Thermodynamics

Department of Physics and Atmospheric Science

PHYC 3200.03 / Fall 2025

Dalhousie University operates in the unceded territories of the Mi'kmaw, Wolastoqey, and Peskotomuhkati Peoples. These sovereign nations hold inherent rights as the original peoples of these lands, and we each carry collective obligations under the Peace and Friendship Treaties. Section 35 of the Constitution Act, 1982, recognizes and affirms Aboriginal and Treaty rights in Canada.

We recognize that African Nova Scotians are a distinct people whose histories, legacies, and contributions have enriched the part of Mi'kma'ki known as Nova Scotia for over 400 years.

Course Instructor(s)

Name	Email	Office Hours
Prof. Thomas J. Duck	tduck@dal.ca	MWF @ 10:30 AM, Dunn 128
Cameron Nickerson	cameron.nickerson@dal.ca	Wednesdays 1-3 PM, Chemistry 322

Course Description

An introduction to the basic concepts and laws of Thermodynamics. There will be a short survey of required Mathematics (partial derivatives). Topics include thermometry, equations of state, energy and entropy, thermodynamic potentials, heat engines, thermodynamic efficiency and phase transitions.

Course Prerequisites

PHYC 2060.03, MATH 2001.03 and MATH 2120.03, or instructor's permission.

Student Resources

Prof. Duck is available immediately after class or by appointment. TA Cameron Nickerson is available Wednesdays 1-3 PM or by appointment.

In general, questions about the course and lectures should be asked of Prof. Duck, while help with homework assignments should be taken to Cameron. Grading concerns should be raised with Cameron first before bringing them to Prof. Duck.

Course Structure

Course Delivery

The course will be delivered in person and will not be recorded to protect privacy and encourage classroom participation. Video lectures may be provided in the event Prof. Duck is away or if there are unforeseen circumstances.

Lectures

Monday, Wednesday and Friday, from 9:35-10:25 AM in Dunn 221C.

Laboratories: None.

Tutorials: None.

Course Materials

There is no required textbook. Material is drawn from a wide range of sources, including scientific journals. The texts below may be helpful in furthering your understanding of Thermodynamics.

1. Callen, Herbert B.: Thermodynamics and an Introduction to Thermostatistics (John Wiley and Sons, 1985).
2. Fermi, E.: Thermodynamics (1936; Dover 1956).
3. Van Ness, H. C.: Understanding Thermodynamics (McGraw-Hill, 1969).

Lectures and weekly assignments will be posted on Brightspace.

Assessment

Component	Weight	Date	Time	Location	Duration
Midterm 1	17.5%	Oct. 28	7 PM	Dunn 221C	50 mins
Midterm 2	17.5%	Nov. 25	7 PM	Dunn 221C	50 mins
Final exam	50%	TBD	TBD	TBD	3 h
Assignments	15%	Weekly	-	-	-

The Final Exam will be scheduled by the Registrar's Office and will cover the entirety of the course.

Assignments are due on Fridays at the beginning of class unless otherwise stated.

Conversion of numerical grades to final letter grades follows the Dalhousie Grade Scale:

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A- (80-84)	B- (70-72)	C- (55-59	

Course Policies on Attendance

Regular attendance is required. Students should notify Prof. Duck by email prior to any expected absence.

Assignments may not be accepted from students who miss classes.

Make-up exams may not be available to students who miss classes.

Exceptions to this policy may be made at Prof. Duck's discretion.

Course Policies on Cell Phones

To get the most out of our time together, students are asked to silence and put away cell phones before entering the classroom. If you need to take a call or send a message during class, please step outside.

Even the presence of a phone can reduce attention, learning and memory (Skowronek et al., 2023). By putting devices away, we create a space where it's easier to concentrate, engage with classmates, and work through challenging ideas. Class time is a chance to unplug and give your full attention to learning.

Course Policies on Missed or Late Academic Requirements

Assignment extensions may be granted at the discretion of Prof. Duck. Late assignments will not be accepted once graded assignments have been returned.

Midterm exams absences should be documented using the Student Declaration of Absence form. A maximum of one Declaration of Absence will be accepted for this purpose. Students who miss writing both midterm exams at their regularly scheduled time will receive a final grade of INC.

Students who miss a midterm or final exam will be required to write a makeup. Students who need to write a makeup exam should not discuss the exam with any other student. Doing so would be considered an academic integrity violation by both students.

As per University Regulations, a student requesting an alternative time for a final examination will be granted that request only in exceptional circumstances.

Course Policies related to Academic Integrity

Students are welcome to discuss homework assignments with each other. However, all submitted work must be your own, written independently.

Generative AI tools, such as ChatGPT, may be used to support learning (e.g., exploring topics) but should not be used to solve assignment problems.

Assignments provide essential preparation for exams, which you will complete independently. But more than that, they are where you will wrestle with ideas, make mistakes, and gain insights that turn information into understanding.

Course Content

Lecture counts are approximate. Some material may be omitted due to the shortened term.

I. FOUNDATIONS (6 lectures): Introduction, thermometry, kinetic theory of gases, ideal gas law, Maxwell-Boltzmann distribution, simple systems, state diagrams, processes of transformation, coefficients of expansion and compressibility.

II. THE FOUR LAWS (10 lectures): The laws, work, heat, reversibility, heat capacity, adiabatic processes, thermodynamic cycles, heat engines, energy flow diagrams, Carnot cycle, Carnot's theorem, Clausius's Theorem, entropy, free expansion.

III. THERMODYNAMIC POTENTIALS (6 lectures): Postulates of thermodynamics, intensive variables, thermodynamic potentials, Maxwell relations, reduction of derivatives, sounds waves, the Joule-Thomson process.

IV. PHASE TRANSITIONS (8 lectures): Van der Waals' equation, critical points, phase diagrams, precision fundamental equations, vaporization and boiling, steam power, heat pumps, the Clausius-Clapeyron equation.

V. COMPLEX SYSTEMS (4 lectures): The chemical potential, chemical equilibrium, the barometric pressure equation, the Euler and Gibbs-Duhem equations, radiation.

Learning Objectives

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

1. Articulate the four laws of thermodynamics and critically apply them in the analysis of physical systems and processes.
2. Master the mathematical tools of the trade — including partial derivatives, thermodynamic potentials, and related identities — to rigorously solve thermodynamic problems.
3. Explain the behaviour of matter in practical devices like car engines, power plants, consumer heat pumps and refrigerators.

University Policies and Statements

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding Mi'kmaq and Indigenous Relations (including the Elders in Residence program, Land Acknowledgements, Understanding Our Roots, and much more) can be found at: https://www.dal.ca/about/mission-vision-values/mikmaq-indigenous-relations.html.

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about/mission-vision-values/global-relations.html.

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html.

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/campus_life/ssc.html).

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: https://www.dal.ca/about/mission-vision-values/equity-diversity-inclusion-and-accessibility/about-office-equity-inclusion.html.

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: https://www.dal.ca/content/dam/www/about/leadership-and-governance/governing-bodies/code-student-conduct.pdf.