

# CHM 328H: Modern Physical Chemistry

## Course Syllabus: Winter 2022

### I CONTACTS

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#### **INSTRUCTOR:**

*Name:* Jeremy Schofield

*Email:* jeremy.schofield@utoronto.ca

*Office:* Lash Miller, room 420E

*Classes:* online using Zoom and in-person (date to be determined) in LM123

- Synchronous delivery at 3 - 4 pm. on Tuesdays and Thursdays.

*Online student hours:* Fridays, 3 – 4 pm using Zoom or by appointment.

#### **TEACHING ASSISTANT:**

*Name:* Kai Gu

*Email:* kai.gu@mail.utoronto.ca

*Tutorials:* online using Zoom and in-person in LM155

- Synchronous delivery at 12:00 – 1:00 pm. on Wednesdays.

### II COURSE OVERVIEW

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#### **COURSE DESCRIPTION:**

In CHM328 macroscopic phenomena are described from a microscopic point of view and to build a bridge between the quantum mechanics of atoms and molecules studied in CHM223 and CHM326 and the thermodynamic treatment of macroscopic systems studied in CHM222 and CHM151/CHM135.

#### **STUDENT LEARNING OUTCOMES:**

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

- Understand how kinetic theory can be used to predict macroscopic properties such as the thermodynamic pressure and energy of a system and chemical properties such as the law of mass action and reaction rates.
- Discuss the thermodynamics of non-ideal systems.
- Use ensemble theory to understand heat capacities, equilibrium constants and phase separation.

### PREREQUISITE COURSES:

This course assumes you have a basic understanding of 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: CHM222 and CHM223.

### READINGS:

Required: Adapted ebook *Physical Chemistry*, by Ira Levine

- Available for purchase from the U of T Bookstore via the link:  
[https://www.campusebookstore.com/integration/AccessCodes/default.aspx?bookseller\\_id=96&Course=STG+CHM+328+CUSTOM+ETEXT+FOR+MODERN+PHYSICAL+CHEMISTRY&frame=YES&t=permalink](https://www.campusebookstore.com/integration/AccessCodes/default.aspx?bookseller_id=96&Course=STG+CHM+328+CUSTOM+ETEXT+FOR+MODERN+PHYSICAL+CHEMISTRY&frame=YES&t=permalink)

## III HOW THE COURSE IS ORGANIZED

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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, attend tutorials, write the weekly quizzes, read the assigned ebook material, and work through the assigned problem sets according to the posted dates.

### TUTORIAL OBJECTIVES:

Online tutorials will provide the opportunity for students to ask questions and receive feedback.

### Tentative Course Schedule & Relevant Sessional Dates:

Dates	Week	Topics/Assignments
Jan. 10 – Jan. 16	1	Kinetic theory of gases: ideal gas
Jan. 17 – Jan. 23	2	Review of probability: Maxwell distribution <b>Online Quiz 1 due on Jan. 19 at 11:59 am</b>
Jan. 24 – Jan. 30	3	Distribution of speeds: effusion <b>Online QUIZ 2 due on Jan. 26 at 11:59 am</b>
Jan. 31 – Feb. 6	4	Collisions: collision frequency <b>Online QUIZ 3 due on Feb. 2 at 11:59 am</b> <b>Problem set 1 (15%) due on Feb. 3</b>
Feb. 7 – Feb. 13	5	Reactions: rate constants <b>Online QUIZ 4 due on Feb. 9 at 11:59 am</b>
Feb. 14 – Feb. 20	6	Non-uniform reactions: diffusion <b>Term test 1 (20%): Thursday Feb. 17</b>
Feb. 21 – Feb. 27		Reading week: no classes

Feb. 28 – Mar. 6	7	Introduction to statistical mechanics: microcanonical ensemble  <b>Online QUIZ 5 due on Mar. 2 at 11:59 am</b>
Mar. 7 – Mar. 13	8	Canonical ensemble: thermodynamics  <b>Online Quiz 6 due on Mar. 9 at 11:59 am</b>
Mar, 14 – Mar. 20	9	Fluctuations and Partition functions  <b>Problem set 2 (15%) due on Mar. 17</b>
Mar. 21 – Mar. 27	10	Diatomic partition function/thermodynamics  <b>Online Quiz 7 due on Mar. 23 at 11:59 am</b>
Mar. 28 – Apr. 3	11	Chemical equilibrium: equil. Constants  <b>Term test 2 (20%): Thursday Mar. 31</b>
Apr. 4 – Apr. 10	12	Classical statistical mechanics  <b>Online Quiz 8 due on Apr, 6 at 11:59 am</b>

#### IV EVALUATION/GRADING SCHEME

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- **Quizzes:** Online single-question weekly quizzes on Wednesdays worth 10% total\*.
- **Marked problem sets:** Two in total, due February 3 and March 17, 2022, worth 15% each.
- **Term tests:** Two in total, on Thursday, February 17 and Thursday, March 31, 2022, worth 20% each. If online, 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\*. Otherwise, term tests will be held in-person on the scheduled date at a time and location that will be posted.
- **Final assessment:** To be held during final assessment period (April 11 – 19, 2022), worth 20% of final mark.

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

For students missing one term test for a valid reason, the missed test grade will be calculated based on performance on the other term test and the class average of the test. For students missing both tests for valid reasons the mark for the missing tests will be replaced by a cumulative, two-hour assessment to be written during the April 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 assessments.

## V COURSE POLICIES

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- 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.

## 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.

## VII INSTITUTIONAL POLICIES AND SUPPORT

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### ACADEMIC INTEGRITY

#### **On 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 (<https://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 assignments:

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 assignment.

On tests and exams:

1. Using or possessing unauthorized aids.
2. Looking at someone else's answers during an exam or test.
3. Misrepresenting your identity.

In academic work:

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

**Please note that the use of websites (such as Chegg.com or the course discussion board) to post 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.**

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 <https://www.academicintegrity.utoronto.ca/>).

## **COPYRIGHT**

This course, including your participation, will be recorded on video and will be available to students in the course for viewing remotely and after each session.

Course videos and materials belong to your instructor, the University, and/or other sources depending on the specific facts of each situation and are protected by copyright. Do not download, copy, or share any course or student materials or videos without the explicit permission of the instructor.

## **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 and 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.