

Chemistry 11 Syllabus

Santa Clara University

Summer 2022

Section: 46121**Lecture Times:** M-F 9:00 a.m.-12:00 p.m.**Location:** SCDI 3115**Instructor:** Dr. Megan Tichy**Email:** mm15tichy@scu.edu**Office:** SCDI 2117K**Office Hours:** Tues/Thurs 1:00-3:00 p.m.

Course topics: This is the first quarter of general chemistry and is designed for science majors and engineering students. We are taking an atoms-first approach. Topics covered include chemical properties and structure, quantitative problem solving, chemical bonding, ions, stoichiometry, and an introduction to thermodynamics. Class proceeds at a very brisk pace; it is imperative that you do not fall behind. There will be drop in Zoom tutoring offered on Thursdays at 5 - 6 p.m.

Prerequisites: Working knowledge of the basic concepts covered in high school chemistry and algebra classes. Review Chapter E in the textbook pages 3-33 (units, measurement, and problem solving) and Chapter 1 sections 1.9 and 1.10 (atomic mass and moles) before the second lecture. We will cover some aspects of these concepts in class or lab, but only as a brief review. This material is considered pre-requisite knowledge that you should have mastered in your high school chemistry course.

Required Course Materials

- **Textbook:** *Chemistry: Structure and Properties* by Tro, 2nd edition (any format)
- **Lab coat, safety goggles:** Required for lab.
- **Scientific calculator:** Bring to every lecture/lab.
- **Chem 11 Camino site:** Contains lecture notes quizzes, solutions to quizzes, practice exams, announcements, grades, all assignments, and more.

Evaluation of Coursework

I will evaluate your comprehension of the course material using the following grading policy:

Category	Points	Percentage of course
Weekly Discussion Post (3 X 10 points each):	30	4%
Weekly In-class quizzes (3 X 20 points each):	60	8%
Graded homework problems 9 X 10 points each):	90	12%
In-class Midterm 1:	140	19%
In-class Midterm 2:	180	24%
In-class Final exam:	250	33%
Total points:	750	

Additional points: You may receive up to (2%) 15 points for your laboratory grade (HIGH PASS)

Weekly Discussion Posts: For class participation, up to 10 points will be awarded for participation in each assigned discussion post.

Weekly in-class quizzes: A 20-minute quiz will be given once a week (on Wednesdays) to test basic comprehension and ensure you are keeping up with course material. Problems you find on quizzes are generally going to be less complex/challenging compared to full-length midterm

exams. There will be NO makeup or online quizzes. Each quiz is worth 20 points. Three quizzes will be administered. If you miss a quiz due to illness, you may ask the instructor to allot the quiz points towards the final exam (see similar policy below for midterms).

Graded homework problems: After each lecture you will be expected to complete a homework set online (Canvas/Camino quiz style). These graded homework sets will be due the following morning at 8:45 a.m. The exceptions will be the day of midterm exams, when no homework will be due. It is up to you to keep up with the material and finish each graded homework set before the deadline. The homework is mastery based, so if there are any auto-graded questions - you will have up to three tries to get those questions correct. However - if it is a file upload question, it will be graded based on completion and effort. You will be required to re-upload your file if you re-take the quiz a second or third time. It is recommended that you solve as many end-of-chapter problems as you can, on your own, in addition to completing these graded homework problems.

In-class Midterm and Final Exams: I aim to give all exams in person, health permitting. Travel is not considered an excused absence so please make your travel plans accordingly. The in-person final exam is comprehensive and will be administered on Friday July 1, 2022 at 9:00 a.m.

Midterm 1: Friday 6/17 (Week 1)

Midterm 2: Friday 6/24 (Week 2)

If you are unable to take a quiz or midterm exam in person due to illness or other non-travel-related reasons, you may request to allocate the points for that quiz or midterm to the final exam by EMAIL as soon as possible (preferably BEFORE the instructor administers the quiz or midterm to your classmates). For example, if you miss the first midterm, and elect to allocate those points toward the final exam, your final exam will be worth $140 + 250 = 390$ out of 750 points. If you miss the first and second midterms, and elect to allocate those points toward your final exam, your final exam will be worth $140 + 180 + 250 = 570$ out of 750 points. Try to stay healthy as best as you can, but know that you won't get a zero on an exam or quiz if you are unable to take it due to illness.

Regrade policy: Regrades will be accepted within two days (48 hours) of the day when the exam is returned to the class as a whole. Concerns must be submitted in writing. Regrading is only done in response to a particular (and valid) concern in the initial grading of the exam, not simply because one is unsatisfied with the numerical score. Upon submission, the ENTIRE exam will be re-graded, not just the question of concern. It is possible for the grade to go up or down. If the error is simply in the totaling of points, I will make the correction without regrading. However, you still MUST submit the exam (with a written note describing the problem) before the regrade deadline.

Laboratory Procedures

You must successfully complete and pass the laboratory section of the course in order to pass the class. Carefully review the schedule for the laboratory section provided in the Laboratory Manual. As required by the Department of Chemistry and Biochemistry, laboratory attendance is mandatory. Each lab period, be sure to bring a notebook for hand-written notes, pen, calculator, lab splash goggles; and a lab coat. In addition, be sure to meet the dress code requirements for lab.

Dress code for lab: Please note that the following dress code has been established for all students, staff and faculty in laboratories in the chemistry department. Failure to meet these requirements will result in a student having to leave the laboratory until the deficiencies have been addressed.

- A “t-shirt” is the minimum coverage of the upper body acceptable
- Long pants are required
- Closed-toe and closed heel shoes, ideally with a non-permeable upper component covering, are required
- Your ankles MUST be covered with pants, socks or shoes.
- Safety splash goggles are required.

Grading of Lab: The Chemistry 11 laboratory will be graded on a modified pass/no pass basis. Students must show proficiency in the laboratory portion of the course and fulfill the minimum attendance requirement as indicated below:

1. In order to be eligible for a course grade of D- or higher you must not accumulate more than one unapproved absence or two total absences (for any reason excused or not) from lab. In rare cases make-up labs may be possible but this is left to the discretion of your individual laboratory instructor. In addition, a 1 % deduction will be subtracted from your lecture total if you have an unexcused absence from lab.

2. The final course grade in Chemistry 11 will be determined by your accumulated points in lecture only since lab is pass/no pass. However, as an added incentive to do your very best in lab, points will be added to or deducted from your lecture total according to the following schedule:

Lab “grade” earned	How this influences your overall course grade
High Pass total	A bonus equal to 2% will be added to your lecture point total
Pass total	A bonus equal to 1% will be added to your lecture point total
Low Pass	No change in lecture point total
Fail	Failure in the entire course

Please note that a Fail in lab will result in failure in the entire course.

ACADEMIC INTEGRITY

You are expected to perform all work associated with any of the graded assignments for this course on your own. Unauthorized consultation in any form is strictly prohibited and may result in failure of this course. The use of computers, cell phones and other electronic communication devices in-class is specifically prohibited. If your phone (or any other electronic device other than a calculator) is found on your person during an examination, it will be considered a breach of academic integrity. I also expect you to apprise me of any violations of academic integrity of which you may be aware.

The Academic Integrity pledge is an expression of the University’s commitment to fostering an understanding of -- and commitment to -- a culture of integrity at Santa Clara University. The Academic Integrity pledge, which applies to all students, states:

I am committed to being a person of integrity. I pledge, as a member of the Santa Clara University community, to abide by and uphold the standards of academic integrity contained in the Student Conduct Code.

Academic integrity is part of your intellectual, ethical, and professional development. I expect you to uphold the principles of this pledge for all work in this class. I will clarify expectations on academic integrity as needed for assignments and exams. If you have questions about what is appropriate on any assignment, please let me know before you hand in work. For more resources about ensuring academic integrity in your work, including the appropriate use of course sharing sites such as Chegg, see this site created by the SCU Library at <https://libguides.scu.edu/academic-integrity> or visit www.scu.edu/academic-integrity.

Tentative Lecture Schedule

This list is only a tentative guide to topics. The exact dates of content and midterms may be adjusted during the course. Please note that the textbook references are only indications and some material may not be covered or may be expanded beyond the scope of the book.

Week	Dates	Day	Chapter	TOPICS	Quiz
1	6/13	Mon	E	Syllabus, Units and Sig Figs	
			1	Atoms and moles	
	6/14	Tues	2	Light and atoms	
			2	Quantum mechanics	
	6/15	Wed	2	Shapes of orbitals	Quiz 1
			3	Electron configurations	
			3	Periodic trends	
	6/16	Thurs	4	Lewis model	
			4	Chemical bonding	
			4	Chemical formulas	
	6/17	Fri		Midterm 1	
2	6/20	Mon	5	Molecular geometry	
			5	Electronegativity	
	6/21	Tues	5	Molecular shape	
			6	Valence bond theory	
			6	Hybrid orbitals	
	6/22	Wed	7	Balancing chemical equations	Quiz 2
			7	Limiting reactants	
	6/23	Thurs	8	Solution chemistry	
			8	Solution stoichiometry	
			8	Types of reactions	
	6/24	Fri		Midterm 2	
3	6/27	Mon	9	Thermochemistry & energy	
			9	Hess's Law	
	6/28	Tues	9	Spontaneous processes	
	6/29	Wed	18	Entropy	Quiz 3
	6/30	Thurs	18	Free energy	
CUMULATIVE FINAL EXAM will be held in SCDI 3115 on Friday, July 1 from 9:00 a.m. - 12:00 p.m.					

OFFICE OF ACCESSIBLE EDUCATION

If you have a documented disability for which accommodations may be required in this class, please contact the Office of Accessible Education (oea@scu.edu, <http://www.scu.edu/oea>) as soon as possible to discuss your needs and register for accommodations with the University. If you have already arranged accommodations through OAE, please be sure to request your accommodations through your myOAE portal and discuss them with me during my office hours within the first two weeks of class.

To ensure fairness and consistency, individual faculty members are required to receive verification from the Office of Accessible Education before providing accommodations. OAE will work with students and faculty to arrange proctored exams for students whose accommodations include double time for exams and/or assistive technology. Students with approved accommodations of time-and-a-half should talk with me as soon as possible. The Office of Accessible Education must be contacted in advance (at least two weeks notice recommended) to schedule proctored examinations or to arrange other accommodations.

In light of shifting health advisories related to COVID-19, exams may be administered online. Students with approved testing accommodations should contact me (**at least two weeks notice recommended**) prior to an exam date to notify me of their intent to use their testing accommodations on the upcoming exam to ensure their accommodations are effectively implemented.

DISCRIMINATION AND SEXUAL MISCONDUCT (Title IX)

SCU faculty are committed to helping create a safe and open learning environment for all students. If you (or someone you know) have experienced any form of discrimination, harassment or sexual misconduct, including sexual assault, dating or domestic violence, or stalking, know that help and support are available, I encourage you seek support and report incidents to the Director of Equal Opportunity and Title IX Coordinator, Belinda Guthrie, at 408-554-3043, bguthrie@scu.edu. For more information about reporting options and resources at Santa Clara University and in the community, please visit <https://www.scu.edu/title-ix/>. If you wish to speak with a confidential resource, please visit <https://www.scu.edu/title-ix/resources/student/>.

ACCOMMODATIONS FOR PREGNANT AND PARENTING STUDENTS

Santa Clara University does not discriminate against any student on the basis of pregnancy or related medical conditions. Absences due to medical conditions relating to pregnancy and childbirth will be excused for as long as deemed medically necessary by a student's doctor, and students will be given the opportunity to make up missed work. Students needing accommodations can often arrange accommodations by working directly with their instructors, supervisors, or departments. Students needing accommodations can also seek assistance with accommodations from the Office of Office of Accessible Education (OAE) or from the Office of Equal Opportunity and Title IX Office. The following link provides information for students and faculty regarding pregnancy rights. <https://www.scu.edu/title-ix/resources/pregnancy/pregnancy>.

CORE CURRICULUM AND PATHWAY COURSE

This course fulfills the Natural Science laboratory requirement for the Core. In addition, this course is associated with the Values in Science and Technology Pathway. If you declare this Pathway, you may use a representative piece of work from this course as one of the Pathway materials you will upload via eCampus during your junior or senior year. Therefore, I recommend that you keep electronic copies of your work, including completed laboratory reports. It is strongly recommended that you save these files in Google drive for your Pathway materials and reflection essay. You can find information about Pathways on the Core Curriculum website <http://scu.edu/core> including specific Pathways, all courses associated with them, and the Reflection Essay prompt and rubric used to evaluate the final essay you will submit. <http://www.scu.edu/provost/ugst/core/pathways/resources/>

USE OF CLASSROOM RECORDINGS

All online class meetings will be recorded and made available on Camino. As is stated in the Student Conduct Code: "...Dissemination or sharing of any classroom recording without the permission of the instructor would be considered "misuse" and, therefore, prohibited. Violations of these policies may result in disciplinary action by the University. At the instructor's discretion, violations may also have an adverse effect on the student's grade."

COPYRIGHT STATEMENT

Materials in this course are protected by United States copyright laws. I am the copyright holder of the materials I create, including notes, handouts, slides, and videos. You may make copies of course materials for your own use and you may share the materials with other students enrolled in this course. You may not publicly distribute the course materials without my written permission.

TECHNOLOGY SUPPORT

SCU can provide you with technology assistance, and you can also reach out to our providers directly for questions. For Camino (SCU's branded instance of Canvas) support, contact caminosupport@scu.edu or call 408-551-3572. You can also use the help button within the Camino platform (on the left hand navigation) for 24/7 support via chat or phone with our vendor. For Zoom assistance, contact Media Services at mediaservices@scu.edu or 408-554-4520. You can also get support from the [Zoom Help Center](#) website. For SCU network and computing support, contact the SCU Technology Help Desk at techdesk@scu.edu or 408-554-5700. They can provide support for MySCU Portal, Duo, eCampus, hardware and software issues, and more.

LAND ACKNOWLEDGMENT

Santa Clara University occupies the unceded ancestral homeland of the Ohlone and Muwekma Ohlone people.

RESPECT FOR DIVERSITY

It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, religion, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.

GENDER INCLUSIVE LANGUAGE

This course affirms people of all gender expressions and gender identities. If you go by a name different from what is on the class roster, please let me know. Using correct gender pronouns is important to me, so I encourage you to share your pronouns with me and correct me if I make a mistake. If you have any questions or concerns, please do not hesitate to contact me. For more on personal pronouns see www.mypronouns.org.

WELLNESS STATEMENT

Do your best in this class (and all of your classes), but never at the expense of your own health and wellness, including your mental health. Jesuit education is grounded in concern for the whole person—mind, body, and spirit. So cut yourself a break. Be kind to others and yourself. Get plenty of sleep, drink lots of water, move, get outside, and pay attention to beauty that isn't coming to you on a screen. Eat good food; enjoy friends and family; look for opportunities to

connect with others in new ways; pray, meditate or otherwise attend to your spirit. And ask for help when you need it. Lots of folks, including me, are here to support you. These resources may be especially helpful: <https://www.scu.edu/wellness/>

The Wellness center provides resources to aid and promote student well-being. It is home to three student groups: the Peer Health Educators, the Violence Prevention Educators, and the Collegiate Recovery Program: <https://www.scu.edu/cowell/counseling-and-psychological-services-caps/>

Santa Clara students are provided counseling sessions at no cost with Counseling and Psychological Services. See website for details: <https://www.scu.edu/osl/culture-of-care/>

If you are concerned for the mental or physical welfare of one of your peers, the [Compassionate and Responsive Educators](#) website provides resources for recognizing and helping someone in distress.

Suggestions for Success

Because many of the concepts will be unfamiliar, gradually exposing yourself to them proves invaluable. Your understanding in the course will greatly be aided by the following approach:

1. Familiarize yourself with the material to be covered before attending lecture. Spend 20-30 min before each lecture scanning the materials to be covered in the book. At this time, don't concern yourself with fully understanding the material, but rather with the "broad strokes". This first contact will enable you to use the lecture time to organize and understand what is presented without being overwhelmed.
2. Attend lecture. I will emphasize the most essential aspects of the material and place it into context for you to best understand. In the least, attending lecture gives you a sense of my approach to the material and what I'll use as a focus on exams. Typically, however, you'll gain much more from lecture if you actively take notes.
3. Study the lecture notes and text in detail after lecture. This should be your third exposure to the information, and you should now be prepared to work on learning smaller details.
4. Work through all assigned problems. This step is essential both because it helps you to learn the material and because it serves as the only way for you to evaluate your understanding. When solving difficult problems it is important to struggle for a while and force yourself to think. Take the time to work through the problems in the textbook. These problems will help you identify individual weaknesses that require additional study, and the practice has been evidenced to substantially improve performance on quizzes and exams. However, when you are no longer making progress, use the solution manual and/or the help of fellow students to point you in the right direction. Always ensure that you work through the printed solutions and understand them. In cases where you are still unclear on the concepts or how to derive a solution to a problem, come to office hours!
5. Peer tutoring: SCU has multiple options for free academic tutoring. Visit the Drahmman Tutoring website (<https://www.scu.edu/drahmann/tutoring/>).

Learning Objectives

The primary objective of the general chemistry sequence is to give you a solid foundation in both theoretical and descriptive chemistry. Emphasis will be placed on the development of problem solving skills, as well as on the application of basic chemical concepts. The laboratory portion of the course will provide the opportunity to develop skills necessary for scientific discovery (e.g., critical thinking and observation skills, ability to handle chemical reagents and instruments safely). The laboratory experiments will provide enrichment and reinforcement of some lecture topics. The following is a list of more specific learning goals and objectives for the course.

Goal 1: Learn the fundamentals of the properties of matter, measurement and uncertainty and acquire a thorough understanding of the modern theory of atomic structure.

1) Ongoing Skill:

a. Dimensional Analysis – Understand how to solve a quantitative problem by applying conversion factors. Careful analysis of units can be used to evaluate and create the approach to solving problems of varying levels of complexity. This is ongoing throughout the year and increases in complexity as your foundational knowledge increases.

2) Objectives for Chapter E (Independent Reading and Independent Problem Solving):

a. Learn and be able to use SI units, derived SI units and metric prefixes, including the recognition of the uncertainty in measurements, the correct use of significant figures.

b. Master the application of dimensional analysis to problem solving.

c. Understand the difference between accuracy and precision.

3) Objectives for Chapter 1 (Independent Reading and Independent Problem Solving):

a. Distinguish elements from compounds, pure substances from mixtures and homogeneous from heterogeneous mixtures (solutions). Learn rudiments of mixture separation into pure substances and the distinction between physical and chemical properties (readings).

b. Comprehend the properties, atomic locations and interactions of protons, neutrons and electrons and the role these subatomic particles play in the identity of atoms and ions.

c. Recognize the importance of subatomic particles in determining the identity of isotopes and how isotopic abundance factors into average atomic mass.

d. Recognize how the atomic number goes into the arrangement of the periodic table

e. Learn the symbols and names of dozens of the common chemical elements, and begin to assimilate the terminology (language) of chemistry.

f. Apply Avogadro's number and the mole concept to allow conversion between the atomic/molecular level and the macroscopic level.

g. Understand how to formulate a testable hypothesis and design an informative experiment to explain phenomena observed in the natural world.

h. Recognize limitations of experimental and observational methods and understand concepts of probability, causation, and correlation.

Goal 2: Acquire a thorough understanding of the modern theory of atomic structure and atomic level phenomena.

Objectives for Chapter 2 (Lecture, Reading and Problem Solving):

a. Understand the importance of and how to calculate the wavelength, the frequency and the energy of a photon.

b. Recognize the characteristics of electromagnetic radiation and how it interacts with matter.

c. Understand the phenomenon of atomic absorption and emission and be able to distinguish ground from excited state atoms.

d. Calculate the energy of the transitions of electrons in atoms and the relationship to the energy of a photon.

e. Understand the implications of wave mechanics and the quantization of electrons energies and spin, including quantum numbers, atomic orbital energy, shape, orientation and electron capacity.

Goal 3: Learn the organization and information conveyed by the periodic table of the chemical elements.

Objectives for Chapter 3 (Lecture, Reading and Problem Solving):

a. Recognize the relationship between the principle quantum number of occupied orbitals, the shape of occupied orbitals and writing of electron configurations for atoms and monatomic ions.

b. Learn the rationale for the table's structure and the rationale for groupings of elements.

c. Explain trends in metallic character, atomic radius, ionization energy, electrons affinity and electronegativity in the periodic table.

d. Know the relationship between position in the periodic table and the likely chemical bonding behavior of an element.

Goal 4: Recognize how atoms are the building block of molecules, compounds and elements.

Objectives for Chapter 4 (Lecture, Reading and Problem Solving):

- Depict valence electrons using representative element Lewis symbols.
- Determine the molecular and empirical formula of a compound.
- Understand the difference between ionic and covalent bonding and be able to recognize ionic compounds and molecular compounds from the chemical formula.
- Apply calculation conversions between grams and moles to chemical problems using molar masses.
- Name common cations and anions and ionic compounds given the chemical formula and be able to write the formulas of common cations and anions and ionic compounds given the name.
- Name covalent compounds given the chemical formula and be able to write the formulas of covalent compounds given the name.
- Determine empirical and actual formulas of chemical compounds from elemental analysis data. Also be able to calculate % composition from this data.

Goal 5: Obtain a thorough introduction to modern chemical bonding theories and their implications.

1) Objectives for Chapter 5 (Lecture, Reading and Problem Solving):

- Learn to write the best Lewis Structures that accurately depicting bonding and non-bonding electrons.
- When multiple Lewis Structures are possible learn to utilize the concepts of Formal Charge and the Octet Rule to predict the structure that contributes the most to the actual molecule.
- Recognize resonance and how to write the needed number of resonance structures to accurately depict a molecule.
- Learn the use of electronegativity as a predictor of ionicity in binary compounds and as a bond polarity predictor in molecules with covalent bonding and be able to predict if molecules have a zero or non-zero dipole moment.
- Predict both VSEPR and actual geometry for simple covalent molecules and polyatomic ions.

2) Objectives for Chapter 6 (Lecture, Reading and Problem Solving):

- Learn the atomic orbital hybridization model in relation to VSEPR theory.
- Learn the difference between sigma and pi bonding, know what atomic orbital overlap is associated with any covalent bond.
- Begin to learn the difference between the valence bond and molecular orbital theories of bonding.

Goal 6: Analyze the quantitative implications of chemical formulas and chemical reactions, including processes occurring in solution.

Objectives for Chapter 7:

- Balance a chemical formula and recognize the importance of stoichiometric coefficients and subscripts in a chemical formula.
- Perform calculations utilizing the stoichiometric coefficients in a balanced reaction.
- Recognize combustion reactions and their ubiquitous importance.
- Complete and balance combustion reactions of C,H,O,N,S containing compounds.
- Master all conversions and calculations relating to chemical reactions, including limiting reactant/theoretical yield/percent yield calculations and reactions occurring in solution.

Goal 7: Begin to learn and categorize selected types of chemical reactions in aqueous solution

Objectives for Chapter 8:

- a. Determine chemical concentration with appropriate units, particularly molarity, and how and when to perform calculations for simple dilutions.
- b. Use of stoichiometry in solution calculations, specifically be able to apply the stoichiometry and limiting reactant concepts to solutions.
- c. Recognize and distinguish between Precipitation Reactions, Acid-Base Reactions and Oxidation-Reduction Reactions.
- d. Predict the products and states of Precipitation reactions.
- e. Recognize and name acids, bases and their salts.
- f. Predict the products and states of Acid-Base reactions.
- g. Recognize strong, weak and non-electrolytes and the role of non-electrolyte and weak electrolyte formation as a driving force for reactions of solutions of strong electrolytes.
- h. Write and balance Molecular Equations, Complete Ionic Equations and Net Ionic Equations.
- i. Assign Oxidation Numbers/States for each element in a compound.
- j. Predict the products of Oxidation-Reduction Reactions and the spontaneity of these reactions.

Goal 8: Understand the various forms of energy and the various roles energy plays in physical processes and chemical systems and reactions.

Objectives for Chapters 9 and 18:

- a. Recognize the nature of the energy of the system and surroundings with respect to heat, work and potential energy.
- b. Comprehend Enthalpy (heat of reaction), a major recurring property.
- c. Learn the First Law of Thermodynamics and its chemical applications/implications.
- d. Learn and use Hess's Law as applied to physical processes and chemical reactions.
- e. Learn the role of enthalpy in physical and chemical processes, including the meaning and the manipulations of enthalpies of formation.
- f. Understand the methods and calculations of basic calorimetry.
- g. Gain basic understanding of standard entropy changes and Gibbs free energy

NATURAL SCIENCE CORE LEARNING GOALS AND OBJECTIVES:

Goal: Scientific Inquiry, Complexity, Critical Thinking, Mathematical & Quantitative Reasoning

- a. Demonstrate an understanding of the theory and concepts central to the study of a particular area or topic treated by the natural sciences.
- b. Understand how to formulate a testable hypothesis and design an informative experiment to explain phenomena observed in the natural world.
- c. Interpret data from scientific experimentation both qualitatively and quantitatively, in order to derive conclusions appropriate to the scope and quality of data.
- d. Recognize limitations of experimental and observational methods and understand concepts of probability, causation, and correlation.