Department of Physics & Astronomy
University of Victoria
Spring Term 2026

COURSE OUTLINE

Physics 317: Thermodynamics

Lectures: *Tuesdays*, *Wednesdays*, & *Fridays* at 9:30 – 10:20 am

(or, via Zoom at https://uvic.zoom.us/j/3347938652 if ever required to be online)

We acknowledge and respect the Lək̓ʷəŋən (Songhees and Esquimalt) Peoples on whose territory the university stands, and the Lək̓ʷəŋən and W̱SÁNEĆ Peoples whose historical relationships with the land continue to this day.

COURSE DESCRIPTION

Course homepage: https://bright.uvic.ca/d2l/home/432599

In this course, we will cover the following very broad topics: 1) The ideal gas law, and its many variants for improved descriptions of real gases; 2) the laws of thermodynamics; 3) temperature and entropy; 4) the thermodynamic potentials; and 5) heat engines. (A fuller description & outline can be found below.)

PREREQUISITES & COREQUISITES

Phys 110 or 120, and Math 200 (or 202, or 205)

TUTORIALS

Tutorials will be led by PhD student Afif Omar (aafif@uvic.ca), and will be on **Fridays at 1:30 – 2:20 pm** (or, via Zoom if ever required to be online).

LABS will be at your scheduled afternoon or evening times.

CONTACT INFORMATION FOR ME

Instructor: Justin Albert
E-mail: jalbert@uvic.ca
Office: Elliott 213

Office Hours: Come by my office anytime! — or, chat with me anytime via the Zoom link above! I'll be sure to stay available for an hour after each class, but please just send e-mail or call if you want to be absolutely sure I will be in my office/available at any given time. If I'm in my office but busy I'll let you know a time to come back. Feel free to always try my office though, or phone, or e-mail. Cell phone is

(250) 661-7066, feel free to call! (I tend to prefer e-mail to text messaging – and e-mail actually tends to reliably get to me faster than texting.) My lab space is in Elliott 015, so you can often find me there too.

COURSE MATERIALS

Text (required): Ashley H. Carter, Classical and Statistical Thermodynamics, 4th edition (or you can also use basically any other edition, e.g. the international edition), Cambridge Univ. Press, 2000. Like textbooks for most courses, you are likely to get a vastly better deal on the book if you purchase it online (at, e.g., abebooks.com) than if you get it at the campus bookstore. If you purchase online and it doesn't arrive until after the first few weeks of classes, don't worry at all!!! — please see the course Brightspace link for an online copy of the book. (It's good to have a physical copy of the textbook though, at least eventually – importantly note that solutions to some of the textbook problems are in the back of the book, but I haven't put those pages into the online copy in Brightspace.) Please kindly read the textbook sections near the beginning of the week that they are covered!

Some other sources that I occasionally consult:
Turns + Pauley, *Thermodynamics*, Cambridge Univ. Press, 2nd Ed., 2020.
Kittel + Kroemer, *Thermal Physics*, Freeman, 2nd Ed., 1980.
Reif, *Statistical and Thermal Physics*, McGraw-Hill, 1965.

EVALUATION

Weekly Assignments	**30%**
Labs	**20%**
Midterm Exam (Feb 13 in class)	**15%**
Final Exam	**35%**

Note:

- Regular weekly assignments (there will be a total of 9 of them during the term) are due by the beginning of class on Tuesday (first one due on Tue., Jan. 20th). Answers will be posted the following Tuesday. Your lowest assignment score (out of the 9) will be dropped. You are allowed *one* **late assignment** without penalty, up to a week late (together with the one lowest assignment score that is dropped). **All** other late assignments count 50% if completed before the answer key is handed out the following week. Afterwards, they count 10% (there is still a little bit of value in copying over the answers to better understand them). No exceptions (other than death in the immediate family, signed doctor's note). Note that the lowest assignment score is dropped, and another assignment can be a week late, so that covers cold/flu issues.

COURSE POLICIES

*Collaboration on the assignments is **at your discretion**.* Each person is responsible for doing one's share of the work, **writing up one's own solutions and for listing one's collaborators on each set**.

Exams are closed book, closed notebook. You will be allowed to bring an 8.5" x 11" formula sheet of your own making (double-sided) to each exam.

Calculator: The only acceptable calculator for student use on exams (as per the department policy) is the Sharp EL-510RB. It is available at the UVic Bookstore for approximately $8.95.

The midterm exam will be held **in class**, on **Fri. Feb. 13**. (**No makeups**; you need to show up & take it! It is like the final exam in that regard.)

Academic Integrity

UVic's Policy on Academic Integrity is found at uvic.ca/calendar/future/undergrad/index.php#/home. It is every student's responsibility to be aware of this policy, including policies on cheating, plagiarism, unauthorized use of an editor, multiple submission, and aiding others to cheat. If you have any questions or doubts, please talk to me. For more information, see uvic.ca/learningandteaching/cac.

Use of AI

Please be advised that in this course you are not authorized to use any form of generative AI. In order to successfully complete course activities, generative AI is not required nor welcomed. Students should not make any use of generative AI tools such as ChatGPT, Grammarly, among others that use AI for content generation and editing. As the University of Victoria states on its Academic Integrity Policy "Academic integrity requires commitment to the values of honesty, trust, fairness, respect, and responsibility." Therefore, I expect you to comply with the course syllabus and I encourage you to enhance your academic experience in this course by refraining from use of generative AI.

COURSE CALENDAR AND OUTLINE

UVic Important Dates: uvic.ca/calendar/dates/
Last day to add courses: Jan. 21
Last day to drop a course without penalty of failure: Feb. 28
Final Exam Period: Apr. 7 – 22

Below is the outline of the topics that will be covered in the course. Note that sections marked with an * will likely be skipped (although you might find that those starred sections make for useful/interesting background material).

Chapter 1. Introductory Remarks
- 1.1 Introduction
- 1.2 Caloric, Calories, Heat and Energy
- 1.3 Extensive and Intensive Quantities
- 1.4 Mole
- 1.5 Prepositions
- 1.6 Applicability of Equations

Chapter 5. Thermodynamic Processes

Chapter 3. Temperature
- 3.1 Introduction
- 3.2 Zeroth Law of Thermodynamics
- 3.3 Temperature Scales (1)
- 3.4 Temperature Scales (2)
- 3.5 Exercises

*(The fact that I have Chapters 5 and 3 here is **not** a typo – I will cover Chapters 5 and 3 of the lecture notes **second**, between Chapters 1 and 2, just in order to be more consistent with the order that the topics are covered in the Carter textbook.)*

Chapter 2. Partial Derivatives

2.1 Introduction
2.2 Partial Derivatives
2.3 Implicit Differentiation
2.4 Product of Three Partial Derivatives
2.5 Second Derivatives and Exact Differentials
2.6 Euler's Theorem for Homogeneous Functions *
2.7 Undetermined Multipliers *
2.8 Dee and Delta *

Chapter 6. Properties of Gases

6.1 The Ideal Gas Equation
6.2 Real Gases
6.3 Van der Waals and Other Gases
6.4 Gas, Vapour, Liquid and Solid

Chapter 7. The First and Second Laws of Thermodynamics

7.1 The First Law of Thermodynamics, and Internal Energy
7.2 Work

Chapter 4. Thermal Conduction

4.1 Introduction
4.2 Thermal Conductivity
4.3 The Heat Conduction Equation
4.0 The Error Function
4.4 A Solution of the Heat Conduction Equation

*(The fact that I have Chapter 4 here [after sections 6.4, 7.1, and 7.2!!!] is **also** not a typo! — Thermal Conduction [which is **only** in the lecture notes, not in the textbook!] belongs best right after we talk about equations of state of solids in section 6.4 — and also after sections 7.1 and 7.2.)*

6.5 Kinetic Theory of Gases: Pressure

7.3 Entropy
7.4 The Second Law of Thermodynamics

Chapter 8. Heat Capacity, and the Expansion of Gases

8.1 Heat Capacity
8.2 Ratio of the Heat Capacities of a Gas
8.3 Isothermal Expansion of an Ideal Gas
8.4 Reversible Adiabatic Expansion of an Ideal Gas
8.5 The Clément-Desormes Experiment
8.6 The Slopes of Isotherms and Adiabats *

8.7 Scale Height in an Isothermal Atmosphere
8.8 Adiabatic Lapse Rate
8.9 Numerical Values of Specific and Molar Heat Capacities *

Chapter 9. Enthalpy

9.1 Enthalpy
9.2 Change of State
9.3 Latent Heat and Enthalpy

Chapter 10. The Joule and Joule-Thomson Experiments

10.1 Introduction
10.2 The Joule Experiment
10.3 The Joule-Thomson Experiment
10.4 $\boldsymbol{C_P}$ Minus $\boldsymbol{C_V}$ *
10.5 Blackbody Radiation

Chapter 11. Heat Engines

11.1 Introduction
11.2 The Carnot Cycle
11.3 The Stirling Cycle
11.4 The Otto Cycle
11.5 The Diesel Cycle
11.6 The Rankine Cycle (Steam Engine)
11.7 A Useful Exercise
11.8 Heat Engines and Refrigerators
11.9 Entropy is a Function of State

Chapter 12. Free Energy

12.1 Review of Internal Energy and Enthalpy
12.2 Free Energy
12.3
12.4 Helmholtz Free Energy
12.5 Gibbs Free Energy
12.6 Summary, the Maxwell Relations, and the Gibbs-Helmholtz Relations
12.7 The Joule and Joule-Thomson Coefficients
12.8 The Thermodynamic Functions for an Ideal Gas
12.9 The Thermodynamic Functions for Other Substances
12.10 Absolute Entropy
12.11 Charging a Battery *
12.12 Surface Energy *

12.13 Fugacity *

Chapter 13. Expansion, Compression and the ***TdS*** Equations

13.1 Coefficient of Expansion
13.2 Compression
13.3 Pressure and Temperature
13.4 The ***TdS*** Equations
13.5 Expansion, Compression and the ***TdS*** Equations
13.6 Young's Modulus *
13.7 Rigidity Modulus (Shear Modulus) *

Chapter 14. The Clausius-Clapeyron Equation

Chapter 15. Adiabatic Demagnetization

15.1 Introduction
15.2 Adiabatic Decompression
15.3 Adiabatic Demagnetization
15.4 Entropy and Temperature

Chapter 16. Nernst's Heat Theorem and the Third Law of Thermodynamics

16.1 Nernst's Heat Theorem
16.2 The Third Law of Thermodynamics

Chapter 17. Chemical Thermodynamics

17.1 Equilibrium Constant
17.2 Heat of Reaction
17.3 The Gibbs Phase Rule
17.4 Chemical Potential
17.5 The Maxwell Relations
17.6 Partial and Mean Molar Quantities
17.7 The Gibbs-Duhem Relation
17.8 Chemical Potential, Pressure, Fugacity
17.9 Entropy of Mixing, and Gibbs' Paradox

CHANGES DUE TO UNFORESEEN CIRCUMSTANCES

The above outline, policies, procedures, and assignments in this course are subject to change in the event of extenuating circumstances. In the event of significant changes, a revised outline will be posted/circulated.

UVIC GRADING SYSTEM – UNDERGRADUATE

As per the Academic Calendar:

Grade	Grade Point Value	Grade Scale	Description
A+	9	90 – 100%	**Exceptional, outstanding** and **excellent** performance. Normally achieved by a minority of students. These grades indicate a student who is self-initiating, exceeds expectation and has an insightful grasp of the subject matter.
A	8	85 – 89%	
A-	7	80 – 84%	
B+	6	77 – 79%	**Very good, good** and **solid** performance. Normally achieved by the largest number of students. These grades indicate a good grasp of the subject matter or excellent grasp in one area balanced with satisfactory grasp in the other area.
B	5	73 – 76%	
B-	4	70 – 72%	
C+	3	65 – 69%	**Satisfactory**, or **minimally satisfactory**. These grades indicate a satisfactory performance and knowledge of the subject matter.
C	2	60 – 64%	
D	1	50 – 59%	**Marginal** Performance. A student receiving this grade demonstrated a superficial grasp of the subject matter.
F	0	0 – 49%	**Unsatisfactory** performance. Wrote final examination and completed course requirements; no supplemental.
N	0	0 – 49%	Did not write examination or complete course requirements by the end of term or session; no supplemental.

COURSE FEEDBACK

I value your feedback on this course. Towards the end of term, as in all other courses at UVic, you will have the opportunity to complete an anonymous **Course Evaluation Survey (CES)** regarding your learning experience. The survey is important for providing feedback to me regarding the course and my teaching, as well as to help the department improve the overall program for students in the future. The survey is accessed online and can be done on your laptop, tablet, or mobile device. I will remind you and provide you with more detailed information nearer the time, but please be thinking about this important activity during the course.

APPENDICES

DEPARTMENT OF PHYSICS AND ASTRONOMY INFORMATION

- **Department Website:** uvic.ca/science/physics/index.php
- **Department General Office:** physgen@uvic.ca
- **Department Undergraduate Advisor:** phast_advising@uvic.ca

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UNIVERSITY STATEMENTS & POLICIES

- Academic Calendar: Information for All Students
- Creating a respectful, inclusive, and productive learning environment
- Accommodation of Religious Observance
- Accommodation and Access for Students with Disabilities
- Student Conduct
- Non-academic Student Misconduct
- Accessibility
- Diversity / EDI
- Equity Statement
- Sexualized Violence Prevention and Response
- Discrimination and Harassment Policy

STUDENT RESOURCES

POSITIVITY AND SAFETY

The University of Victoria is committed to promoting, providing, and protecting a positive and safe learning and working environment for all its members.

Student Groups & Resources

ACADEMIC RESOURCES

UVic Library - *UVic Library offers many services and resources for undergraduate and graduate students*.

uvic.ca/students/academics/library-services

Learning Resources - *UVic Learn Anywhere is the primary learning resource for students that offers many learning workshops and resources to help students with academics and learning strategies.*

onlineacademiccommunity.uvic.ca/uviclearn/

Centre for Academic Communication - *Offers online and in-person one-on-one tutorials, workshops, and more.* uvic.ca/learningandteaching/cac

Physics Aid Service – *Addresses problems with conceptual understanding, difficulties encountered with homework assignments, preparation for mid-term and final exams, and occasionally even preparation for external exams such as the MCAT. Instruction may be one-to-one or in small groups, with emphasis placed on engaged interaction between the students and the instructor.*

https://www.uvic.ca/science/physics/current/undergraduate/pas/index.php

MENTAL HEALTH & WELLNESS

A note to remind you to take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, getting enough sleep, and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. You are not alone.

Student Wellness Centre - *Our team of practitioners offers a variety of services to support students' mental, physical, and spiritual health.*

uvic.ca/student-wellness

Counselling Services - *Counselling Services can help you make the most of your university experience. They offer free professional, confidential, inclusive support to currently registered UVic students.*

uvic.ca/student-wellness

Health Services - *University Health Services (UHS) provides a full-service primary health clinic for students and coordinates healthy student and campus initiatives.*

uvic.ca/student-wellness

ACCESSIBILITY

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a documented disability or health consideration that may require accommodations, please feel free to approach me and/or the Centre for Accessible Learning (CAL) as soon as possible.

Centre for Accessible Learning - *The CAL staff are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations. The sooner you let us know your needs the quicker we can assist you in achieving your learning goals in this course.*

uvic.ca/accessible-learning

ADVISING

For academic advising-related questions, students in the Department of Physics & Astronomy are also encouraged to meet with the Undergraduate Advisor (phast_advising@uvic.ca) as well as an academic advisor in the Academic Advising Centre early in their studies to help map out a plan to declare a major and complete university program requirements.

Academic Advising Centre - *Academic advice and support is currently available by phone, email and virtual or in-person appointments*. uvic.ca/services/advising

Ombudsperson - *The ombuds office is an independent, impartial, and confidential resource for undergraduate and graduate students and other members of the University of Victoria community. The ombudsperson helps resolve student problems or disputes fairly.* uvicombudsperson.ca

ACADEMIC CONCESSION

You can request an academic concession if your course requirements are affected by unexpected and unavoidable circumstances, or conflicting responsibilities. Concession requests can be for an in-course extension, deferral, withdrawal under extenuating circumstances, or an aegrotat. Please speak to an advisor at the Academic Advising Centre if you have questions on how requesting a concession will affect your academic program.

Undergraduate Academic Concessions - uvic.ca/students/academics/academic-concessions-accommodations

EQUITY AND HUMAN RIGHTS AT UVIC

EQHR is a resource for students, staff, and faculty who have experienced sexualized violence, discrimination, and/or harassment and are looking for informal and/or formal resolution options as well as advice, coaching, and/or education. We are available for confidential consultations so that you can ask questions and learn your options.

EQHR – By email at eqhr01@uvic.ca or in-person (Sedgewick C115). uvic.ca/equity

Sexualized Violence Resource Office – *If you have been directly or indirectly impacted by sexualized violence, reach out to the SVRO for information, advice, and resolution options (restorative and disciplinary) as well as support options and referrals. The SVRO is both survivor-centred and trauma-informed in their approach. You can reach us by phone at 250-721-8021 or by email at eqhr01@uvic.ca to book either an in-person (Sedgewick C119) or online appointment.* uvic.ca/sexualizedviolence

RESOURCES FOR INTERNATIONAL STUDENTS

International Centre for Students - *The primary office supporting international students on campus at the university-wide level*. uvic.ca/international-experiences

UVic Global Community Initiative - *Provides various supportive programming, including a Mentorship Program and Conversation Partner Program*. uvic.ca/international-experiences/get-involved/uvic-global-community

RESOURCES FOR INDIGENOUS STUDENTS

Indigenous Student Support - *UVic offers holistic services to Indigenous students throughout their academic journey.* uvic.ca/students/info-for/indigenous-students

Elders in Residence - *The Office of Indigenous Academic and Community Engagement (IACE) has the privilege of assembling a group of Elders from local communities to guide students, staff, faculty, and administration in Indigenous ways of knowing and being.* uvic.ca/iace/