2020

Physical Chemistry I

North Carolina Agricultural and Technical State University

NORTH CAROLINA AGRICULTURAL AND TECHNICAL STATE UNIVERSITY

COURSE SYLLABUS

College Name: College of Science and Technology

Department Name: Chemistry

Course Name: Physical Chemistry I

COURSE INFORMATION

- Course Number/Section: CHEM 441
- Term:
- Semester Credit Hours: 3
- Times and Days:
- Class Location:

INSTRUCTOR CONTACT INFORMATION

- Instructor:
- Office Location:
- Office Phone:
- Email Address:

Faculty must notify students of the approximate time and method they can expect to receive an answer to all communications (e.g., email, phone, course messages). Excluding holidays, the response should be provided within 48 hours.

If there's a graduate teaching assistant assigned to work with this course, please include their names also.

STUDENT HOURS

These are times students may visit the professor without an appointment to request the assistance they need.

NOTE: Students are responsible for reading, understanding, and following the syllabus.

: AM ☐ / PM ☐ – : AM ☐ / PM ☐

Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐

COURSE PREREQUISITES

MATH 231, PHYS 241, and CHEM 231.

COURSE DESCRIPTION

This course is a study of the fundamental laws governing matter in the gaseous states, the laws of thermodynamics, Kinetics/Equilibrium and their application to chemistry.

STUDENT LEARNING OBJECTIVES/OUTCOMES (SLO)

Learning outcomes should be specific, measurable, and focused on the content knowledge the students are expected to master and not what the faculty will teach.

If the course is a General Education Course, the SLO should be listed and labeled as "General Education."

SLO 1: Work with the gas laws for ideal and real gases.
SLO 2: Apply all concepts of thermodynamics such as heat processes in calorimeters, enthalpy, entropy and free-energy changes in the chemical reactions.
SLO 3: Summarize all concepts related to Gibbs free energy and chemical potential and know how to apply these concepts on chemical reactions.
SLO 4: Narrate the properties of simple mixtures in terms of partial molar quantities, the thermodynamics of mixing, the chemical potentials of liquids, liquid mixtures, colligative properties, the solvent activity, the solute activity.
SLO 5: Apply Chemical kinetics, reaction rates and dynamic equilibrium of chemical processes by applying thermodynamic principles.

REQUIRED TEXTBOOKS AND MATERIALS

Any course-level subscriptions and tools linked in Blackboard Learn learning management system (LMS) should be listed here. The Blackboard LMS must have links to their student data privacy statement.

REQUIRED TEXTS:

Atkins, P. W., Paula, J. D., & Keeler, J. (2018). *Atkins' Physical chemistry: thermodynamics and kinetics*. Oxford University Press.

REQUIRED MATERIALS:

SUGGESTED COURSE MATERIALS

SUGGESTED READINGS/TEXTS:

Bolgar, P., Lloyd, H., North, A., Oleinikovas, V., Smith, S., Keeler, J., … Giunta, C. (2018). *Student solutions manual to accompany Atkins' physical chemistry*. Oxford University Press.

SUGGESTED MATERIALS:

GRADING POLICY

ASSIGNMENTS AND GRADING POLICY

94% and above	A		76% - 74%	C
93% - 90%	A-		73% - 70%	C-
89% - 87%	B+		69% - 67%	D+
86% - 84%	B		66% - 64%	D
83% - 80%	B-		63% - 0%	F
79% - 77%	C+			

For GRADUATE COURSES: See 2019-2020 Graduate Catalog p.38 for graduate grading scale and Non-Graded Courses

GRADING ALLOCATION

Course grades are based on a weighted grading scale of 100%. The breakdown for the course is as follows: *[Faculty, please adjust according to your course.]*

Category	# of Activities	Percentage Grade Weight
Self-Introduction	1	0%
Homework	15	0%
Quizzes	15	30%
Exams	4	50%
Final Exam	1	20%
Total		**100%**

COURSE POLICIES

USE OF BLACKBOARD AS THE LEARNING MANAGEMENT SYSTEM

Blackboard is the primary online instructional and course communications platform. Students can access the course syllabus, assignments, grades, and learner support resources. Students are encouraged to protect their login credentials, complete a Blackboard orientation, and log in daily to the course.

Note: Uploading assignments through Blackboard presents a challenge for Chromebook users in locating the files for submission. If you use a Chromebook, please be sure you also have access to a Mac computer or Windows computer so you can fully participate in your Blackboard class. For more information about student computer recommendations, please visit https://hub.ncat.edu/administration/its/computer-recommendations.php.

MAKE-UP EXAMS

See << Update Academic Year >>*Undergraduate Bulletin:*

https://www.ncat.edu/provost/academic-affairs/bulletins/index.php

For GRADUATE STUDENTS: See 2019-20 Graduate Catalog p. 54

EXTRA CREDIT

LATE WORK

SPECIAL ASSIGNMENTS

For GRADUATE STUDENTS: FAILING TO MEET COURSE REQUIREMENTS (Graduate Catalog p.40)

For GRADUATE STUDENTS: CLASS ATTENDANCE (see 2019-20 Graduate Catalog p. 53-54)

Students are expected to attend class and participate on a regular basis in order to successfully achieve course learning outcomes and meet federal financial aid requirements (34 CFR 668.22). Class attendance in online courses is defined as active participation in academically-related course activities. Active participation may consist of course interactions with the content, classmates, and/or the instructor. Examples of academically-related course activities include, but are not limited to:

- Completing and submitting assignments, quizzes, exams, and other activities within Blackboard or through Blackboard (3rd-party products).
- Participating in course-related synchronous online chats, discussions, or meeting platforms such as Blackboard Collaborate in which participation is tracked.

CLASSROOM CITIZENSHIP

Courtesy, civility, and respect must be the hallmark of your interactions.

COMPLIANCE WITH THE AMERICANS WITH DISABILITIES ACT

North Carolina A&T State University is committed to following the requirements of the Americans with Disabilities Act Amendments Act (ADAAA) and Section 504 of the Rehabilitation Act.
If you need an academic accommodation based on the impact of a disability, you must initiate the request with the Office of Accessibility Resources (OARS) and provide documentation in accordance with the Documentation Guidelines at N.C. A&T. Once documentation is received, it will be reviewed. Once approved, you must attend a comprehensive meeting to receive appropriate and reasonable accommodations. If you are a student registered with OARS, you must complete the Accommodation Request Form to have accommodations sent to faculty.

OARS is located in Murphy Hall, Suite 01 and can be reached at 336-334-7765, or by email at accessibilityresources@ncat.edu. Additional information and forms can be found on the internet at https://www.ncat.edu/provost/academic-affairs/accessibility-resources/index.php.

Please note: Accommodations are not retroactive and begin once the Disability Verification Form is provided to faculty.

TITLE IX

North Carolina A&T State University is committed to providing a safe learning environment for all students—free of all forms of discrimination and harassment. Sexual misconduct and relationship violence in any form are inconsistent with the university's mission and core values, violates university policies, and may also violate federal and state law. Faculty members are considered "Responsible Employees" and are required to report incidents of sexual misconduct and relationship violence to the Title IX Coordinator. If you or someone you know has been impacted by sexual harassment, sexual assault, dating or domestic violence, or stalking, please visit the Title IX website to access information about university support and resources. If you would like to speak with someone confidentially, please contact Counseling Services at 336-334-7727 or the Student Health Center at 336-334-7880.

TECHNICAL SUPPORT

If you experience any problems with your A&T account, you may call Client Technology Services (formerly Aggie Tech Support and Help Desk) at 336-334-7195, or visit https://hub.ncat.edu/administration/its/dept/ats/index.php.

FIELD TRIP POLICIES / OFF-CAMPUS INSTRUCTION AND COURSE ACTIVITIES

If applicable:

Off-campus, out-of-state, foreign instruction, and activities are subject to state law and university policies and procedures regarding travel and risk-related activities. Information regarding these rules and regulations may be found at https://www.ncat.edu/campus-life/student-affairs/index.php.

STUDENT HANDBOOK

https://www.ncat.edu/campus-life/student-affairs/departments/dean-of-students/student-handbook.php

STUDENT TRAVEL PROCEDURES AND STUDENT TRAVEL ACTIVITY WAIVER

https://hub.ncat.edu/administration/student-affairs/staff-resources/studen_activity_travel_waiver.pdf

OTHER POLICIES *(e.g., Copyright Guidelines, Confidentiality, etc.)*

STUDENT HANDBOOK

https://www.ncat.edu/campus-life/student-affairs/departments/dean-of-students/student-handbook.php

Graduate Catalog

SEXUAL MISCONDUCT POLICY

https://www.ncat.edu/legal/title-ix/sexual-harassment-and-misconduct-policies/index.php

FAMILY EDUCATIONAL RIGHTS AND PRIVACY ACT (FERPA)

https://www.ncat.edu/registrar/ferpa.php

STUDENT COMPLAINT PROCEDURES

https://www.ncat.edu/current-students/student-complaint-form.php

STUDENT CONDUCT AND DISCIPLINE

North Carolina A&T State University has rules and regulations that govern student conduct and discipline meant to ensure the orderly and efficient conduct of the educational enterprise. It is the responsibility of each student to be knowledgeable about these rules and regulations.

Please consult the following about specific policies such as academic dishonesty, cell phones, change of grade, disability services, disruptive behavior, general class attendance, grade appeal, incomplete grades, make-up work, student grievance procedures, withdrawal, etc.:

- Undergraduate Bulletin
  https://www.ncat.edu/provost/academic-affairs/bulletins/index.php
- Graduate Catalog
  https://www.ncat.edu/tgc/graduate-catalog/index.php
- Student Handbook
  https://www.ncat.edu/campus-life/student-affairs/departments/dean-of-students/student-handbook.php

ACADEMIC DISHONESTY POLICY

Academic dishonesty includes but is not limited to the following:

1. Cheating or knowingly assisting another student in committing an act of cheating or other academic dishonesty;
2. Plagiarism (unauthorized use of another's words or ideas as one's own), which includes but is not limited to submitting exams, theses, reports, drawings, laboratory notes or other materials as one's own work when such work has been prepared by or copied from another person;
3. Unauthorized possession of exams or reserved library materials; destroying or hiding source, library or laboratory materials or experiments or any other similar actions;
4. Unauthorized changing of grades, or marking on an exam or in an instructor's grade book or such change of any grade record;
5. Aiding or abetting in the infraction of any of the provisions anticipated under the general standards of student conduct;
6. Hacking into a computer and gaining access to a test or answer key prior to the test being given. N.C. A&T reserves the right to search the emails and computers of any student suspected of such computer hacking (if a police report of the suspected hacking was submitted prior to the search); and
7. Assisting another student in violating any of the above rules.

A student who has committed an act of academic dishonesty has failed to meet a basic requirement of satisfactory academic performance. Thus, academic dishonesty is not only a basis for disciplinary action, but may also affect the evaluation of a student's level of performance. Any student who commits an act of academic dishonesty is subject to disciplinary action.

In instances where a student has clearly been identified as having committed an act of academic dishonesty, an instructor may take appropriate disciplinary action, including loss of credit for an assignment, exam, or project; or awarding a grade of "F" for the course, **subject to review and endorsement by the chairperson and dean**.

For GRADUATE STUDENTS: Reference for academic dishonesty – 2010-2020 Graduate Catalog, p.58-59

For GRADUATE STUDENTS: STUDENT RELIGIOUS OBSERVANCE (see Graduate Catalog, p.55)

ASSIGNMENTS AND ACADEMIC CALENDAR

Include topics, reading assignments, due dates, exam dates, withdrawal dates, pre-registration and registration dates, all holidays, and convocations.*

THE WEEK OF MM/DD/YY	SUBJECT	UNIT LEARNING OUTCOMES (ULO)	READING IN TEXT, ACTIVITY, HOMEWORK, EXAM
	Unit 1: Ideal and Real Gases	ULO 1: Explain the basic laws governing ideal gases. (SLO 1) ULO 2: Solve problems related to pressure, volume, density, and temperature changes in ideal and real gases. (SLO 1)	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 1: Gases 2. **Complete:** Homework #1 (ULO 1 – 2) 3. **Complete:** Quiz #1 (ULO 1 – 2)
	Unit 2: First Law of Thermodynamics	ULO 1: Interpret the relationship between work and heat of thermodynamic systems and formulate the first law of thermodynamics. (SLO 2) ULO 2: Calculate the work and heat flow in reversible and irreversible processes. (SLO 2) ULO 3: Explain the measure of enthalpy and internal energy using calorimetric methods. (SLO 2)	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 2: The First Law 2. **Complete:** Homework #2 (ULO 1 – 3) 3. **Complete:** Quiz #2 (ULO 1 – 3)
	Unit 3: Heat Capacities and Equiparition Principle	ULO 1: Interpret the relationship between the heat capacities at constant pressure and constant volume for ideal gases. (SLO 2)	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 2: The First Law

		ULO 2: Calculate the enthalpy and internal energies using the concept of heat capacities. (SLO 2) ULO 3: Solve problems related to the calculation of heat capacities using the equipartition principle. (SLO 2)	2. **Complete:** Homework #3 (ULO 1 – 3) 3. **Complete:** Quiz #3 (ULO 1 – 3)
	Unit 4: Review of Gas Laws and the First Law of Thermodynamics	ULO 1: Develop a comprehensive understanding of the modules 1-6 that are covered in Units 01,02 and 03. (SLO 1, 2) ULO 2: Interpret and apply right conceptual framework with correct formulas to solve the problems both quantitatively and qualitatively. (SLO 1, 2) ULO 3: Study for Exam-01, which covers modules 1-6. (SLO 1, 2)	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 1: Gases b. Chapter 2: The First Law 2. **Complete:** Homework #4 (ULO 1 – 2) 3. **Complete:** Quiz #4 (ULO 1 – 2) 4. **Complete:** Exam #1 (ULOs from units 1 – 4)
	Unit 5: Adiabatic Processes, Enthalpy Calculations and Thermodynamic Constants	ULO 1: Explain the constant heat thermodynamic processes. (SLO 2) ULO 2: Develop mathematical skills to calculate various thermodynamic quantities under constant volume and constant pressure conditions. (SLO 2) ULO 3: Interpret correctly and apply right conceptual framework to solve the problems on energy changes in thermochemical reactions. (SLO 2)	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 2: The First Law 2. **Complete:** Homework #5 (ULO 1 – 5) 3. **Complete:** Quiz #5 (ULO 1 – 5)

		ULO 4: Apply mathematical principles to derive the thermodynamic quantities and inter-relation among these parameters. (SLO 2) ULO 5: Solve problems related to the energy calculations in chemical reactions. (SLO 2)	
	Unit 6: Entropy and the Second Law of Thermodynamics	ULO 1: Explain the principles behind cooling and heating processes of gases using Joule-Thompson experiments. (SLO 3) ULO 2: Explain the concepts of thermal disorder, entropy, and the interpretation of the second law of thermodynamics. (SLO 3) ULO 3: Analyze and calculate the entropy changes in reversible and irreversible processes under several experimental conditions. (SLO 3)	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 3: The Second and Third Laws 2. **Complete:** Homework #6 (ULO 1 – 3) 3. **Complete:** Quiz #6 (ULO 1 – 3)
	Unit 7: Entropy and Phase Transitions	ULO 1: Describe the entropy changes in the phase-transitions among the three phases (from module-13). (SLO 3) ULO 2: Develop a comprehensive understanding of the topics covered in the modules 7 through 13 by reviewing all concepts. (SLO 3) ULO 3: Interpret correctly and apply right conceptual	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 1: The First Law b. Chapter 3: The Second and Third Laws 2. **Complete:** Homework #7 (ULO 1 – 4) 3. **Complete:** Quiz #7 (ULO 1 – 4) 4. Complete: Exam #2 (ULO 1 – 4)

		framework with correct formulas to solve the problems both quantitatively and qualitatively. (SLO 3) ULO 4: Get prepared to take Exam-02 that covers modules 7-13. (SLO 3)	
	Unit 8: Third Law Entropy, Free-Energy, and Clausius Inequality	ULO 1: Apply the first law and second of thermodynamics to derive Clausius inequality expression. (SLO 3) ULO 2: Under the conditions that lead to the definition of free-energy and Helmholtz energy. (SLO 3) ULO 3: Analyze and calculate the free-energy changes in reversible and irreversible processes under several experimental conditions. (SLO 3)	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 3: The Second and Third Laws 2. **Complete:** Homework #8 (ULO 1 – 3) 3. **Complete:** Quiz #8 (ULO 1 – 3)
	Unit 9: Free-Energy and Entropy Changes in the Phase-Diagrams	ULO 1: Explain Gibbs free-energy change at constant pressure and volume conditions. (SLO 3) ULO 2: Solve free-energy changes in chemical processes at various conditions. (SLO 3) ULO 3: Analyze the measurement of free energy for real gases using fugacity. (SLO 3) ULO 4: Describe the relationship among the solid, liquid, and gas phases using P-T plots. (SLO 3)	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 4: Simple Mixtures 2. **Complete:** Homework #9 (ULO 1 – 5) 3. **Complete:** Quiz #9 (ULO 1 – 5)

		ULO 5: Interpret phase-diagrams of common substances such as water and carbon dioxide. (SLO 3)	
	Unit 10: Chemical Potential in Multi-Component Systems	ULO 1: Analyze the difference between free-energy and chemical potential for multi-component systems. (SLO 3) ULO 2: Develop skills to interpret phase-diagrams to derive Clapeyron and Clausius-Clapeyron equations. (SLO 3) ULO 3: Compute enthalpy, entropy, vapor pressure, and freezing/boiling points for physical processes of phase-transitions. (SLO 3) ULO 4: Describe the concept of partial molar volumes in multi-component liquid systems. (SLO 3) ULO 5: Calculate partial molar volumes of simple mixtures. (SLO 3)	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 4: Simple Mixtures 2. **Complete:** Homework #10 (ULO 1 – 5) 3. **Complete:** Quiz #10 (ULO 1 – 5) 4. **Complete:** Exam #3 (ULOs 1 – 3 from unit 8 and 1 – 5 from unit 9)
	Unit 11: Free-Energy of Mixing in Gases and Liquids	ULO 1: Describe the concept of free-energy and enthalpy changes in gas mixtures. (SLO 3) ULO 2: Calculate free-energy of mixing in gas mixtures. (SLO 3) ULO 3: Explain the chemical potential changes in ideal liquid mixtures. (SLO 3)	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 4: Simple Mixtures 2. **Complete:** Homework #11 (ULO 1 – 5) 3. **Complete:** Quiz #11 (ULO 1 – 5)

		ULO 4: Apply the Roult's and Henry's laws for ideal and ideal-dilute solutions. (SLO 3) ULO 5: Interpret colligative properties using intermolecular forces in liquids. (SLO 3)	
	Unit 12: Colligative Properties	ULO 1: Apply the colligative principles to predict changes in boiling and freezing point changes in solutions. (SLO 4) ULO 2: Solve mathematical problems in estimate changes in boiling and freezing points. (SLO 4) ULO 3: Apply the colligative principles to estimate changes in osmotic pressure in liquid solutions. (SLO 4) ULO 4: Solve mathematical problems in computing the osmotic pressure, molar mass of solutes. (SLO 4)	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 4: Simple Mixtures 2. **Complete:** Homework #12 (ULO 1 – 5) 3. **Complete:** Quiz #12 (ULO 1 – 5) 4. **Complete:** Exam #4 (ULOs from Unit 10 and 11)
	Unit 13: Chemical Equilibrium	ULO 1: Understand the changes in free-energy and chemical potential in chemical equilibrium processes. (SLO 5) ULO 2: Calculate free-energy changes and equilibrium constants in chemical equilibrium reactions. (SLO 5) ULO 3: Interpret the influence of pressure,	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 5: Chemical Equilibrium 2. **Complete:** Homework #13 (ULO 1 – 5) 3. **Complete:** Quiz #13 (ULO 1 – 4)

		volume and temperature on shifting chemical equilibrium. (SLO 5) ULO 4: Explain the relationship among equilibrium constant, enthalpy, entropy and free-energy using Van't Hoff equation. (SLO 5) ULO 5: Solve the problems in estimating thermodynamic values using Van't Hoff equation. (SLO 5)	
	Unit 14: Free-Energy and Electrochemical Reactions	ULO 1: Explain the principles of electron-transfer in electrochemical reactions. (SLO 5) ULO 2: Write cell-diagrams and estimate cell potential for various oxidation-reduction reactions. (SLO 5) ULO 3: Explain the mathematical equations that relate cell potential, free energy, and entropy. (SLO 5) ULO 4: Calculate thermodynamic parameters in electrochemical reactions. (SLO 5)	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 5: Chemical Equilibrium 2. **Complete:** Homework #14 (ULO 1 – 4) 3. **Complete:** Quiz #14 (ULO 1 – 4)
	Unit 15: Comprehensive Review of the Course	ULO 1: Gain an overall understanding of the course content from all modules. (SLO 1 – 3) ULO 2: Apply correct approach to solve any thermodynamic problems	1. **Read Textbook:** Atkins, P. W., Paula, J. D., & Keeler, J. (2018). Atkins' Physical chemistry: thermodynamics and kinetics. Oxford University Press. a. Chapter 5: Chemical Equilibrium

		learning in the modules. (SLO 1 – 3) ULO 3: Apply right mathematical formulas to solve any quantitative problems. (SLO 1 – 3)	2. **Complete:** Homework #15 (ULO 1 – 3) 3. **Complete:** Quiz #15 (ULO 1 – 3) 4. **Complete:** Final Exam #1 (ULOs from units 1 – 15)

** These descriptions and timelines are subject to change at the discretion of the instructor.*