South Dakota School of Mines & Technology

General Chemistry, Spring 2024

Chem 112 – M01, MT
3 credits

Instructor Information

- **Dr. Zhengtao Zhu, Professor of Chemistry.**
  - **Section:** Chem 112 – MT
  - **Phone:** 605-394-2447**;**
  - **Email:** Zhengtao.Zhu@sdsmt.edu;
  - **Office:** CBEC 2206;
  - **Office Hours:** M 4:00 to 4:50 pm, WF 2:00 to 2:50 pm or by appointment.
- **Dr. Catherine Moulder, Chemistry Lecturer.**
  - **Section:** Chem 112 – M01
  - **Phone:** 605-394-6130**;**
  - **Email:** Catherine.Moulder@sdsmt.edu;
  - **Office:** CBEC 3317;
  - **Student Support Hours:** MW 2:00 to 4:00 pm & F 10:00 am to 12:00 pm or by appointment.
- Appointments can be scheduled for in person or by Zoom. Email communication is preferred, and typically you will receive email response within two business days. In your email subject line, please use the format [Chem 112 – M01 Student Name – Subject (*e.g.,* grades, HW issues, *etc.*)].

Course Information

- **Course Start/End Dates:**
  - January 8, 2024 – May 1, 2024

- **Course Meeting Times and Location:**
  - Chem 112 – M01: MWF 1:00 – 1:50 pm, CBEC 2228.
  - Chem 112 – MT1: online, asynchronous

- **Course Description**
  - An introduction to the basic principles of chemistry for students needing an extensive background in chemistry (including chemistry majors, science majors, and pre-professional students). Completion of a high school course in chemistry is recommended.
- **Course Prerequisites**
  - Math 114 College Algebra.
- **Course Delivery Method:**
  - Chem 112 – M01:
    - In-person classes with recordings will be posted on D2L.

- Chem 112 – MT1:
    - The course will be offered as an asynchronous class in D2L. The students are required to watch the lecture videos on D2L, study the lecture notes, and read the textbook to understand the course materials. The D2L course site is extensively used to post the lecture notes/videos, quizzes, homework, and other course materials.
    - **While the course is asynchronous, students are required to complete the homework assignments and quizzes by the due dates and to take the in-person exam at the scheduled dates and times.**

- **Course Learning Outcomes**

  As a result of taking courses, students will:

  1. Describe and apply foundational knowledge of chemistry concepts.
  2. Observe natural phenomena and employ chemical models to describe those phenomena; *e.g.,* molecular geometry, gas laws, *etc*.
  3. Problem solving through applied algebra.
  4. Practice critical thinking skills; *e.g.,* do things sound reasonable?
  5. Apply the scientific method to the fundamentals of chemistry.

- **Course Goals**
    - Students will obtain a foundation in the fundamental principles and models of chemistry necessary for an understanding of the composition, structure, and properties of matter and the changes that matter undergoes.
    - Chem 112 can be used in partial fulfillment of General Education Goal 6.
        - SGR Goal 6: Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world.
- **Course Topics**
    - Chemistry 112, General Chemistry I, is the first semester of a two-semester sequence that surveys the important concepts, principles, and models of chemistry.
        - Topics treated in the first semester are: measurements, atomic theory, stoichiometry, thermochemistry, states of matter, periodicity, bonding, and physical properties of solutions.

- ## Course Materials
    - **Required Textbook(s) and Materials**
        - Chemistry – Atoms First, 2e, https://openstax.org/details/books/chemistry-atoms-first-2e
        - Aktiv Chemistry, access and enrollment in the course through D2L.
        - **Technology Equipment Needed for the Course**
        - Laptop
        - Scientific Calculator that could be used on standardized testing (only scientific notation function needed). **NO graphing calculators, QWERTY keys or**

calculators with ports will be allowed on tests. Cell phones are not allowed in testing rooms or to be used as calculators.

- **Technology Skills Needed for the Course**
  - Ability to navigate D2L, communicating via email, accessing and navigating digital textbooks or other learning materials, using scientific calculator, etc.

• Course Grading

Coursework

1. Exams (5; 550 pts).

a. Four 1-hour exams (100 pts each) and one 2-hour cumulative final (150 pts) will be given as noted below and in the lecture schedule.

b. An absence from any exam results in a score of zero for that exam;
   i. no make-up exams are given,
   ii. and no exam is dropped.

c. All students must take all exams on the dates and times scheduled in person.
   i. No hats, cell phones, headphones, or backpacks are allowed during the exams.
   ii. Violations of this will be dismissed from the exam with no chance of makeup.
   iii. If participation in a school-sponsored activity requires a student to be absent on the day an exam is scheduled, the student is required to take the exam prior to leaving on the activity.
      1. Arrangements to do so must be made with the instructor by email, a minimum of one week in advance of the exam date.
      2. In the case of extreme illness, a student must inform the Instructor and Dean of Students within 24 hours, so the exam can be rescheduled.

Exam Dates: All exams will take place in CBEC 2228 unless otherwise arranged with your instructor.

Exam	Date	Time	Length	Points
Exam 1	Monday, January 29, 2024	4 pm to 5 pm	1-hr exam	100
Exam 2	Wednesday, February 21, 2024	4 pm to 5 pm	1-hr exam	100
Exam 3	Wednesday, March 7, 2024	4 pm to 5 pm	1-hr exam	100
Exam 4	Monday, April 8, 2024	4 pm to 5 pm	1-hr exam	100
Final Exam	Wednesday, May 1, 2024	8 am to 10 am	2-hr exam	150
Total Exam Points				**550**

Special Note Regarding Final Exams: Per South Dakota Mines Policy (II-6-2), if you are scheduled to take three or more final/last exams on the same day during finals week, you may request that the middle exam(s) of the day be rescheduled. ***You are required to make this request of your instructor(s) at least 30 days prior to the last day of regular classes***.

2. Online Homework and Quizzes (200 pts): Homework assignments are online assignments through ActivChemistry.

Module	Asignments	Points
0 & 1	HW 0, HW 1, HW 2, HW 3, HW 4	50
2	HW 5, HW 6, HW 7, HW 8	40
3	HW 9, HW 10, HW 11	30
Total Homework Points		**120**
Best 8 quizzes out of ~12		**80**
Total non-Exam Points		**200**

- Each module's set of homework assignments are averaged and weighted against the total possible points (*e.g.*, Module 3: 89% average score × 30 points = 26.7 points).
- The in-class quizzes have 80 total possible points, each exam is worth 10 points with 5 points awarded for attendance and 5 for correct answers. There will be more than 8 pop quizzes, but only the top 8 will count to the total quiz points.
- The main objective of these assignments is to help you understand and master the concepts and knowledges you have learned. The homework assignments are available on the D2L course site and must be completed before the due dates. No homework assignment can be printed and turned in without permission of the instructor.

3. Suggested Homework: Students are encouraged to work out all the practice problems from the textbook. At any time, student needs help or guidance within this class, please come see or email the instructor. Additional help may be available from Student Success Center, tutoring, or online resources.

4. Extra Credit: Extra credit opportunities will be extremely limited. There is a small syllabus quiz worth 5 points of extra credit on your final total points that must be completed within 24 hours of the first lecture. All extra credit opportunities will be at the discretion of the instructor. If you send your best chemistry meme or joke in prior to the 4th exam, it may find its way into the lecture and gain you 5 points of extra credit to your final score if submitted before the time limit; there will NOT be any extra credit awarded in the last three weeks of this class.

Attendance Policy

Regular attendance and consistent study are student responsibilities and are the two factors that contribute most to a successful college experience. Registration for this course implies that student have made a commitment to complete, on time, all the work that is assigned and to participate in any in-class exercises and discussions; regular attendance is critical to meet this commitment. Students having excessive absences or

showing disrespect for the instructor or fellow students or demonstrating any behavior deemed disruptive to the class may be dropped from the class with a failing grade.

Late/Make-up Assignment Policy

There are no makeups for exams, homework assignments, and quizzes past the due date.

Academic Integrity

South Dakota Mines is committed to academic honesty and scholarly integrity. The South Dakota Board of Regents Policy 2:33 provides a comprehensive definition of "Academic Dishonesty", which include cheating and plagiarism. All Instructors at South Dakota Mines are required to report allegations of academic misconduct to the Student Conduct Officer. The South Dakota Board of Regents Policy 3:4 provides detailed information regarding key definitions, policy information, prohibited conduct, and the Student Conduct process adhered to at South Dakota Mines. Any student suspected of violating academic integrity standards will be reported in accordance with the process outlined on the South Dakota Mines website.The consequences of academic dishonesty in this class are as follows: *Any student found not to be following the policies during test taking will be removed from the testing room and a grade of zero will be given for the exam. The offence will be reported to the Dean of Students Office followed by additional process.* http://www.sdsmt.edu/Campus-Life/Community-Standards/Academic-Integrity/.

Grading and Assessment

Your final letter grade will be assigned based on percentile.

A	675 - 750	90 – 100%
B	600 - 674	80 – 89%
C	525 - 599	70 – 79%
D	450 - 524	60 – 69%
F	< 449	below 60%
Decimals are rounded to the nearest whole number according to the rules of significant figures.		

ADA Statement

South Dakota Mines strives to ensure that physical resources, as well as information and communication technologies, are reasonably accessible to users in order to provide equal access to all. If you encounter any accessibility issues, you are encouraged to immediately contact the instructor of the course and the Title IX and Disability Coordinator, Ms. Amanda Lopez at disabilityservices@sdsmt.edu or (605) 394-2533, who will work to resolve the issue as quickly as possible.

Academic Freedom Statement

Academic Freedom is the cornerstone upon which higher education is built. Academic freedom, as defined by BOR policy 1:11, is fundamental to the advancement of truth, development of critical thinking, promotion of civil discourse, and contribution to the public good. Each course includes the freedom to discuss relevant matters and present various scholarly views in the classroom, as determined by the subject-matter expertise of the instructor. Students are encouraged to develop the capacity for critical thinking and to pursue the truth, debate ideas, express and evaluate their opinions, and draw conclusions. Students are free to take reasoned exception to the views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled.[1]

[1]Language adapted from the American Association of University Professors "Joint Statement on Rights and Freedoms of Students".

Complaint Process

While we hope that every student has a meaningful and positive experience at South Dakota Mines, should a concern arise, students are encouraged to first attempt to resolve their concern directly with the person or office directly involved. Following that attempt, should the concern remain unresolved, students are encouraged to reach out to the Dean of Students office at DeanOfStudents@sdsmt.edu or 605.394.2416. Additionally, students may access the online form to submit their complaint, appeal, or grievance.

Grade Appeal Policy

In alignment with BOR Policy 2:9, students who wish to appeal their final course grade shall first discuss the matter with the course instructor. If the concerns are unresolved following that discussion, students may utilize the online form to submit "Appeal – Academic" for a "Grade Dispute".

Opportunity for All - Student Success Services and Support

Students are provided a one-stop source for information regarding all the services and supports to ensure success. Visit the Opportunity for All page to access service and department information including ADA accommodations, Career Services, Counseling, Office for Inclusion, Slide Rule (math support), Student Success, Title IX, Tutoring, and Veterans Services, to name a few.

South Dakota Board of Regents Required Syllabus Statements

The following statements may be found online in South Dakota Board of Regents Academic Affairs Council Guideline 5.3.A:

- Freedom in Learning
- Americans with Disabilities Act
- Academic Dishonesty and Misconduct
- Acceptable Use of Technology
- Emergency Alert Communications

Final Word

This syllabus outlines how the course is planned. If circumstances warrant, changes may be made, and students will be notified by a message to your official SDSM&T e-mail address and posting on D2L.

Schedule for Spring 2024 CHEM112 - M01 and MT01		Topics (Read/watch video before class and In-class discussion)	Homework Due
Monday	January 8, 2024	First day of class/Syllabus Discussion	Chemistry Placement Quiz, HW# 0 January 15, 11:00 PM
Wednesday	January 10, 2024	Module 0, LO #1, #2, #3	
Friday	January 12, 2024	Module 0, LO #4, #5	HW #1 – M0,
Monday	January 15, 2024	**Martin Luther King Day, no class**	January 16, 11:00 PM
Wednesday	January 17, 2024	Module 1.1, LO #1, #2, #3, #4	
Friday	January 19, 2024	Module 1.1, LO #5, #6, #7, #8, #9, #10	
Monday	January 22, 2024	Module 1.1, LO #11, #12, #13	
Wednesday	January 24, 2024	Module 1.1, LO #14, #15, #16	HW #2 – M1.1,
Friday	January 26, 2024	Module 1.1, LO #16 Module 1.2 LO #1, #2, #3	January 28, 11:00 PM
Monday	**January 29, 2024**	**Test 1 (Module 0, Module 1.1) 4 – 5 pm in CBEC 2228, No class at a regular time, only office hrs.**	
Wednesday	January 31, 2024	Module 1.2, LO #4, #5, #6, #7	
Friday	February 2, 2024	Module 1.2, LO #8, #9, #10	HW #3 – M1.2,
Monday	February 5, 2024	Module 1.2, LO #11	February 7, 11:00 PM
Wednesday	February 7, 2024	Module 1.3, LO #1, #2, #3, #4	
Friday	February 9, 2024	Module 1.3, LO #5, #6 (no formal charge or resonance, #7, #8)	
Monday	February 12, 2024	Module 1.3, LO #9, #10, #11	HW #4 – M1.3,
Wednesday	February 14, 2024	Module 1.3, LO #12, #13, #14, #15, #16	February 20, 11:00 PM
Friday	February 16, 2024	Module 2.1, LO #1, #2, #3	
Monday	February 19, 2024	**President Day, no class**	
Wednesday	**February 21, 2024**	**Test 2: (Module 1.2, 1.3) 4 – 5 pm in CBEC 2228, No class at a regular time, only office hrs.**	
Friday	February 23, 2024	Module 2.1 LO #4, #5	
Monday	February 26, 2024	Module 2.1, LO #6, #7, #8	
Wednesday	February 28, 2024	Module 2.1, LO #9, #10	
Friday	March 2, 2024	Module 2.1, LO #11, #12	HW #5 – M2.1,
Monday	March 5, 2024	Module 2.1, LO #9, #10	March 6, 11:00 PM
Wednesday	**March 7, 2024**	**Test 3: (Module 2.1) 4 – 5 pm in CBEC 2228, No class at a regular time, only office hrs.**	
Friday	March 9, 2024	Module 2.2, LO #1, #2, #3	HW #6 – M2.2,
Monday-Friday	March 12-16	**Spring Break, no class**	March 25, 11:00 PM

Monday	March 18, 2024	Module 2.2, LO #4, #5, #6	
Wednesday	March 20, 2024	Module 2.2, LO #7, #8, #9, #10	
Friday	March 22, 2024	Module 2.2, LO #11, #12, #13, #14	
Monday	March 25, 2024	Module 2.3, LO #1, #2, #3, #4, #5	
Wednesday	March 27, 2024	Module 2.3, #6, #7, LO #8, #9	HW #7 – M2.3,
Friday	March 29, 2024	**Easter Holiday, no class**	
Monday	April 2, 2024	Module 2.3, LO #10, #11, #12	April 8, 11:00 PM
Wednesday	April 4, 2024	Review	
Friday	April 6, 2024	Module 3.1, LO #1, #2, #3, #4	
Monday	**April 9, 2024**	**Test 4 (Module 2.2, 2.3), 4 – 5 pm in CBEC 2228, No class at a regular time, only office hrs.**	HW #8 – M3.1,
Wednesday	April 11, 2024	Module 3.1, LO #5, #6, #7, #9, #10	April 13, 11:00 PM
Friday	April 13, 2024	Module 3.2, LO #1, #2, #3	
Monday	April 16, 2024	Module 3.2, LO #4, #5, #6, #7, #8, #9	HW #9 – M3.2,
Wednesday	April 18, 2024	Module 3.2, LO #10, #11, #12	April 20, 11:00 PM
Friday	April 20, 2024	Module 3.3, LO #1, #2, #3, #4	
Monday	April 23, 2024	Module 3.3, LO #5	HW #10 – M3.3,
Wednesday	April 25, 2024	Module 3.3, LO #6, #7	
Friday	April 27, 2024	Review	April 30, 11:00 PM
	May 1, 2024	**Final Exam, 8:00 to 10:50 am**	

CHEM 112 Details of Learning Objectives (LO)

Course Objective:

Students will obtain a foundation in the fundamental principles and models of chemistry necessary for an understanding of the composition, structure, and properties of matter and the changes that matter undergoes.

[HW0: Chem 112 readiness]

Module 0: Scientific Method, Dimensional Analysis, Math Refresh (Ch1.1, 1.4, 1.5, 1.6)

1. Describe the scientific method (Ch 1.1)
2. Describe the properties and units of length, mass, volume, density, temperature, and time (Ch 1.4)
3. Describe uncertainty of measurements and correctly represent uncertainty in quantities using significant figures (Ch1.5)
4. Use dimensional analysis to carry out unit conversions for a given property and computations involving two or more properties (Ch1.6)
5. Essential Mathematics (Appendix B)

Homework Assignment: HW1 – M0 – Ch1

Module 1: Atoms and Molecules

Module-Level Objective: To develop the atomic and molecular view of matter.

M1.1. The Basic Language of Chemistry (Ch1.2, 1.3, Ch2) Apply the language of chemistry, including the symbolic representations, chemical notation, formulas, and systematic rules of nomenclature.

1. Classify matter and describe the physical states of matter (chapter 1.2)
2. Identify properties of and changes in matter as physical or chemical (chapter 1.3)
3. State and use the postulates of Dalton's atomic theory (Ch2.1)
4. Outline milestones in the development of modern atomic theory (Ch2.2)
5. Write and interpret symbols that depict the atomic number, mass number, and charge of an atom or ion (Ch2.3)
6. Define the atomic mass unit and average atomic mass (Ch2.3)
7. Calculate average atomic mass and isotopic abundance (Ch2.3)
8. Explain the organization of elements in the periodic table and (Ch3.6)
9. Predict the general properties of elements based on their location within the periodic table (Ch3.6)
10. Identify metals, nonmetals, and metalloids by their properties and/or location on the periodic table (Ch3.6)
11. Define ionic and molecular (covalent) compounds (Ch 3.7)
12. Predict the type of compound formed from elements based on their location within the periodic table (3.7)
13. Determine formulas for simple ionic compounds (3.7)
14. Symbolize the composition of molecules using molecular formulas and empirical formulas (chapter 2.4)
15. Derive names for common types of inorganic compounds using a systematic approach (Chapter 4.3)
16. Derive chemical equations from narrative descriptions of chemical reactions. (Ch 7.1)

Homework Assignment: HW2 – M1.1 – Ch2

M1.2. Explain the various models of atomic structure, the basic principles of quantum theory, and use modern atomic theory to understand and predict the properties of different elements. (Chapter 3)

1. Describe light as both a particle and a wave (chapter 3.1)
2. Use appropriate equations to calculate related light-wave properties such as period, frequency, wavelength, and energy (Ch3.1)
3. Describe the Bohr model of the hydrogen atom and explain how a line spectrum of hydrogen is generated (chapter 3.2)
4. Understand the general idea of the quantum mechanical description of electrons in an atom (chapter 3.3)
5. List and describe traits of the four quantum numbers that form the basis for completely specifying the state of an electron in an atom (chapter 3.3)
6. Describe the Pauli Exclusion Principle (chapter 3.3)
7. Draw the shapes and orientations of s, p, and d orbitals in an atom (chapter 3.3)
8. Derive the predicted ground-state electron configurations of atoms (Ch 3.4)
9. Identify and explain exceptions to predicted electron configurations for atoms and ions (Ch3.4)
10. Relate electron configurations to element classifications in the periodic table (Ch3.4)
11. Describe and explain the observed trends in atomic size, ionization energy, and electron affinity of the elements (Ch3.5)

HW3-M1.2-Ch7

M1.3. Demonstrate understanding of the fundamental aspects of chemical bonding (Chapter 4).

1. Explain the formation of cations, anions, and ionic compounds (4.1)
2. Predict the charge of common metallic and nonmetallic elements, and write their electron configurations (4.1)
3. Describe the formation of covalent bonds (4.2)
4. Define electronegativity and assess the polarity of covalent bonds (4.2)
5. Write Lewis symbols for neutral atoms and ions (4.4)
6. Draw Lewis structures depicting the bonding in simple molecules (4.4)

Homework Assignment: HW4-M1.3-Ch8

7. Predict the structures of small molecules using valence shell electron pair repulsion (VSEPR) theory (4.6)
8. Explain the concepts of polar covalent bonds and molecular polarity (4.6)
9. Assess the polarity of a molecule based on its bonding and structure (4.6)
10. Describe the formation of covalent bonds in terms of atomic orbital overlap (5.1)
11. Define and give examples of σ and π bonds (5.1)
12. Explain the concept of atomic orbital hybridization (5.2)
13. Determine the hybrid orbitals associated with various molecular geometries (5.2)
14. Describe multiple covalent bonding in terms of atomic orbital overlap (5.3)

Homework Assignment: HW5 – M1.3 – Ch9

Module 2: Chemical Reactions

Module-Level Objective: To develop the molecular view of the chemical reactions.

M2.1 Recognize the different types of chemical transformations: acid-base, precipitation, combination, decomposition, single-replacement, oxidation-reduction, double replacement, and combustion. (Chapter 4,5)

1. Describe the basic properties of solutions (11.1)
2. Distinguish electrolyte and nonelectrolyte solutions (chapter 11.1, 11.2)
3. Identify common acids and bases (chapter 7.2)
4. Derive chemical equations from narrative descriptions of chemical reactions.(chapter 7.1)
5. Write and balance chemical equations in molecular, total ionic, and net ionic formats. (7.1)
6. Define three common types of chemical reactions (precipitation, acid-base, and oxidation-reduction) (chapter 7.2)
7. Classify chemical reactions as one of these three types given appropriate descriptions or chemical equations (7.2)
8. Predict the solubility of common inorganic compounds by using solubility rules. (chapter 7.2)
9. Define oxidation, reduction, oxidizing agents, reducing agents, and oxidation numbers (chapter 7.2)
10. Balance equations for oxidation-reduction reactions in acidic or basic solutions (chapter 7.2)
11. Describe the reaction with oxygen of organic compounds, metals, and nonmetals (?)
12. Explain the activity series of metals and use it to predict the product of a redox reactions involving a metal

Homework Assignment: HW6 – M2.1 – Ch4

M2.2 Perform calculations related to composition of substances and stoichiometry of chemical reactions.

1. Define the amount unit mole and the related quantity Avogadro's number. (2.4)
2. Explain the relation between mass, moles, and numbers of atoms or molecules and perform calculations deriving these quantities from one another (chapter 2.4)
3. Calculate formula masses for covalent and ionic compounds (chapter 6.1)
4. Calculate percent composition of a compound (6.2)
5. Derive the chemical formulas of unknown substances from experimental mass measurements. (Chapter 6.2)
6. Calculate solution concentrations using molarity and dilution equation (6.3)
7. Explain the concept of stoichiometry as it pertains to chemical reactions (chapter 7.3)
8. Use balanced chemical equations to derive stoichiometric factors relating amounts of reactants and products (chapter 7.3)
9. Perform stoichiometric calculations involving mass, moles, and solution molarity (7.3)
10. Explain the concepts of theoretical yield and limiting reactants/reagents. (7.4)
11. Derive the theoretical yield for a reaction under specified conditions. (7.4)
12. Calculate the percent yield for a reaction. (7.4)
13. Describe the fundamental aspects of titrations and gravimetric analysis. (7.5)
14. Perform stoichiometric calculations using typical titration and gravimetric data. (7.5)

Homework Assignment: HW7 – M2.3 – Ch3

M2.3 Understand the basic principles of energy transfer involving chemical systems, including the transfer of heat and work between system and surroundings, the qualitative and quantitative interpretation of thermochemical equations, and the application of Hess's Law. (Chapter 9)

1. Define energy, distinguish types of energy, and describe the nature of energy changes that accompany chemical and physical changes (chapter 9.1)
2. Distinguish the related properties of heat, thermal energy, and temperature (9.1)
3. Define and distinguish specific heat and heat capacity, and describe the physical implications of both (9.1)
4. Describe the energy changes in exothermic and endothermic reactions (9.1)
5. Perform calculations involving heat, specific heat, and temperature change (9.1)

6. Explain the technique of calorimetry (9.2)
7. Calculate and interpret heat and related properties using typical calorimetry data (9.2)
8. State the first law of thermodynamics (chapter 9.3)
9. Define enthalpy and explain its classification as a state function (9.3)
10. Write and balance thermochemical equations (chapter 9.3)
11. Explain Hess's law and use it to compute reaction enthalpies (chapter 9.3)
12. Calculate enthalpy changes for various chemical reactions (9.3)
13. Describe the energetics of covalent and ionic bond formation and breakage (9.4)
14. Use the Born-Haber cycle to compute lattice energies for ionic compounds (9.4)

Homework Assignment: HW8 – M2.3 – Ch6

Module 3: Physical Properties

Module-Level Objective: To develop the molecular view of the physical properties of matter

M3.1. Describe the properties of the gaseous state and the laws governing the behavior of gases. (Chapter 10)

1. Describe the basic properties of each physical state of matter: solid, liquid, and gas (chapter 1.2)
2. Define the property of pressure (8.1)
3. Describe the operation of common tools for measuring gas pressure (8.1)
4. Identify the mathematical relationships between the various properties of gases (8.2)
5. Use the ideal gas law to compute gas densities and molar masses (8.3)
6. Perform stoichiometric calculations involving gaseous substances (8.3)
7. State Dalton's law of partial pressures and use it in calculations involving gaseous mixtures (8.3)
8. Define and explain effusion and diffusion and use Graham's law to compute relevant gas properties (8.4)
9. Use the kinetic molecular theory of gases to explain the gas laws (8.5)
10. Describe the physical factors that lead to deviations from ideal gas behavior (8.6)

Homework Assignment: HW9 – M3.1 – Ch10

M3.2. Apply the molecular kinetic theory and the concepts of the intermolecular interactions among particles to explain the physical properties of liquid and solid. (Chapter 10)

1. Describe the types of intermolecular forces possible between atoms or molecules in condensed phases (dispersion forces, dipole-dipole attractions, and hydrogen bonding) (10.1)
2. Identify the types of intermolecular forces experienced by specific molecules based on their structures (10.1)
3. Explain the relation between the intermolecular forces present within a substance and the temperatures associated with changes in its physical state (10.1)
4. Define viscosity, surface tension, and capillary rise (10.2)
5. Describe the roles of intermolecular attractive forces in each of these properties/phenomena (10.2)
6. Explain the concept of vapor pressure and its relationship with intermolecular forces (10.3)
7. Define phase transitions and phase transition temperatures (10.3)
8. Explain the relation between phase transition temperatures and intermolecular attractive forces (10.3)
9. Describe the processes represented by typical heating and cooling curves, and compute heat flows and enthalpy changes accompanying these processes (10.3)
10. Use phase diagrams to identify stable phases at given temperatures and pressures, and to describe phase transitions resulting from changes in these properties (10.4)
11. Describe the main types of crystalline solids: ionic solids, metallic solids, covalent network solids, and molecular solids (10.5)

12. Define and describe the bonding and properties of ionic, molecular, metallic, and covalent network crystalline solids
13. Describe the arrangement of atoms and ions in crystalline structures

Homework Assignment: HW10 – M3.2 – Ch11

M3.3. Describe the behavior of solutions and their colligative properties. (Chapter 12)

1. Describe the basic properties of solutions and how they form (11.1)
2. Predict whether a given mixture will yield a solution based on molecular properties of its components (11.1)
3. Explain why some solutions either produce or absorb heat when they form (11.1)
4. Describe the effects of temperature and pressure on solubility (11.3)
5. Express solution concentrations: percent concentration, molal concentration, molar concentration, and convert between the different units (chapter 11.4, 6.4)
6. Describe the effect of solute concentration on various solution properties (vapor pressure, boiling point, freezing point, and osmotic pressure) (11.4)
7. Perform calculations using the mathematical equations that describe these various colligative effects (11.4)
8. Describe the process of distillation and its practical applications (11.4)
9. Explain the process of osmosis and describe how it is applied industrially and in nature (11.4)

Homework Assignment: HW11 – M3.3 – Ch12

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Chem 112L can be used in partial fulfillment of General Education Goal 6.

SGR Goal 6: Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world.

Student Learning Outcomes: As a result of taking courses meeting this goal, students will:

1. Explain the nature of science including how scientific explanations are formulated, tested, and modified or validated.

2. Distinguish between scientific and non-scientific evidence and explanations and use scientific evidence to construct arguments related to contemporary issues.

3. Apply basic observational, quantitative, or technological methods to gather and analyze data and draw evidence-based conclusions in a laboratory setting.

4. Understand and apply foundational knowledge and discipline-specific concepts to address issues, solve problems, or predict natural phenomena.