

Chem 1420.400 / General Chemistry for Science Majors, 2nd semester

Instructor Information

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Course Schedule

Lecture: There are no scheduled class meetings or recitations. All course material is posted on Canvas in Chem 1420.400 at <https://unt.instructure.com/courses/145549>

Course Prerequisites

Grade of "C" or better in CHEM 1410 (General Chemistry I) or equivalent.

Course Corequisites

CHEM 1420.411 (recitation)

Course Description

Chem 1420 is the second semester of general chemistry for science majors. Topics include entropy and free energy, reaction spontaneity, solutions, solubility equilibria, acid-base equilibria, electrochemistry, kinetics and nuclear chemistry.

Course Objectives

Upon successful completion of this course, you will be able to (numbered in order of presentation):

- I. Review Enthalpy
 1. What is internal energy
 2. What is Enthalpy
 3. What is Enthalpy of reactions
 4. What is Hess's law
 5. What is standard states
 6. What is standard formation enthalpy
 7. Determine standard reaction enthalpy with standard formation enthalpy
- II. Thermodynamics
 1. Entropy
 - a. Compare entropy according to volume
 - b. Compare entropy according to temperature
 - c. Compare entropy according to molar mass
 - d. Compare entropy according to phase change
 - e. Compare entropy after mixing
 - f. Compare entropy after chemical reactions
 2. The second law of thermodynamics
 - a. Predict spontaneity based on the change in entropy of the universe
 3. The third law of thermodynamics

- a. Explain why the molar entropies of any elements or compounds are positive values.
 - b. Calculate the standard entropy change of reactions.
- 4. Gibbs free energy
 - a. Calculate the standard free energy change of reactions at 298 Kelvins according to the standard free energy of formation
 - b. Calculate the standard free energy change of reactions at any temperature according to the standard enthalpy change of the reaction and the standard entropy change of the reaction
- 5. Spontaneity
 - a. Predict spontaneity according to the sign of enthalpy change, the sign of entropy change and the absolute temperature
 - b. Calculate the temperature at which the system is at equilibrium under standard conditions.
- III. Solutions
 - 1. Electrolytes
 - a. Identify strong electrolytes.
 - b. Identify weak electrolytes.
 - c. Identify nonelectrolytes.
 - 2. Convert between various units of solution concentrations
 - a. Calculate molality
 - b. Calculate mole fraction
 - c. Calculate ppm
 - d. Convert between mass percent and molality or molarity
 - 3. Colligative properties
 - a. Calculate vapor pressure when solute is nonvolatile
 - b. Calculate vapor pressure when solute is volatile
 - c. Calculate boiling point elevation by nonelectrolytes
 - d. Calculate boiling point elevation by electrolytes
 - e. Calculate freezing point depression by nonelectrolytes
 - f. Calculate freezing point depression by electrolytes
- IV. Equilibrium
 - 1. What are chemical equilibria
 - a. Explain that reactions reach chemical equilibrium when forward reaction rate equals reverse reaction rate.
 - b. Explain why the concentration of each reactant/product stops changing when reactions reach chemical equilibrium.
 - c. Explain why a reaction can reach equilibrium from either the forward or reverse direction.
 - 2. The nature of equilibrium constant
 - a. Explain why equilibrium constant is affected by temperature, but not by concentrations.
 - b. Relate equilibrium constant to the standard free energy change of the reaction.
 - 3. The form of equilibrium constant
 - a. Write the expression of K for homogeneous equilibria

- b. Relate K_p to K_c for gaseous equilibria
 - c. Write the expression of K for heterogeneous equilibria
 - d. Manipulate K according to how equations are manipulated
 - 4. Equilibrium calculations
 - a. Calculate K or Q according to their mass action expressions.
 - b. Calculate K by ICE approach
 - c. Calculate equilibrium concentrations by ICE approach
 - 5. Direction of spontaneity
 - a. Determine the direction of spontaneity by comparing Q with K
 - 6. Le Chatelier's principle
 - a. Identify the changes that can stress a system out of equilibrium
 - b. Predict how a system restore equilibrium when Q changes
 - c. Predict how a system restore equilibrium when K changes
- V. Solubility equilibria
 - 1. Solubility
 - a. Write the expression of K_{sp}
 - b. Convert between K_{sp} and solubility
 - c. Calculate solubility under common ion effect
 - 2. Precipitation
 - a. Determine if precipitation occurs by comparing Q with K_{sp}
- VI. Acid-base equilibria
 - 1. pH and pOH
 - a. Concert between hydronium ion concentration and hydroxide ion concentration
 - b. Concert between ion concentration and pH/pOH
 - c. Convert between pH and pOH
 - d. Calculate pH of strong diprotic base solution
 - 2. Bronsted-Lowry theory and Lewis theories
 - a. Identify Bronsted-Lowry acids
 - b. Identify Bronsted-Lowry bases
 - c. Identify conjugate pairs
 - d. Identify amphoteric species
 - e. Identify Lewis acids and bases
 - 3. Hydrolysis of salts
 - a. Identify neutral salts
 - b. Identify acidic salts
 - c. Identify basic salts
 - 4. Relative strength of acids
 - a. Compare the strength of acids or bases according to the values of K_a or K_b
 - b. K_a of an acid = K_w / K_b of its conjugate base
 - c. Compare the strength of binary acids
 - d. Compare the strength of ternary acids
 - 5. Ionization calculations
 - a. Compare the acidity of solutions according to K_a
 - b. Calculate pH of a weak acid/base solution

- c. Calculate percent ionization
- 6. Polyprotic acids
 - a. Simplify calculation of the pH of a polyprotic acid solution based on the stepwise ionization mechanism.
 - b. Simplify calculation of the concentration of conjugate bases of a polyprotic acid due to its stepwise ionization.
- 7. Buffers
 - a. Identify buffers.
 - b. Calculate pH of buffers.
 - c. Compare buffer capacities.
- 8. Titrations
 - a. Find equivalence point.
 - b. Calculate pH before equivalence point of strong-strong titrations.
 - c. Identify titration curves.
- VII. Electrochemistry
 - 1. Redox chemistry
 - a. Identify what is reduced/oxidized
 - b. Identify what is reducing/oxidizing agent
 - 2. Balance redox reactions according to half-reaction method
 - a. Balance aqueous redox reactions under acidic conditions
 - b. Balance aqueous redox reactions under basic conditions
 - 3. Galvanic cells
 - a. Describe the function of anodes
 - b. Describe the function of cathodes
 - c. Describe the function of salt bridges
 - d. Describe the function of outer circuit
 - 4. Cell notations
 - a. Given cell notation, identify what's reduced/oxidized
 - b. Given a redox reaction equation, write the cell notation
 - 5. Standard cell potential and standard electrode potential
 - a. Calculate standard cell potential according to standard electrode potential
 - b. Predict spontaneity under standard conditions according to standard cell potential
 - c. Compare strength of reducing/oxidizing agent according to standard electrode potential
 - d. Choose a metal for cathodic protection
 - 6. Cell potential and redox spontaneity
 - a. Relate the sign of standard cell potential to the range of K or the sign of standard free energy change of the reaction
 - b. Calculate standard free energy change of reactions according to standard cell potentials
 - c. Calculate K according to standard cell potential
 - d. Relate the sign of cell potential to the sign of free energy change of the reaction or redox spontaneity
 - e. Apply Nernst equation to calculate cell potential

VIII. Kinetics

1. What is reaction rate
 - a. Calculate average reaction rate
 - b. Convert between expressions of reaction rate with different substances according to reaction stoichiometry
2. Rate law
 - a. Determine rate law
 - b. Derive units of rate constant according to overall reaction orders
 - c. Calculate how reaction rate changes when concentrations change
3. Integrated rate law
 - a. Calculate according to Zero-order integrated rate law
 - b. Calculate according to first-order integrated rate law
 - c. Calculate according to second-order integrated rate law
4. Collision theory
 - a. Relate activation energy to reaction rate
 - b. Relate activation energy to enthalpy change of the reaction
 - c. Use collision theory to explain why temperature affects reaction rates
 - d. Use collision theory to explain why concentrations affects reaction rates
5. Reaction mechanisms
 - a. Identify the number of elementary steps, the number of intermediates, the number of transition states, the rate-limiting step, and whether the reaction is exothermic or endothermic according reaction profile.
 - b. Given a reaction mechanism, derive overall reaction equation
 - c. Given a reaction mechanism, identify reaction intermediates
 - d. Given a reaction mechanism, determine rate law
6. Catalysis
 - a. Explain how catalysis works
 - b. Given a reaction mechanism, identify catalysts

IX. Nuclear chemistry

1. Nuclear structure and stability
 - a. Describe nuclear structure
 - b. Describe band of stability
2. Nuclear reactions
 - a. Compare nuclear reactions with chemical reactions
 - b. Balance nuclear reactions
3. Nuclear decay
 - a. Balance nuclear decay equations
 - b. Apply first order kinetics of nuclear decay to do radiometric dating

Textbook

[Chemistry: Atoms First](#) The textbook is available in [web view](#) and [PDF](#) for free. The web view is recommended when you are online, because the embedded hyperlinks work seamlessly on any device. The PDF is for you to browse when you are offline.

Course material on Canvas

All course materials are posted on Canvas in Chem 1420.400. You do NOT need to purchase textbooks or homework programs for this course.

Resources

Graduate TA office hours

Please refer to the schedule posted on Canvas in the top module "Learning Support" in Chem 1420.400.

Chemistry Resource Center

This is free tutoring provided by graduate students in chemistry department and located in chemistry building (CHEM 231). Please check out the schedule and more details at

<https://chemistry.unt.edu/undergraduate-program/instructional-resources>

How to study for this online course

All course contents are distributed into 26 lectures. In each Canvas page titled "Lecture XX", a PDF of the lecture notes, a homework quiz, a pre-recorded lecture and the link to the corresponding section in the free e-textbook are embedded. After every two lectures, a recitation quiz is posted to review the important topics covered in the previous two lectures. I recommend you follow the link to read the sections in the e-text before watching the pre-recorded lecture. Print out the lecture notes to make it easier for you to take notes while watching the pre-recorded lectures. Take the homework quiz after you watch the pre-recorded lecture to gauge your understanding. Review the material by taking the recitation quizzes whenever they are provided. When you have questions, please reach out for assistance by attending my office hours, the graduate TAs' office hours or [CRC \(tutoring service provided by graduate students\)](#) in chemistry department at CHEM 231.

PLEASE PACE YOURSELF ACCORDING TO THE DUE DATES OF 26 HOMEWORK QUIZZES TO GO THROUGH THE COURSE MATERIAL.

The practice exams contain the same number of questions on the same topics and the same difficulty levels as the questions in real exams. You are supposed to use the practice exams as a study guide to prepare for exams. After you work through the practice exams, make sure you can correct your mistakes. You can do so by re-watching the corresponding recorded lectures, going to office hours or CRC tutoring center. You have three attempts on each practice exam. Each attempt has a 60-minute time limit, the same as real exams. To study for the final exam, you need to review all four practice exams. The practice exams are not for credit.

Late Policy and Make-up Exams

This is an online course with no in-person meetings. Given the extremely tight schedule in a 5-week semester, it is crucial that you keep up with the vigorous pace of the course. I set the due dates of all assignments for you gauge if you are on schedule. If you submit a homework quiz or a recitation quiz after the due date, there is no late penalty, because again the due dates are used as a reminder for you to stay on schedule for this course. No quizzes would be available after 11:59 PM on 7/23/2026.

Missing exams because you forgot about it, remembered the wrong date, overslept, were too tired or too busy to take it, **cannot** be excused.

Excusable absence includes [recognized religious holy days](#), participation in official university functions such as student athlete events, pregnancy and parenting, required military service, and medical or other emergency.

Make-up exams are only granted if it is an **excusable absence** as described above and with **written proof**. You do not need to request extensions on submitting any assignments because there is no late penalty when you submit an assignment after the due date.

Course Calendar

In the following table, the assignments due on the corresponding day are shown. H stands for homework quizzes. R stands for recitation quizzes. E stands for lecture exams. P stands for practice exams.

	Mon.	Tue.	Wed.	Thur.	Fri.	Sat.
Week 1	H1, H2	H3, R1	H4, R2	H5, H6	H7, R3	R4
Week 2	P1, E1	H8, H9, R5	H10, R6	H11, H12	R7	July 4th
Week 3	H13, R8	P2, E2	H14, H15	H16, R9	H17	R10
Week 4	H18	H19, R11	P3, E3	H20, H21	H22, R12	R13
Week 5	H23, H24	H25, R14	H26, R15	P4, E4	Final	

Course Grade Breakdown

Assignment Groups	Group Weight
Lecture Exams (drop the lowest)	45%
Final Exam	25%
Homework	20%
Recitation Quizzes	10%
Total	100%

Lecture Exams

Lecture exams weigh up to 45% of your overall grade. The lowest out of the four lecture exams will be dropped.

Exams	Scope	Date	Location	# of questions	Time allowed
Exam 1	Lecture 1-7	Week 2 Mon.	Online	20	60 mins
Exam 2	Lecture 8-13	Week 3 Tue.	Online	20	60 mins
Exam 3	Lecture 14-19	Week 4 Wed.	Online	20	60 mins
Exam 4	Lecture 20-26	Week 5 Thur.	Online	20	60 mins
Final Exam	Lecture 1-26	Week 5 Fri.	Online	70	120 mins

Final Exam

The final exam is cumulative. The final exam CANNOT be dropped. Final exam weighs up to 25% of your overall grade.

Homework quizzes

One homework quiz is provided for each of the 26 lectures. Three attempts are given and there is no time limit on any attempt. Each homework quiz is due at the end of day in which the corresponding lectures are supposed to be studied. Homework weighs up to 20% of your overall grade.

Some homework quizzes contain different questions in each attempt, while others contain the same questions in each attempt. If a homework quiz contains the **same** questions in each attempt. The key is revealed after the last attempt. If a homework quiz contains **different** questions in each attempt. The key is revealed after each attempt.

Recitation Quizzes

Each recitation quiz reviews materials covered in the previous two lectures. Recitation quizzes are up to 10% of your overall grade.

You have three attempts at each quiz. The key will only be shown after the last attempt. When you see the key, an explanation of the key is provided for some of the questions.

Grading

- A = 90% - 100%
- B = 80% - 89%
- C = 70% - 79%
- D = 60% - 69%
- F = 0% - 59%

I include two decimal places in the percentage number when I assign letter grades and look for a natural break when I decide on the cut-off value. In the following series of numbers - 90.00, 89.99, 89.89, 89.79, 89.49, 89.39, 89.29 - the natural break is at 89.79/89.49. Hence, in this example 89.79 and above gets an A. **Note that these numbers are just given as an example. It does NOT mean that the cut off value between A and B for this semester is 89.79.** To be fair to everyone, I won't reply to email requests to bump up grades.

Incomplete Grades

Between 7/17 and 7/25, you can request for an incomplete grade only if you meet all three criteria:

1. You are passing the course at the time point when you request for an incomplete grade.
2. You have a justifiable and documented reason beyond your own control (such as serious illness or military service) for not completing the work on schedule.
3. You have a specific date within a year by which you propose to finish the course work.

UNT policies

Academic Integrity Policy

Academic Integrity Standards and Consequences. According to UNT Policy 06.003, Student Academic Integrity, academic dishonesty occurs when students engage in behaviors including, but not limited to cheating, fabrication, facilitating academic dishonesty, forgery, plagiarism, and sabotage. A finding of academic dishonesty may result in a range of academic penalties or sanctions ranging from admonition to expulsion from the University.

ADA Policy

UNT makes reasonable academic accommodation for students with disabilities. Students seeking accommodation must first register with the Office of Disability Accommodation (ODA) to verify their eligibility. If a disability is verified, the ODA will provide a student with an accommodation letter to be delivered to faculty to begin a private discussion regarding one's specific course needs. Students may request accommodations at any time, however, ODA notices of accommodation should be provided as early as possible in the semester to avoid any delay in implementation. Note that students must obtain a new letter of accommodation for every semester and must meet with each faculty member prior to implementation in each class. For additional information see the [ODA website](#).

Prohibition of Discrimination, Harassment, and Retaliation (Policy 16.004)

The University of North Texas (UNT) prohibits discrimination and harassment because of race, color, national origin, religion, sex, sexual orientation, gender identity, gender expression, age, disability, genetic information, veteran status, or any other characteristic protected under applicable federal or state law in its application and admission processes; educational programs and activities; employment policies, procedures, and processes; and university facilities. The University takes active measures to prevent such conduct and investigates and takes remedial action when appropriate.

Emergency Notification & Procedures

UNT uses a system called Eagle Alert to quickly notify students with critical information in the event of an emergency (i.e., severe weather, campus closing, and health and public safety emergencies like chemical spills, fires, or violence). In the event of a university closure, please refer to Canvas for contingency plans for covering course materials.

Retention of Student Records

Student records pertaining to this course are maintained in a secure location by the instructor of record. All records such as exams, answer sheets (with keys), and written papers submitted during the duration of the course are kept for at least one calendar year after course completion. Course work completed via the Canvas online system, including grading information and comments, is also stored in a safe electronic environment for one year. Students have the right to view their individual record; however, information about student's records will not be divulged to other individuals without proper written consent. Students are encouraged to review the Public Information Policy and the Family Educational Rights and Privacy Act (FERPA) laws and the University's policy. See UNT Policy 10.10, Records Management and Retention for additional information.

Acceptable Student Behavior

Student behavior that interferes with an instructor's ability to conduct a class or other students' opportunity to learn is unacceptable and disruptive and will not be tolerated in any instructional forum at UNT. Students engaging in unacceptable behavior will be directed to leave the classroom and the instructor may refer the student to the Dean of Students to consider whether the student's conduct violated the Code of Student Conduct. The University's expectations for student conduct apply to all instructional forums, including University and electronic classroom, labs, discussion groups, field trips, etc. Visit UNT's [Code of Student Conduct](https://deanofstudents.unt.edu/conduct) (<https://deanofstudents.unt.edu/conduct>) to learn more.

Access to Information - Eagle Connect

Students' access point for business and academic services at UNT is located at: my.unt.edu. All official communication from the University will be delivered to a student's Eagle Connect account. For more information, please visit the website that explains Eagle Connect and how to forward e-mail [Eagle Connect](https://it.unt.edu/eagleconnect) (<https://it.unt.edu/eagleconnect>).

Student Evaluation Administration Dates

Student feedback is important and an essential part of participation in this course. The student evaluation of instruction is a requirement for all organized classes at UNT. Students will receive an email from "UNT SPOT Course Evaluations via IASystem Notification" (no-reply@iasystem.org) with the survey link. Students should look for the email in their UNT email inbox. Simply click on the link and complete the survey. Once students complete the survey they will receive a confirmation email that the survey has been submitted. For additional information, please visit the [SPOT website](http://spot.unt.edu/) (<http://spot.unt.edu/>) or email spot@unt.edu.

Survivor Advocacy

UNT is committed to providing a safe learning environment free of all forms of sexual misconduct. Federal laws and UNT policies prohibit discrimination on the basis of sex as well as sexual misconduct. If you or someone you know is experiencing sexual harassment, relationship violence, stalking and/or sexual assault, there are campus resources available to provide support and assistance. The Survivor Advocates can be reached at SurvivorAdvocate@unt.edu or by calling the Dean of Students Office at 940-5652648.

Important Notice for F-1 Students taking Distance Education Courses

Federal Regulation

To read detailed Immigration and Customs Enforcement regulations for F-1 students taking online courses, please go to the [Electronic Code of Federal Regulations website](http://www.ecfr.gov/) (<http://www.ecfr.gov/>). The specific portion concerning distance education courses is located at Title 8 CFR 214.2 Paragraph (f)(6)(i)(G).

The paragraph reads:

(G) For F-1 students enrolled in classes for credit or classroom hours, no more than the equivalent of one class or three credits per session, term, semester, trimester, or quarter may be counted toward the full course of study requirement if the class is taken on-line or through distance education and does not

require the student's physical attendance for classes, examination or other purposes integral to completion of the class. An on-line or distance education course is a course that is offered principally through the use of television, audio, or computer transmission including open broadcast, closed circuit, cable, microwave, or satellite, audio conferencing, or computer conferencing. If the F-1 student's course of study is in a language study program, no on-line or distance education classes may be considered to count toward a student's full course of study requirement.

University of North Texas Compliance

To comply with immigration regulations, an F-1 visa holder within the United States may need to engage in an on-campus experiential component for this course. This component (which must be approved in advance by the instructor) can include activities such as taking an on-campus exam, participating in an on-campus lecture or lab activity, or other on-campus experience integral to the completion of this course.

If such an on-campus activity is required, it is the student's responsibility to do the following:

- (1) Submit a written request to the instructor for an on-campus experiential component within one week of the start of the course.
- (2) Ensure that the activity on campus takes place and the instructor documents it in writing with a notice sent to the International Student and Scholar Services Office. ISSS has a form available that you may use for this purpose.

Because the decision may have serious immigration consequences, if an F-1 student is unsure about his or her need to participate in an on-campus experiential component for this course, s/he should contact the UNT International Student and Scholar Services Office (telephone 940-565-2195 or email internationaladvising@unt.edu) to get clarification before the one-week deadline.

Student Verification

UNT takes measures to protect the integrity of educational credentials awarded to students enrolled in distance education courses by verifying student identity, protecting student privacy, and notifying students of any special meeting times/locations or additional charges associated with student identity verification in distance education courses.

See [UNT Policy 07-002 Student Identity Verification, Privacy, and Notification and Distance Education Courses](https://policy.unt.edu/policy/07-002) (<https://policy.unt.edu/policy/07-002>).

Use of Student Work

A student owns the copyright for all work (e.g. software, photographs, reports, presentations, and email postings) he or she creates within a class and the University is not entitled to use any student work without the student's permission unless all of the following criteria are met:

The work is used only once.

The work is not used in its entirety.

Use of the work does not affect any potential profits from the work.

The student is not identified.

The work is identified as student work.

If the use of the work does not meet all of the above criteria, then the University office or department using the work must obtain the student's written permission.

Download the UNT System Permission, Waiver and Release Form

Transmission and Recording of Student Images in Electronically-Delivered Courses

No permission is needed from a student for his or her image or voice to be transmitted live via videoconference or streaming media, but all students should be informed when courses are to be conducted using either method of delivery.

In the event an instructor records student presentations, he or she must obtain permission from the student using a signed release in order to use the recording for future classes in accordance with the Use of Student-Created Work guidelines above.

Instructors who video-record their class lectures with the intention of re-using some or all of recordings for future class offerings must notify students on the course syllabus if students' images may appear on video. Instructors are also advised to provide accommodation for students who do not wish to appear in class recordings.

Example: This course employs lecture capture technology to record class sessions. Students may occasionally appear on video. The lecture recordings will be available to you for study purposes and may also be reused in future course offerings.

No notification is needed if only audio and slide capture is used or if the video only records the instructor's image. However, the instructor is encouraged to let students know the recordings will be available to them for study purposes.

Pre-recorded lectures

Pre-recorded lectures are the intellectual property of the university or instructor and are reserved for use only by students in this class and only for educational purposes. Students may not post or otherwise share the recordings outside the class, or outside the Canvas Learning Management System, in any form. Failing to follow this restriction is a violation of the UNT Code of Student Conduct and could lead to disciplinary action.