions and problems in tutorial work, tests, and the final exam.
- Self-assess the level of confidence in the acquired knowledge of the core concepts and ideas in the fields of Thermodynamics and Statistical Mechanics through the decision-making process associated with the allocation of resources during tests and the final exam.
- Review and update the mathematical toolbox of quantitative and analytical skills relevant and useful in the scientific endeavour in general, and to the study of Physics in particular.

Course Pre-Requisites: Physics II (PHYA21); Calculus of Several Variables I (MATB41)
Course Corequisite: Calculus of Several Variables II (MATB42)

Required Materials

- **Calculator:** A scientific, non-programmable, and non-graphing calculator is required.

- **Textbook:** ***An Introduction to Thermal Physics*** by Daniel V. Schroeder (OUP Oxford 2021)

The schedule found at the end of this document indicates the chapters and sections you must read **before** each lecture or the release of a lecture video. The textbook also provides the conceptual questions and detailed problems that will be the subject of the weekly problem sets, reading quizzes, and tutorial work.

Grading Scheme

Component	%	Due Date
Reading Quizzes	5	Ongoing (Pre-Lecture)
Tutorial Work	20	Ongoing (Weekly Tutorials)
Test #1	15	Week 05 (Tentative)
Test #2	20	Week 09 (Tentative)
Final Examination	40	Exam Period (April 13 - 27)

Grade Components

Reading Quizzes (5%)
Each week on the course website you will be asked a set of questions from the assigned readings for the upcoming week. You will have until **9:55 pm** on **Tuesday** to submit your answers. Each quiz is worth **5 points**, and your final grade is the total sum of all quizzes up to a maximum of **50 points**. Use the **Class Schedule** found at the end of this document to prepare for the lectures and reading quizzes.

Tutorial Work (20%)
Prior to each tutorial session you will have the opportunity to review the problem set containing relevant examples and problems for that week. During the tutorials we will discuss the most important points from the problem set as well as any difficulties you may have encountered in your weekly readings.

Depending on the goals and discussions for a given session, the tasks that will be assessed as the tutorial work for credit could be assigned for completion during the session or they could be assigned for completion after the end of the session. Work submitted for credit will be graded out of **10 points**, and the final grade is the average of the **best 10** results.

The format and modality of the tutorial work for a given week will not be announced in advance and will only be revealed during the respective tutorial session. For further details, review the information available in the course website under Problem Sets & Tutorial Work.

Test #1 (15%)
This **2-hour** test will be scheduled during **Week 05**. Content includes all lecture discussions, textbook readings, and problem sets up to and including the material assigned and discussed in Week 04.

Test #2 (20%)
This **2-hour** test will be scheduled during **Week 09**. Content includes all lecture discussions, textbook readings, and problem sets up to and including the material assigned and discussed in Week 08.

Final Examination (40%)
The **3-hour** final examination will be scheduled during the exam period of **April 13 - 27**. Content for the final examination includes all the topics discussed in the assigned textbook readings, lecture discussions, problem sets, and tutorial work.

Format and Allowed Aids - Tests and Final Examination
Both tests and the final examination will include conceptual questions in multiple-choice and short-answer format, as well as detailed problems. The only aids allowed are your non-programmable and non-graphing scientific calculator, and a hand-written, double-sided, and letter-sized aid sheet that may not include explicit problem solutions. Photocopies or computer printouts are not allowed.

Class Policies and Course Support

Copyright Notice
All course materials, including assignments and various assessment instruments, belong to your instructor, the University, and/or other sources depending on the specific facts of each situation, and are protected by copyright. Do not download, copy, or share any course materials without the explicit permission of the instructor.

Name and Student Number
Any work you hand in physical form as paper hard-copy must clearly indicate your name and student number, this includes tutorial work, tests, and the final exam. Failing to meet this requirement will result in a 10% deduction, provided we are able to identify the work as yours. If we are unable to identify the work as yours, a grade of zero will be awarded.

Absences
In order to ensure fairness in the assessment of all students, there will be no default makeup options for any term work. In the case of a **valid** and **documented** problem that supports a missed assignment the grade will be calculated on the basis of all other submitted work. In the case of a valid and documented problem that supports an absence to the first test, the second test will have its weight increased accordingly. In the case of a valid and documented problem that supports an absence to the second test, the final examination will have its weight increased accordingly.

Exceptional circumstances requiring a makeup test would be reviewed on a case-by-case basis. Any resulting makeup tests will be scheduled as oral examinations to be conducted in-person.

All valid and documented absences must be declared through **both** the Absence Declaration in ACORN **and** the DPES Self-declaration Absence Form, and the onus is fully on the student to contact promptly the course instructor. Depending on the circumstances you might be required to provide additional supporting documentation to your instructor, such as a completed Verification of Illness or Injury form.

Access*Ability*
Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or the Access*Ability* Services Office as soon as possible. I will work with you and Access*Ability* Services to ensure you can achieve your learning goals in this course. Enquiries are confidential. The UTSC Access*Ability* Services staff (located in AA142) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations. Contact by phone (416) 287-7560 or email at ability@utsc.utoronto.ca

Academic Integrity and Respect for the Academic Endeavor

Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's *Code of Behaviour on Academic Matters:*

https://governingcouncil.utoronto.ca/media/15068/view

outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

- In papers and assignments: Using someone else's ideas or words without appropriate acknowledgment; submitting your own work in more than one course without the permission of the instructor; making up sources or facts; obtaining or providing unauthorized assistance on any assignment; using someone else's clicker or multiple clickers for participation grades.
- On tests and exams: Using or possessing unauthorized aids; looking at someone else's answers during an exam or test; misrepresenting your identity.
- In academic work: Falsifying institutional documents or grades; falsifying or altering any documentation required by the University, including (but not limited to) doctor's notes.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the *Code of Behaviour on Academic Matters*. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see https://www.utsc.utoronto.ca/vpdean/academic-integrity).

Email Communications

If you want to ask a question via email, please first check the various threads in the PeppeR section of the course website. Quite likely, you are not the only person with that same question, and if that question has already been asked, you will find the answer there. If the question has not been asked, go ahead and post it yourself instead of sending it by email. This way you will also help other students facing the same issue. These discussions are monitored regularly by the course instructor and your peers, making it the best way of communicating for various queries of a diverse nature.

However, if these electronic forums are not the best place for your specific concern, make sure you send your email from an official **utoronto.ca** address (e.g., your UTmail+ account), as all other addresses will be filtered out automatically. For a quicker response time include the code **PHYB52** in the subject line of your message. I reply to emails within a period of 24 hours and I rarely reply to emails during weekends.

Policies for In-Person Lectures and Tutorials

- All students are required to follow the latest UTSC Regulations concerning COVID-19.
- Lectures start at 9:10am and end at 11:00am. Tutorials run from 12:10pm to 2:00pm and 3:10pm to 5:00pm. Late arrival or early departure is inappropriate and highly disruptive so please be respectful of the learning environment.
- Regarding anything that you want to use in the classroom: if you are not using it to perform a task specifically related to what we are doing in class at that very moment, you must put it away. This includes but is not limited to cell phones, laptop computers, tablets, and other electronic devices.
- Consumption of food or drinks in the classroom during lectures or tutorials is not permitted as this creates unwanted distractions that negatively affect the learning environment.

PeppeR on Quercus

The course website supports electronic forums useful for questions and discussions on course content, conceptual and detailed problems, textbook readings, as well as any issues relating to administrative aspects of the course such as deadlines and scheduling.

It is recommended that you check the threads on a regular basis to keep on top of current issues. You can subscribe to the various threads in order to receive email notifications when new posts are available.

Class Schedule

This schedule is ***tentative*** and might change during the term in order to accommodate for variations in the lectures in response to student performance and understanding of the various topics.

Please note that it is your responsibility to read the assigned sections **before** each lecture discussion and in preparation for the completion of the respective reading quiz. The lectures will **not** be a direct repetition of the basic material found in the textbook. Instead, we will concentrate on important and difficult aspects of the theory and concepts from your textbook readings.

A minimum understanding of the basic concepts from the assigned readings will be the assumed starting point for each lecture discussion. As a result, failing to complete the textbook readings before each lecture will significantly affect your ability to understand the class discussions.

Week # Date	**Wednesday Lecture**	**Wednesday Tutorials**
Week 01 Jan. 11	**Equilibrium, The Ideal Gas, Equipartition** Chapter 1: Sections 1 - 3	**No Tutorial Session**
Week 02 Jan. 18	**Heat, Mechanical Work, Heat Capacity** Chapter 1: Sections 4 - 6	**Problem Set #01**
Week 03 Jan. 25	**Two-State Systems, The Einstein Solid** Chapter 2: Sections 1 - 2	**Problem Set #02**
Week 04 Feb. 01	**Interacting Systems, Large Systems** Chapter 2: Sections 3 - 4	**Problem Set #03**
Week 05 Feb. 08	**The Ideal Gas, Entropy** Chapter 2: Sections 5 - 6	**Problem Set #04**
Week 06 Feb. 15	**Temperature, Entropy, Paramagnetism** Chapter 3: Sections 1 - 3	**Problem Set #05**
Week RW Feb. 22	**Reading Week** Reading Review: Chapters 1 - 2	**Problem Set #06**
Week 07 Mar. 01	**Equilibrium: Pressure & Chemical Potential** Chapter 3: Sections 4 - 6	**Problem Set #07**
Week 08 Mar. 08	**Heat Engines, Refrigerators** Chapter 4: Sections 1 - 2	**Problem Set #08**
Week 09 Mar. 15	**Free Energy: Available Work & Equilibrium** Chapter 5: Sections 1 - 2	**Problem Set #09**
Week 10 Mar. 22	**Boltzmann Factors, Averages, Equipartition** Chapter 6: Sections 1 - 3	**Problem Set #10**
Week 11 Mar. 29	**Maxwell, Partition Functions, The Ideal Gas** Chapter 6: Sections 4 - 7	**Problem Set #11**
Week 12 Apr. 05	**Gibbs Factors, Bosons & Fermions** Chapter 7: Sections 1 - 3	**Problem Set #12**