

CHEM 234-02
Thermodynamics (3 credits)
Final Course Outline
Winter 2026

Gregor Kos

January 6, 2026

1 Course description

CHEM 234 is an introductory course in Physical Chemistry focusing on thermodynamics, the transfer of energy that accompanies chemical and physical change. It allows for the quantitative evaluation of equilibria and the determination of the direction of natural change. Thermodynamics provides a mathematical framework to discuss processes as diverse as gas chemistry and phase transitions. Topics covered include the properties of gases, internal energy, enthalpy & the First Law, entropy, free energy & the Second and Third Laws, phase equilibria, simple mixtures and chemical equilibria.

2 Learning outcomes

1. Understand the molecular behaviour of ideal and real gases and use their mathematical description to calculate values for their variables of state.
2. State the First, Second and Third Laws, define heat, work and explain differences between forms of energy and exchange.
3. Explain and apply concepts of path dependence/independence and reversibility/irreversibility of thermodynamic processes. Understand how these result in changes and differences of the thermodynamic state.
4. Apply ideal cycle analysis to simple heat engine cycles to estimate work, heat and entropy as a function of pressures, volume and temperature at all points in the cycle.
5. Based on state functions and variables understand and apply concepts to describe ideal, ideal-dilute and real solutions using concentrations and activities.
6. Read and quantitatively evaluate binary phase diagrams for gases, liquid and solid states of compounds and their mixtures
7. Using thermodynamic state functions for ideal and real systems derive the equilibrium constant and apply mathematical concepts to real problems.

3 Course administration

Instructor: Dr. Gregor Kos, gregor.kos@concordia.ca

Office: Chemistry & Biochemistry, SP 275.21

Office hours: Tue, 10h00–11h00 & Thu, 14h00–15h00

Prerequisites: CHEM 205, 206; PHYS 204, 206, 224, 226; MATH 203, 205

Class time: Wed & Fri, 08h45 – 10h00

Room: CC 308 LOY

Course website: <http://moodle.concordia.ca> (automatic enrolment)

Course text: Peter Atkins and Julio De Paula, Physical Chemistry, Volume 1: Thermodynamics and Kinetics, 12ed, 2023, Oxford University Press; **rent through Perusall (see below)**

4 Electronic teaching tools

In addition to Moodle, electronic teaching tools will support your preparation and in-class work; sign-up links are available on Moodle. These are –

- **Perusall** (<https://perusall.com>) for pre-reading and online discussions; sign-up required with real name, email and Student ID for grading.
- **myDalite** (<https://mydalite.org>) for online quizzes; sign-up required with email and Student ID for grading.

- **iClicker** (<https://www.iclicker.com>) for responses during in-class exercises; sign-up required with real name and Student ID for grading.

Regarding the use of third-party software and transmission of personal information, please see below.

5 Assessment

During the lecture period one midterm exam will be given. Together with the pre-reading, pre-reading quiz, cumulative final exam and the tutorial (scheduled separately) the final mark will be calculated:

- Weekly pre-reading & discussions (Perusall): 12%
- Weekly quizzes (myDalite): 6%
- iClickers: 6%
- Midterm (in-class): 16%
- Final (centrally scheduled): 40%
- Tutorial: 20%

You need a passing grade for both, the lecture and tutorial portion of the course. For the lecture a passing grade from midterm and final exams ($> 50\%$) is required. The passing grade for the tutorial is also $> 50\%$. The final exam is mandatory to pass the course. Once a passing

grade from the midterm and final exams is determined, all other grades will be added to calculate the final mark for the course.

For the midterm and the final exam, a single letter-sized page (one-sided) with notes of any kind is allowed. Bring your draft to class for practice sessions and update it frequently before the exams. You may use programmable calculators for exams and tutorials only after a hard reset in front of the instructor.

For calculation of exam marks, **missing units** (−1 mark) and an incorrect number of **significant figures** (−0.5 marks) in a final result will lead to **automatic deductions** outside the regular marking scheme for each occurrence of the error(s) in the exam. Revise unit analysis and significant figures as early as possible, if needed.

5.1 Passing and failing grades

Passing grades –

A+	A	A-	B+	B	B-
100-90	89-85	84-80	79-77	76-73	72-70
C+	C	C-	D+	D	D-
69-67	66-63	62-60	59-57	56-53	52-50

Failing grades –

F	R
< 50% (lecture)	< 40% (lecture) or < 50% (tutorial)

Students receiving an “F” or “R” grade for the course must repeat all components of the course. There are no exemptions for tutorials.

6 Important dates

Every week assigned pre-reading sections will be posted on Perusall. Marks will be awarded for participating in discussions (asking good questions, providing answers). You have until Sunday evening (11 pm) of the week to complete the pre-reading, discussions and a weekly quiz on myDalite.

Date	Event
14 Jan 2026	Class starts Register for CHEM 101 seminar
21 Jan 2026	Clicker usage starts
26 Jan 2026	DNE; withdrawal with refund
27 Feb 2026	Midterm exam
2-6 Mar 2026	Reading week; no class
23 Mar 2026	DISC; withdrawal without refund
10 Apr 2026	Last class
TBD	Final exam (scheduled by Exams Office)

7 Extraordinary circumstances

In the event of extraordinary circumstances and pursuant to the Academic Regulations, the University may modify the delivery, content, structure, forum, location and/or evaluation scheme. In the event of such extraordinary circumstances, students will be informed of the changes.

8 Attendance

8.1 Lecture

I strongly suggest to attend class regularly. Midterm and final examinations will be conducted following university regulations. For a missed

midterm (no supplemental) with short term absence form or with a doctor's note during an extended absence, marks will be transferred to the final exam (for a contribution of 56% to the course mark). Missed midterms, pre-reading assignments, online quizzes and iClicker sessions will be marked zero, unless an official excuse is provided.

8.2 Tutorial

Attendance at the tutorials is mandatory. You must go to the section you are registered in. Otherwise you will receive zero marks and the tutorial will be marked as missed (unless permission is granted by the tutorial leader). For any missed tutorial a doctor's note or other official note for the day of the tutorial is the only acceptable excuse, otherwise zero marks will be given. For missed tutorials you must schedule a make-up tutorial within 1 week with the tutorial instructor. If you miss more than one tutorial without a suitable excuse and fail to attend the make-up tutorial, you will get a failing grade for the course. The tutorial instructor is Nathan Fischer (nathan.fischer@mail.concordia.ca).

You must show all your work when answering a quiz or assessment question, otherwise you will get zero marks for the question. You can use your personal formula sheet (letter-sized, single sided) for all assessments, but the use of class notes is not permitted. Anti-plagiarism and Academic Dishonesty rules will be strictly enforced!

There are no tutorial exemptions for the course. If you repeat the course following a failing grade or a DISC, you will need to complete the tutorials again.

9 Course content

Chemistry CHEM 234 is an introduction to thermodynamics. The course will closely follow selected topics from Chapters 1–6 of the assigned textbook.

9.1 Review chapters

In preparation for the course, **I strongly suggest to review the following chapters from General Chemistry.** Do not forget to extensively practice your problem-solving skills.

- Stoichiometry
- Gases
- Thermochemistry
- Liquids and Solids
- Properties of Solutions
- Chemical Equilibrium

9.2 Chapters covered in detail

Chapter 1 – The Properties of Gases (1A and 1C)

Chapter 2 – The First Law

Chapter 3 – The Second and Third Laws

Chapter 4 – Physical Transformation of Pure Substances

Chapter 5 – Simple Mixtures

Chapter 6 – Chemical Equilibrium (6A and 6b)

9.3 Preparatory reading & quiz

Every week assigned pre-reading sections will be posted on Perusall. Marks will also be awarded for participation in discussions (asking questions, providing answers). You have until Sunday evening (11 pm) of the week to complete the pre-reading, discussions and a weekly quiz on myDalite. **Copy/paste, regardless of your own text or text from other sources is prohibited.** However, you are allowed to copy/paste special characters (e.g., Δ) and links. **Copy/pasting (other than the mentioned exception) will result in zero marks for the pre-reading assignment.**

The questions and answers from Perusall and the quiz results from myDalite will aid me in preparing lectures, examples and exercises to cover the most challenging sections of the course material. In-class peer exercises using clickers will allow you to solidify and test your knowledge of the course material.

10 Academic Integrity

10.1 Mandatory seminar & quiz

As part of your CHEM course, you are required to (i) attend a Chemistry and Biochemistry Departmental Seminar on the academic conduct code and the appropriate use of information sources and (ii) pass the online quiz associated with this seminar (the passing grade for the quiz is 100%).

Note: This quiz is graded by the Department of Chemistry and Biochemistry, and you do not have access to it until after you have attended the seminar. Therefore, any other quiz you may have taken on the academic code of conduct does not count toward the CHEM 101 requirement. The aim of this seminar and quiz is to clarify the academic conduct code in terms of which practices will be considered unacceptable with regard to work submitted for grading in your CHEM course. You are only exempt from repeating the seminar and the quiz if you have done both in **Winter 2021 or more recently** *. otherwise you are required to repeat both this term.

This short seminar (1 hour) will be held at the following times (note that you will not be given credit if you join too late and/or leave too early):

Date	Time	Registration Link (paste without line break)
Tue, 27 Jan	21h00-22h00	https://concordia-ca.zoom.us/join/abB53MlnQSC6LrNsCnRepw
Thu, 29 Jan	21h00-22h00	https://concordia-ca.zoom.us/join/0v3k0gZLTgGLTXRYpNJ7zg

As space for each of the Zoom seminars is limited, please register early for your preferred slot (copy the corresponding link above into your browser). Look out for the Zoom email with the link to the actual seminar. Then do not forget to attend that seminar slot on the date above. You will not receive a reminder on or before the date!

We will take attendance at the Zoom seminar; this means that you must log in with the code that was supplied for your registration. Do not “join a friend” in watching at their computer.

If you do not complete this course requirement, your final grade for the course may be lowered by one full letter grade with an incomplete (INC) notation until such time as this requirement is completed. Please refer to the undergraduate calendar (section 16.3.5) for details on removal of an incomplete notation.

[*] You are exempt if you can locate your ID in the pdf file located on the Departmental web site (<http://www.concordia.ca/content/dam/artsci/chemistry/docs/Compliance-list.pdf>) and if there is no entry in

the “quiz” column for you. If the list does not say “Winter 2021-Fall 2025”, you have the wrong list: Clear your browser cache.

10.2 Plagiarism and other forms of academic dishonesty

The Academic Code of Conduct can be found in section 17.10 of the academic calendar (<http://www.concordia.ca/academics/undergraduate/calendar/current/17-10.html>). Any form of unauthorized collaboration, cheating, copying or plagiarism found in this course will be reported and the appropriate sanctions applied. The mandatory seminar is a clear and fair opportunity to learn what our faculty regards as academic misconduct. Failure to take part in this learning opportunity and thus ignorance of these regulations is no excuse and will not result in a reduced sanction in any case where academic misconduct is observed.

11 Privacy and use of external software

11.1 Personal data

Students are advised that external software and/or websites will be used in the course and students may be asked to submit or consent to the submission of personal information (for example, name and email) to register for an online service. Students are responsible for reading and deciding whether or

not to agree to any applicable terms of use. Use of this software and service is voluntary. Students who do not consent to the use the software or service should identify themselves to the course instructor as soon as possible, and in all cases before the DNE deadline, to discuss alternate modes of participation.

11.2 Submission of work

Students are further advised that external software and/or websites will be used in the course and students may be asked to submit or consent to the submission of their work to an online service. Students are responsible for reading and deciding whether or not to agree to any applicable terms of use. Use of this software and service is voluntary. Students who do not consent to the use the software or service should identify themselves to the course instructor as soon as possible to discuss alternate modes of participation that do not require them to give copyright or the right to use their work to a third party.

By using the external software or websites, students agree to provide and share their work and certain personal information (where applicable) with the website/software provider. Students are advised that the University cannot guarantee the protection of intellectual property rights or personal information provided to any website or software company. Intellectual property and personal information held in foreign jurisdictions are subject to the laws of such jurisdictions.

12 Intellectual property

Content belonging to instructors shared in courses, including, but not limited to, online lectures, course notes, and video recordings of classes remain the intellectual property of the faculty member. It may not be distributed, published or broadcast, in whole or in part, without the express permission of the faculty member. Students are also forbidden to use their own means of recording any elements of an online class or lecture without express permission of the instructor. Any unauthorized sharing of course content may constitute a breach of the Academic Code of Conduct and/or the Code of Rights and Responsibilities. As specified in the Policy on Intellectual Property, the University does not claim any ownership of or interest in any student IP. All university members retain copyright over their work.

13 Behaviour

All individuals participating in courses are expected to be professional and constructive throughout the course, including in their communications. Concordia students are subject to the Code of Rights and Responsibilities which applies both when students are physically and virtually engaged in any University activity, including classes, seminars, meetings, etc. Students engaged in University activities must respect this Code when engaging with any members of the Concordia community, including faculty, staff, and students, whether such interactions are verbal or in writing, face to face or

online/virtual. Failing to comply with the Code may result in charges and sanctions, as outlined in the Code.

14 List of student services

1. Access Centre for Students with Disabilities (<http://www.concordia.ca/students/accessibility>)
2. Student Success Centre (<http://www.concordia.ca/students/success>)
3. Counselling and Psychological Services (<http://www.concordia.ca/students/counselling-life-skills>)
4. Concordia Library Citation and Style Guides (<https://library.concordia.ca/help/citing>)
5. Health Services (<http://www.concordia.ca/students/health>)
6. Financial Aid and Awards (<http://www.concordia.ca/offices/faao>)
7. Academic Integrity (<http://www.concordia.ca/students/academic-integrity>)
8. Dean of Students Office (<http://www.concordia.ca/offices/dean-students>)
9. International Students Office (<http://www.concordia.ca/students/international>)

10. Student Hub (<http://www.concordia.ca/students>)
11. Sexual Assault Resource Centre (<http://www.concordia.ca/students/sexual-assault>)
12. As a Concordia student, you are a member of the Concordia Student Union and have many resources available to you including HOJO (Off Campus Housing and Job Bank: <https://www.csu.qc.ca/services/hojo/>) and the CSU Advocacy Centre (<https://www.csu.qc.ca/services/advocacy/>).
13. Aboriginal Student Resource Centre (<http://www.concordia.ca/students/aboriginal>)
14. Concordia Mental Health (<https://www.concordia.ca/students/health/mental-health.html>)

15 Territorial acknowledgement

We would like to begin by acknowledging that Concordia University is located on unceded Indigenous lands. The Kanien'kehá:ka Nation is recognized as the custodians of the lands and waters on which we gather today. Tiohtià:ke/Montréal is historically known as a gathering place for many First Nations. Today, it is home to a diverse population of Indigenous and other peoples. We respect the continued connections with the past, present and future in our ongoing relationships with Indigenous and other peoples within the Montreal community.