

Introduction to Thermal Physics: Phys 3400a Fall 2023 Course Outline

Prerequisite Requirements: *The prerequisites for this class are Phys 2101 and 2102, or Phys 2128 and 2129; and Phys 2110.*

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

Instructor Information: Prof. Colin Denniston, cdennist@uwo.ca, office: PAB230. If you wish to contact your instructor privately, please send an email **using your Western email address** and include Phys3400 in the subject line. You can also contact the instructor on the MS Teams course site.

TA/grader: TBA

Office Hours: TBA. Asking questions on the MS Teams course site is the preferred means of getting help on the course material. This information is then accessible to all the students in the class.

First Class	Non-instructional*	Reading Week	Classes End	Study day	Exam Period
[*]	29 Sept, 9 Oct	30 Oct. – 5 Nov.	8 Dec.	9 Dec.	10-22 Dec.

Key Sessional Dates:

* 29 September is National Day for Truth & Reconciliation, 9 October is Thanksgiving

**13 November: Last day to drop a second-term half course without penalty

Course Description

David Goodstein's textbook opens with the line: "Ludwig Boltzmann, who spent much of his life studying statistical mechanics, died in 1906 by his own hand. Paul Ehrenfest, carrying on the work, died similarly in 1933. Now it is our turn to study statistical mechanics." Statistical mechanics describes the emergent properties of unimaginably large numbers ($\sim 10^{23}$) of particles. Those early workers in the field had to deal with that by hand. Fortunately for us, we now have computers to help us understand how these properties emerge, as well as the deep insights of those who have gone before us.

Learning Outcomes: : *i) To use the concepts of statistical mechanics to understand emergent properties of simple systems with large numbers of degrees of freedom*

ii) To use entropy to answer questions about the thermal properties of a system.

iii) To be comfortable working with both analytical and computational formalisms of statistical mechanics.

Anticipated Topics: Lecture topics are centered on the key objectives of the course. The topic coverage shown below is approximate and may change depending on lecture progress.

1. CLASSICAL IDEAL GAS
2. DISCRETE PROBABILITY THEORY
3. CONFIGURATIONAL ENTROPY (IDEAL GAS)
4. CONTINUOUS RANDOM NUMBERS
5. ENERGY DEPENDENCE OF ENTROPY (IDEAL GAS)
6. CLASSICAL GASES: IDEAL AND OTHERWISE
7. TEMPERATURE, PRESSURE, CHEMICAL POTENTIAL, ET AL.
8. POSTULATES & LAWS OF THERMODYNAMICS

9. PERTURBATIONS OF THERMODYNAMIC STATE FUNCTIONS
10. THERMODYNAMIC PROCESSES & POTENTIALS
11. EXTENSIVITY AND THERMODYNAMIC IDENTITIES
12. EXTREMUM PRINCIPLES AND STABILITY CONDITIONS
13. PHASE TRANSITIONS
14. NERNST POSTULATE AND THE THIRD LAW.
15. ENSEMBLES IN CLASSICAL STATISTICAL MECHANICS
16. QUANTUM ENSEMBLES

Contingency plan for an in-person class pivoting to 100% online learning: The current plan is to have in-person lectures MWF as scheduled. In the event of a situation (eg. COVID-19 resurgence) that necessitates the course delivery moving away from face-to-face interaction, affected course content will be delivered entirely online via the MS Teams course site, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., with a link posted on OWL). The grading scheme will **not** change. Any remaining assessments will also be conducted online as determined by the course instructor.

Course Materials

Text: The required textbook is *An Introduction to Statistical Mechanics and Thermodynamics*, 2nd edition, by Robert H. Swendsen. This is available online at: [An Introduction to Statistical Mechanics and Thermodynamics | Oxford Academic \(oup.com\)](#) (free access to pdf for each chapter, at least on campus). If you get a paper copy elsewhere, make sure it is the 2nd edition. There are a lot of typos in the first edition and the 2nd edition also contains extra chapters that we will be covering.

Assignments, supplemental information, and other references will be posted on the course website.

Website: Students should check OWL (<http://owl.uwo.ca>) on a regular basis for news and updates. This is one of two methods by which information will be disseminated to all students in the class. Students are responsible for checking OWL on a regular basis. The missing of critical information due to your failure to check OWL cannot be used as a basis for appeal.

MS Teams: I will be setting up a team for the course on MS Teams. This is the second method by which information will be disseminated to all students in the class. Students are responsible for checking updates on MS Teams on a regular basis. The missing of critical information due to your failure to check MS Teams cannot be used as a basis for appeal.

If you do not have MS Teams installed already, you can get a copy for Windows, Apple, or Linux using your UWO Office 365 account. If you do not want to install the application, you can also access it through the browser the same way you access your UWO Outlook mail in a browser. All online lectures or meetings and will be done through MS Teams (not Zoom).

If students need assistance with OWL or setting up MS Teams, they can seek support on the [OWL Help page](#) or they can contact the [Western Technology Services Helpdesk](#). They can also be contacted by phone at 519-661-3800 or ext. 83800.

Up-to-date versions of [Google Chrome](#) or [Mozilla Firefox](#) are the preferred browsers to optimally use OWL (though MS Edge should work just as well); Students interested in evaluating their internet speed, please click [here](#).

Technical Requirements: A sizeable portion of the homework assignments will require computational work. The assumption is that you will do this using Python and Jupyter notebooks. You could potentially use other computational tools, but this should be discussed with the instructor first to ensure that they are appropriate, and that the TA can grade them. You will need a laptop computer running any of Windows, Linux, or MacOS and with an Anaconda Python installation (free from [Anaconda | The World's Most Popular Data Science Platform](#)).

Course Evaluation: Your grade will be based on:

5% Participation,
20% Assignments,
40% Quizzes,
35% Final Exam (cumulative).

The Department of Physics and Astronomy may, in *exceptional* circumstances, adjust the final course marks to conform to Departmental policy.

Participation: Students are expected to participate and engage with content posted on OWL in a timely manner. Students can also participate by interacting on MS Teams with their peers and instructors. There will be a *HW discussion* channel and a *Lecture, Text, Notes discussion* channel for this purpose. Attendance can also count towards participation marks (only best 80% of attendance marks will count towards final grade to account for possible illness or other serious circumstances that might prevent attendance). Three participation grades will be assigned, each covering approximately 4 weeks.

Assignments: There will be six assignments of similar weight (about one every 2 weeks, usually due on a Friday). Anticipated due dates are **22 Sept, 6 Oct, 20 Oct, 10 Nov, 24 Nov, 8 Dec**. You will need to turn-in the assignments electronically. The written part of an assignment needs to be scanned and turned in as a **single pdf file** (**NOT a separate file for every page**). You can use a printer/scanner to pdf or a phone app like Office Lens to do this. You need to make sure the file is clearly readable with nothing cut-off. The TA will grade whatever is turned in and marks will be deducted if they cannot read the whole page. Computational parts of assignments will typically be handed in as a single jupyter notebook that should be internally documented, so it is straightforward to determine which problem any code/plots/other results pertain to.

Quizzes: There will be a quiz roughly every 3 weeks (3 altogether plus 1 makeup). Anticipated dates for **quizzes are** [*]. Quizzes will be written in-person in the regular lecture classroom.

Final: At this point we plan to have an in-person written final exam. As with quizzes, there could be the option of moving the exam online. An online exam could consist of a mix of written and oral components. For written components you will need to scan and return them (printer/scanner to pdf is ideal but a phone app like Office Lens that will produce a pdf with all pages as a single document is ok).

Student Absences: If you are unable to meet a course requirement due to illness or other serious circumstances, please follow the procedures below.

Assessments worth less than 10% of the overall course grade:

Assignments: Late penalties are automatically waived for the first 48 hours after the due date, after which late assignments will be penalized at a rate of up to 10% per day at the instructor's discretion.

Weekends count: an assignment due on Friday but submitted on Monday is three days late. In addition, grading of the assignments will be based on the best 5 of 6 assignments to account for extended illness or other extended serious circumstance.

Assessments worth 10% or more of the overall course grade:

Quizzes are individually worth more than 10% of the final course grade. As such, you must provide valid medical or supporting documentation to the Academic Counselling Office of your Faculty of Registration as soon as possible if you miss a quiz. For further information, please consult the University's medical illness policy at

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/academic_consideration.pdf.

The Student Medical Certificate is available at

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf.

There will be a makeup quiz the last week of classes. The makeup will be cumulative and will act as a makeup for any quiz missed during the semester (this needs to be for a properly reported and approved absence as described above). If more than 1 quiz is missed with valid excuse, weight will be transferred to the final exam.

Absences from Final Examinations

If you miss the Final Exam, please contact the Academic Counselling office of your Faculty of Registration as soon as you are able to do so. They will assess your eligibility to write the Special Examination (the name given by the University to a makeup Final Exam).

You may also be eligible to write the Special Exam if you are in a “Multiple Exam Situation” (e.g., more than 2 exams in 23-hour period, more than 3 exams in a 47-hour period).

If a student fails to write a scheduled Special Examination, the date of the next Special Examination (if granted) normally will be the scheduled date for the final exam the next time this course is offered. The maximum course load for that term will be reduced by the credit of the course(s) for which the final examination has been deferred. See the Academic Calendar for details (under [Special Examinations](#)).

Note: missed work can *only* be excused through one of the mechanisms above. Being asked not to attend an in-person course requirement due to potential COVID-19 symptoms is **not** sufficient on its own.

6. Accommodation and Accessibility

Religious Accommodation

When a course requirement conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request accommodation for their absence in writing at least two weeks prior to the holiday to the course instructor and/or the Academic Counselling office of their Faculty of Registration. Please consult University's list of recognized religious holidays (updated annually) at

<https://multiculturalcalendar.com/ecal/index.php?s=c-univwo>.

Accommodation Policies

Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Accommodation_disabilities.pdf.

7. Academic Policies

The website for Registrarial Services is <http://www.registrar.uwo.ca>.

In accordance with policy,

https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf,

the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at their official university address is attended to in a timely manner.

Calculator Policy: For the exams it is likely you will need a scientific calculator (with log, trig functions), pen and pencil. These will not be provided and if you forget them you will probably fail the exam. However, you cannot use anything capable of wireless communication, or anything capable of storing and displaying large text files. If you are not sure if your calculator is ok, go to www.staples.ca web site, type “scientific calculator” into the search bar and any one of the calculators that come up costing less than \$20 is ok. Make sure you know how to use the calculator before the exam.

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf.

Tests and examinations are planned to be in-person. However, if it is required that tests and examinations in this course be moved online (eg. In the event of a health lock-down) they may be conducted using a remote proctoring service. By taking this course, you are consenting to the use of this software and acknowledge that you will be required to provide **personal information** (including some biometric data) and the session will be **recorded**. Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. More information about this remote proctoring service, including technical requirements, is available on Western's Remote Proctoring website at:

<https://remoteproctoring.uwo.ca>.

8. Support Services

Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: <https://www.uwo.ca/sci/counselling/>.

Students who are in emotional/mental distress should refer to Mental Health@Western (<https://uwo.ca/health/>) for a complete list of options about how to obtain help.

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at

https://www.uwo.ca/health/student_support/survivor_support/get-help.html.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at

http://academicsupport.uwo.ca/accessible_education/index.html

if you have any questions regarding accommodations.

Learning-skills counsellors at the Student Development Centre (<https://learning.uwo.ca>) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Western University is committed to a thriving campus as we deliver our courses in the mixed model of both virtual and face-to-face formats. We encourage you to check out the Digital Student Experience website to manage your academics and well-being: <https://www.uwo.ca/se/digital/>.

Additional student-run support services are offered by the USC, <https://westernusc.ca/services/>.