



Chemistry

UNIVERSITY OF TORONTO

## CHM 222H: Introduction to Physical Chemistry

### Course Syllabus

#### I TEACHING TEAM

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**INSTRUCTOR:**

Name: Professor Jeremy Schofield

Email: [Jeremy.schofield@utoronto.ca](mailto:Jeremy.schofield@utoronto.ca)

Office: Lash Miller 420E

In-person Lectures: LM158, MW 4 – 5 pm

Online student hours: Friday's 4 – 5 pm or by appointment.

**TAS:**

Tutorial sessions will be held in LM157 during the scheduled period (either Tuesdays from 2 – 3 pm or Fridays from 1 – 2 pm) by the teaching assistants.

Name: Margarita Gladkikh

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#### II COURSE OVERVIEW

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**COURSE DESCRIPTION:**

**Classes** will be concerned with presenting a systematic approach to the topic of *thermodynamics*, one of the fundamental pillars of Physical Chemistry.

**STUDENT LEARNING OUTCOMES:**

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

- Discuss the laws of thermodynamics and how they can be used for chemical systems.
- Apply the laws of thermodynamics to compute changes in observable physical properties for specific processes.
- Apply thermodynamic principles to compute the physical properties of chemical systems in an equilibrium state, such as the determination of phase and chemical composition as a function of the thermodynamic properties that specify the state.

**PREREQUISITE COURSE(S):**

This course assumes you have a basic understanding of elementary differential and integral calculus and elementary physics and physical chemistry. The language used to express the principles of thermodynamics is mathematical and involves multi-variable calculus. A modest level of mathematical sophistication is required for success in the course. The pre-requisites for the course are: CHM 135H, 136H)/[151Y](#), [MAT \(135H, 136H\)/137Y/157Y](#), PHY (131H, 132H)/(151H, 152H). In addition, it is recommended that students be concurrently enrolled in a course in multivariable calculus such as [MAT 235Y](#) or [MAT 237Y](#).

**READINGS:**

Required: This course will combine a MyLab online teaching resource with the textbook. The required textbook for CHM222 for 2021 is **Physical Chemistry: Thermodynamics, Statistical Thermodynamics, and Kinetics**, 4th edition, by Thomas Engel and Philip Reid. A link MyLab and Mastering Chemistry resource can be found on the Quercus Canvas page.

Electronic access to be the teaching tool and an electronic copy of the textbook can be purchased through the University Bookstore via the link:  
[https://www.campusbookstore.com/integration/AccessCodes/default.aspx?bookseller\\_id=96&Course=STG+CHM+222HF+MODIFIED+MASTERING+WITH+PEARSON+eTEXT&frame=YES&t=permalink](https://www.campusbookstore.com/integration/AccessCodes/default.aspx?bookseller_id=96&Course=STG+CHM+222HF+MODIFIED+MASTERING+WITH+PEARSON+eTEXT&frame=YES&t=permalink)

To get started with the MyLab Mastering Chemistry tool, see the video:  
[https://www.youtube.com/watch?v=8w\\_oUy4IGlg](https://www.youtube.com/watch?v=8w_oUy4IGlg)

### **III COURSE ORGANIZATION**

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Course content is organized in content by week. For each week, there will be assigned reading material from the ebook and problems posted on Quercus for discussion in tutorials.

Students are expected to follow the live classes online, read the assigned ebook material, and work through the assigned tutorial questions according to the posted dates.

The following is only a *rough* schedule:

**COURSE SCHEDULE & RELEVANT SESSIONAL DATES:**

<b>Dates</b>	<b>Week</b>	<b>Topics</b>	<b>Reading</b>
Sept. 13 – Sept. 19	1	Definitions of thermodynamic systems and properties. Temperature and the zeroth law of thermodynamics.	Math essentials 1, 2 and 3. Chapter 1.1-1.5
Sept. 20 – Sept. 26	2	Energy, calculations of work.	Chapter 2: 2.1, 2.3, 2.6
Sept. 27 – Oct. 3	3	Work, heat, and the First Law of Thermodynamics.  <b>Online quiz 1:</b> Wednesday, Sept. 29: 10% of final mark	Chapter 2: 2.2, 2.6
Oct. 4 – Oct. 10	4	Enthalpy, internal energy, heat capacities at constant volume and constant pressure.	Chapter 2: 2.4, 2.5
Oct. 11 – Oct. 17	5	Changes in state functions for isothermal, adiabatic, irreversible and reversible processes.  <b>Term Test 1:</b> Monday, Oct. 18: 25% of final mark	Chapter 3 3.1 – 3.8  Chapter 4 4.1 – 4.3
Oct. 18 – Oct. 24	6	Carnot cycle and heat engines: heat, work and efficiency for a cyclic process.	Chapter 5: 5.10 – 5.13
Oct. 25 – Oct. 31	7	Statements of the Second Law of Thermodynamics, calculation of entropy changes.  <b>Online quiz 2:</b> Monday, Nov. 1: 10% of final mark	Chapter 5: 5.1 – 5.4
Nov. 1 – Nov. 7	8	Spontaneity, Helmholtz and Gibbs free energies.	Chapter 5: 5.4 – 5.6 Chapter 6:

			6.1 – 6.2
Nov. 8 – Nov. 12		Reading week	
Nov. 15 - Nov. 21	9	Chemical potential and changes in phase.  <b>Term Test 2:</b> Wednesday, Nov. 17: 25% of final mark	Chapter 6: 6.4
Nov. 22 – Nov. 28	10	Equilibrium in chemical reactions.	Chapter 6: 6.3 – 6.9
Nov. 29 – Dec. 5	11	One-component phase equilibria	Chapter 8: 8.1 - 8.7

### TUTORIAL OBJECTIVES:

Online tutorials will provide the opportunity for students to ask questions and receive feedback on assigned problems. Tutorial problems will be assigned weekly and it is *imperative* for success in the course that each student attempts to solve the assignments on their own. The problem sets not only provide a valuable means of reinforcing concepts introduced in class but also serve as an example of the level of mastery of material expected of them.

## IV EVALUATION/GRADING SCHEME

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### OVERVIEW:

- **Quizzes:** (two in total, to be completed on Wednesday, September 30, 2020 and on Monday, November 2, 2020) worth 10% each\*.
- **Homework completion:** Average completion rate of reading and answering textbook questions: 10%
- **Term tests:** (two in total, on Monday, October 19 and Wednesday, November 18, 2020) worth 20% each. Term tests will be scheduled to be completed during a 24-hour period and students will be granted a 2-hour window to complete them once started\*.
- **Final assessment:** (to be held during final assessment period in December 2020), worth 30% of final mark.

\*No resources such as lecture notes or internet allowed.

## MARK BREAKDOWN

**Student mark will be based on the higher outcome of two different marking schemes:**

Homework completion: 10% total grade  
Quizzes: 2 x 10% = 20% total grade  
Term test: 2 x 20% = 40% total grade  
Final Assessment = 30% total grade

or

Homework completion: 10% total grade  
Quizzes: 2 x 10% = 20% total grade  
Term test: 2 x 15% = 30% total grade  
Final Assessment = 40% total grade

For students missing one of the term tests for a valid reason, the missed test grade will be calculated based on performance on the other term test. **For students missing both tests for valid reasons the mark for the missing tests will be replaced by a cumulative, three-hour assessment to be written during the final assessment period. This assessment will cover all aspects of the classroom components of the course.**

**IMPORTANT:** if an unexpected technical issue occurs with a university system (e.g., Quercus services, network outage) that affects availability or functionality, it may be necessary to revise the timing or weighting of the quizzes/term tests.

## V COURSE POLICIES

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The University of Toronto is committed to equity, human rights and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. As a Course Instructor, I will neither condone nor tolerate behaviour that undermines the dignity or self-esteem of any individual in this course and wish to be alerted to any attempt to create an intimidating or hostile environment. It is our collective responsibility to create a space that is inclusive and welcomes discussion. Discrimination, harassment and hate speech will not be tolerated. If you have any questions, comments, or concerns, we encourage you to reach out to the staff in our Equity Offices.

- We will strive to answer all communications such as emails in a 24-hour period.
- The University of Toronto is committed to equity, human rights and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our

community can express themselves, engage with each other, and respect one another's differences. U of T does not condone discrimination or harassment against any persons or communities.

- All work for the course must be submitted using Quercus.
- Normal University procedures should be followed to signal course absences and request make-up tests or exemptions from exams.

Each member of this course is expected to maintain a:

- (i) professional and respectful attitude during all course activities, including classes, laboratories, tutorials and online activity.
- (ii) personal calendar/schedule/organizer to ensure that all course activities are completed, and due dates are met.
- (iii) collection of notes recorded independently based on concepts covered in course activities (students registered with Accessibility Services requiring a class note-taker will have access to this accommodation)
- (iv) familiarity with the university policy on Academic Integrity (overleaf)

## **VI TECHNOLOGY REQUIREMENTS**

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This course requires the use of computers, and of course sometimes things can go wrong when using them. You are responsible for ensuring that you maintain regular backup copies of your files, use antivirus software (if using your own computer), and schedule enough time when completing an assignment to allow for delays due to technical difficulties. Computer viruses, crashed hard drives, broken printers, lost or corrupted files, incompatible file formats, and similar mishaps are common issues when using technology, and are not acceptable grounds for a deadline extension.

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## **VII INSTITUTIONAL POLICIES & SUPPORT**

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### **ACADEMIC INTEGRITY**

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 ([governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019](http://governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019)) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

In virtual laboratory reports:

1. Using someone else's ideas or words without appropriate acknowledgement.
2. Submitting your own work in more than one course without the permission of the instructor.
3. Making up sources or facts.
4. Obtaining or providing unauthorized assistance on any report. **Please note that the use of websites (such as Chegg.com or the course discussion board) to post virtual laboratory report material/questions or to post/access answers to questions is an academic offence under the University of Toronto's Code of Behaviour on Academic Matters. Alleged instances of this nature are forwarded to the Faculty of Arts & Science Student Academic Integrity office.**

On quizzes and term tests:

1. Using or possessing unauthorized aids. **Please note that the use of websites (such as Chegg.com or the course discussion board) to post quiz/term test questions or to post/access answers to questions is an academic offence under the University of Toronto's Code of Behaviour on Academic Matters. Alleged instances of this nature are forwarded to the Faculty of Arts & Science Student Academic Integrity office.**
2. Looking at someone else's answers or collaborating/discussing answers during a quiz or term test.
3. Misrepresenting your identity.

In general academic work:

1. Falsifying institutional documents or grades.
2. Falsifying or altering any documentation required by the University.

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 [www.academicintegrity.utoronto.ca/](http://www.academicintegrity.utoronto.ca/)).

## **COPYRIGHT**

If a student wishes to copy or reproduce class presentations, course notes or other similar materials provided by instructors, he or she must obtain the instructor's written consent beforehand. Otherwise, all such reproduction is an infringement of copyright and is absolutely prohibited. More information regarding this is available here: <https://teaching.utoronto.ca/ed-tech/audio-video/copyright-considerations/>

## **ACCESSIBILITY NEEDS**

Students with diverse learning styles and needs are welcome in this course. The University of Toronto is committed to accessibility: if you require accommodations for a disability, or have any other accessibility concerns about the course, please contact [Accessibility Services](#) as soon as possible.

### **ACCOMMODATIONS FOR RELIGIOUS OBSERVANCES**

Following the University's policies, reasonable accommodations will be made for students who observe religious holy days that coincide with the due date/time of an assignment, tutorial, class or laboratory session. Students must inform the instructor **before** the session/assignment date to arrange accommodations.

### **ADDITIONAL SERVICES & SUPPORT**

The following are some important links to help you with academic and/or technical service and support:

- General student services and resources at [Student Life](#)
- Full library service through [University of Toronto Libraries](#)
- Resources on conducting online research through [University Libraries Research](#)
- Resources on academic support from the [Academic Success Centre](#)
- Learner support at the [Writing Centre](#)
- Information for [Technical Support/Quercus Support](#)

### **ACKNOWLEDGEMENT OF TRADITIONAL LANDS**

We wish to acknowledge this land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca and, most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.