CHEM 1312/1112  
General Chemistry  
Spring, 2021

Instructors:

Mr. Kevin Boudreaux  
Email: Kevin.Boudreaux@angelo.edu  
Phone: 486-6623  
Office: CAV 207B  
Office Hours: MWF 9:30-11, TR 8:30-9:30, or by appointment; Review sessions W 5 pm

Mr. Rigel Rilling  
Email: Rigel.Rilling@angelo.edu  
Phone: 486-6654  
Office: CAV 201B  
Office Hours: MW 2:00-5:00 pm, T 11:00 am-2:00 pm.

Dr. Edith Osborne  
Email: Edith.Osborne@angelo.edu  
Phone: 486-6629  
Office: CAV 218  
Office Hours: MWF 11:00 – 11:50, T 10:00 – 11:00, or by appointment

Dr. Gregory Smith  
Email: Gregory.Smith@angelo.edu  
Phone: 486-6628  
Office: CAV 207A  
Office Hours: MTWR 1:00 – 2:00, or by appointment

Dr. Ralph Zehnder  
Email: Ralph.Zehnder@angelo.edu  
Phone: 486-6662  
Office: CAV 204B  
Office Hours: Office Hours: M 11:00 - 1:30, W 11:00-12:30, F 11-12:00, or by appointment. Also available for virtual office meetings.
CHEM 1312 — GENERAL CHEMISTRY CLASS MEETINGS

Class Meeting Times

<table>
<thead>
<tr>
<th>Sec</th>
<th>Days</th>
<th>Time</th>
<th>Instructor</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>010</td>
<td>TR</td>
<td>09:30 am-10:45 am</td>
<td>Mr. Boudreaux</td>
<td>CAV 211</td>
</tr>
<tr>
<td>020</td>
<td>MWF</td>
<td>10:00 am-10:50 am</td>
<td>Dr. Smith</td>
<td>CAV 223</td>
</tr>
<tr>
<td>030</td>
<td>MWF</td>
<td>10:00 am-10:50 am</td>
<td>Dr. Zehnder</td>
<td>CAV 200</td>
</tr>
<tr>
<td>040</td>
<td>TR</td>
<td>09:30 am-10:45 am</td>
<td>Dr. Zehnder</td>
<td>CAV 219</td>
</tr>
</tbody>
</table>

Required Texts and Materials

- **Textbook, ALEKS online homework, and TopHat Pro online student engagement platform [all three required]:**
  Paul Flowers, Klaus Theopold, Richard Langley, and William R. Robinson,

  **Purchasing Options:**
  1. Textbook – FREE!
  2. ALEKS – McGraw-Hill; [https://www.aleks.com](https://www.aleks.com)

- **Respondus Lockdown & Respondus Monitor** Access through Blackboard. Make sure that your computer/laptop is compatible with Respondus software. Respondus Monitor requires a webcam. Lockdown and Monitor will be used for the administration of exams.

- **Approved Lab Goggles [Required]** (available from the ASU Bookstore or from the lab stockroom)

- **Calculator [Required]:** Scientific calculator capable of performing calculations with scientific notation and logarithms. *Bring your calculator to class and to lab every day. Only non-programmable calculators may be used during the exams.*

Course Description

**1312/CHEM 1312 General Chemistry II (3-0).** This course, which is a continuation of CHEM 1311, focuses on intermolecular forces, chemical kinetics, chemical equilibrium, acid-base chemistry, thermodynamics, and electrochemistry. Additional topics, such as environmental chemistry, coordination chemistry, nuclear chemistry, and/or polymers may be introduced.

**Prerequisites:** Chemistry 1311 is to be completed with a grade of C or better before Chemistry 1312. Proficiency in algebra required. Only students eligible to take college-level mathematics courses may take Chemistry 1312.

**Corequisite:** Chemistry 1112.
**1112/CHEM 1112 General Chemistry II Laboratory (0-3).** Laboratory experiments that focus on laboratory technique, data collection, and analysis. The experiments will expand upon the concepts and topics presented in Chemistry 1312. **Corequisite:** Chemistry 1312.

**Course Delivery**
To maintain academic quality while accommodating physical distancing needs this semester, this course will use a split delivery model that combines face-to-face teaching with remote instruction. The goal is to provide face-to-face instruction to students who want to return to campus, while also allowing students who may need to learn remotely to participate via virtual class sessions. **How Does It Work?**
Your lab sections will be divided, and you will be placed into two laboratory rooms to maintain physical distancing requirements in our assigned laboratory space. You will attend laboratory experiments in face to face manner and as form of online virtual labs alternating weekly. The first week we will only meet online at 11:00 am (2:00 pm) using collaborate. Prelab meetings will always be online using collaborate at 11:00 am (2:00 pm) and the face to face laboratory experiments will take place in CAV 212 and CAV 216 laboratory rooms right after the prelab. This means you need to attend the virtual prelab meeting somewhere near campus, so that you can be at the laboratory within minutes after the prelab meeting has been completed. When your scheduled lab is a virtual online laboratory you do not have to be near campus for prelab or actual lab. You will also be expected to complete coursework via Blackboard®.

Please refer to this Health and Safety web page for updated information about campus guidelines as they relate to the COVID-19 pandemic.

**Technology Requirements**
To successfully complete this course, students need to obtain access to ALEKS, an online homework program. These assignments will be averaged to give a 200-point grade. To register with ALEKS, log into BlackBoard and click on the ALEKS link on the upper left. Then follow the instructions given.

**Virtual Labs through CONNECT from McGraw-Hill**
To register with for the virtual labs, log into BlackBoard and click on the virtual lab link on the upper left. Then you see a list of virtual lab assignments. Click on the first virtual lab assignment you are required to do and follow the instructions.
As a general chemistry II student you will have free access to the virtual labs this semester. During the registration process plug in the following code to complete the registration process: JTBA-771B-36BD-FUPX-EHRM
Do NOT purchase an access code!

Respondus Lockdown Browser
Access to exams and quizzes will be through Respondus Lockdown Browser and will be video recorded via Respondus Monitor. Respondus requires a desktop computer or laptop (not a Chromebook) and a webcam. For best results, use an ethernet cable to connect to your Internet source instead of relying on Wifi. Refer to the Blackboard course for Respondus installation instructions.
Click here for more information:
https://www.youtube.com/watch?time_continue=9&v=XuX8WoeAycs&feature=emb_title

There will be a midterm lab exam and a final lab exam that will be administered through Respondus Lockdown Browser and Respondus Monitor respectively.

Attendance
You are expected to attend all face to face lab meetings according to the schedule of hands on and virtual laboratory experiments. You are expected to arrive for the hands-on laboratory within 10 minutes after the virtual prelab has been completed. You will not be automatically dropped if you stop attending class.
If you feel sick, please stay home. Keep your professor informed as to your status by email (preferred) or telephone (if necessary). Your faculty will work with you to keep up to date in the class.

Grading

Evaluation and Grades
Course grades will be determined as indicated in the table below.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Total Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exams (3×100 pts)</td>
<td>300 pts</td>
</tr>
<tr>
<td>Final Exam</td>
<td>150 pts</td>
</tr>
<tr>
<td>Quizzes, classroom participation</td>
<td>150 pts</td>
</tr>
<tr>
<td>ALEKS Homework</td>
<td>200 pts</td>
</tr>
<tr>
<td>Laboratory</td>
<td>200 pts</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1000 pts</strong></td>
</tr>
</tbody>
</table>
Students who are taking both CHEM 1112 and CHEM 1312 for the first time who wish to drop either course **must** drop both courses, because dropping either course would result in the co-requisite requirement no longer being met.

Overall grades in CHEM 1312/1112 will be determined as follows:

- If **BOTH** CHEM 1312 and CHEM 1112 are completed, the letter graded will be based on a total of 1000 points.
- For students who begin and complete **ONLY** CHEM 1312, a percentage will be calculated using only lecture assessments (first four items listed above with 800 points possible) and the letter grade will be assigned based on that percentage.
- For students who begin and complete **ONLY** CHEM 1112, the percentage will be calculated using only lab assessments and that percentage will be used to assign a letter grade.

**Grading System**

Course grades will be dependent upon completing course requirements and meeting the student learning outcomes.

The following grading scale will be used for this course:

- **A** = 900-1000 points (90-100%)
- **B** = 800-899 points (80-89.9%)
- **C** = 700-799 points (70-79.9%)
- **D** = 600-699 points (60-69.9%)
- **F** = 0-599 points (<60%)

**Exams**

The exams will be given remotely outside of regular class time on the dates listed below:

<table>
<thead>
<tr>
<th>Exam</th>
<th>Date</th>
<th>Room</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam 1</td>
<td>Thursday, February 25</td>
<td>virtual</td>
<td>5:30 pm</td>
</tr>
<tr>
<td>Exam 2</td>
<td>Thursday, March 25</td>
<td>virtual</td>
<td>5:30 pm</td>
</tr>
<tr>
<td>Exam 3</td>
<td>Thursday, April 22</td>
<td>virtual</td>
<td>5:30 pm</td>
</tr>
</tbody>
</table>

Most of the exams will be over material covered since the last exam. However, the course builds on material delivered earlier so the concepts, calculations and techniques from earlier exams may be required. **Only non-programmable calculators may be used on the exams** (i.e., no graphic calculators are allowed).
Make up exams will be at the discretion of your individual faculty. Usually, allowances will only be made in the case of an excused university absence. Communication with your instructor is critical.

**Final Exam**
The Final Exam will be a comprehensive multiple-choice standardized exam published by the American Chemical Society (ACS). Study guides for the ACS exam (“General Chemistry - Official Study Guide”) are available for sale in the lab stockroom and from the [ACS web page](http://acs.org). The schedule for the 1312 final exams is shown below. The complete final exam schedule is also available on the [ASU web page](http://asu.edu).

<table>
<thead>
<tr>
<th>Sec</th>
<th>Days</th>
<th>Time</th>
<th>Instructor</th>
<th>Final Exam Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>010</td>
<td>TR</td>
<td>09:30 -10:45 am</td>
<td>Mr. Boudreaux</td>
<td>Thursd., May. 13</td>
<td>08:00-10:00 am</td>
</tr>
<tr>
<td>020</td>
<td>MWF</td>
<td>10:00 -10:50 am</td>
<td>Dr. Smith</td>
<td>Mon., May. 10</td>
<td>10:30 am-12:30 pm</td>
</tr>
<tr>
<td>030</td>
<td>MWF</td>
<td>10:00 -10:50 am</td>
<td>Dr. Zehnder</td>
<td>Mon., May. 10</td>
<td>10:30 am-12:30 pm</td>
</tr>
<tr>
<td>040</td>
<td>TR</td>
<td>09:30 -10:45 am</td>
<td>Dr. Zehnder</td>
<td>Thursd., May. 13</td>
<td>08:00-10:00 am</td>
</tr>
</tbody>
</table>

**Blackboard**
Grades will be posted on [Blackboard](http://blackboard.com). Information, handouts, homework assignments, and other course documents will either be posted on your instructor’s faculty web page, or on Blackboard.

**Last Day to Drop**
The last day to drop the course with a grade of “W” is **Friday, April 30, 2021**.
Laboratory Meeting Times
The lab classes that accompany the CHEM 1312 lecture course are shown in the table below.

<table>
<thead>
<tr>
<th>Section</th>
<th>Day</th>
<th>Meeting Time</th>
<th>Instructor</th>
<th>Prelab</th>
<th>Lab Rooms</th>
</tr>
</thead>
<tbody>
<tr>
<td>05Z</td>
<td>M</td>
<td>11:00 am-01:50 pm</td>
<td>Mr. Rilling</td>
<td>virtual</td>
<td>CAV 212/216</td>
</tr>
<tr>
<td>06Z</td>
<td>T</td>
<td>11:00 am-01:50 pm</td>
<td>Dr. Osborne</td>
<td>virtual</td>
<td>CAV 212/216</td>
</tr>
<tr>
<td>07Z</td>
<td>M</td>
<td>02:00 pm-04:50 pm</td>
<td>Dr. Zehnder</td>
<td>virtual</td>
<td>CAV 212/216</td>
</tr>
<tr>
<td>08Z</td>
<td>T</td>
<td>02:00 pm-04:50 pm</td>
<td>Dr. Zehnder</td>
<td>virtual</td>
<td>CAV 212/216</td>
</tr>
<tr>
<td>09Z</td>
<td>W</td>
<td>02:00 pm-04:50 pm</td>
<td>Dr. Smith</td>
<td>virtual</td>
<td>CAV 212/216</td>
</tr>
<tr>
<td>10Z</td>
<td>W</td>
<td>11:00 am-01:50 pm</td>
<td>Mr. Rilling</td>
<td>virtual</td>
<td>CAV 212/216</td>
</tr>
<tr>
<td>11Z</td>
<td>R</td>
<td>11:00 am-01:50 pm</td>
<td>Dr. Zehnder</td>
<td>virtual</td>
<td>CAV 212/216</td>
</tr>
<tr>
<td>12Z</td>
<td>R</td>
<td>02:00 pm-04:50 pm</td>
<td>Mr. Rilling</td>
<td>virtual</td>
<td>CAV 212/216</td>
</tr>
</tbody>
</table>

The CHEM 1112 General Chemistry laboratory class accompanies the lecture class. The lab is designed to illustrate some of the principles involved in performing scientific measurements, handling chemicals, and performing chemistry experiments. In some cases, the experiments in the lab will introduce you to concepts before you cover them in the lecture course, and in some cases, the experiments will reinforce concepts already covered in the lecture course.

Laboratory Attire
Beginning on the first day of lab, everyone MUST have approved goggles, long-sleeved shirts which cover the midriff, long pants, and shoes with closed toes and heels (no sandals, slides, etc.). (Basically, you should have as little exposed skin as possible.) Anyone not wearing the appropriate attire will not be allowed into lab.

Lab Procedures and Lab Reports
The procedures for these labs will be posted on Blackboard in the section labeled “Lab Resources.” The procedures will provide a description of the background for each experiment, pre-laboratory questions that will be turned in at the beginning of the lab period, a procedure for the experiment, and a lab report form which must be handed in
when the lab is completed. It is essential that you read the materials posted in Blackboard for that week’s lab before coming to lab. Each lab will be worth 100 points.

**Cleaning Up After Lab**
Make sure that your lab area is clean and that all glassware and hardware has been cleaned and returned to the appropriate drawers before leaving the lab.

**Make-Up Lab Policy**
The lowest lab score will be dropped from the total. If you miss a lab for a valid reason, that is the score that will be dropped.

**Lab Safety Training**
All students enrolled in lab courses are required to take a Mandatory Laboratory Safety Training and Quiz on Blackboard. Instructions for completing the quiz are given below:
1. Login to Blackboard, and choose the course: entitled “Lab Safety Training.”
2. Under the left-hand menu, choose: “Get Started Here”.
3. There are three sections:
   a. Welcome to Lab Safety Training — There are your instructions.
   b. Lab safety training — Click on “Lab Safety — Click here to begin”. This will download a PowerPoint slide show which will cover the safety training.
   c. The lab safety quiz. You must score 90% or higher. You can take it again in 24 hours.

The Lab Safety Training must be completed by the evening of Sunday, 2/7/2021.
If you took the lab safety training during the last year you do not need to do this again.

**Lab Midterm and Final Exams**
There will be a 100-point lab midterm (week of 3/15) and a 100-point lab final exam (week of 4/26). Both will be taken online using Respondus lockdown browser and monitoring with webcam.
Either of these grades will not be dropped from the lab total.
<table>
<thead>
<tr>
<th>Week Of</th>
<th>Class</th>
<th>Lab</th>
</tr>
</thead>
</table>
| 1 1/25  | Chapter 10: Intermolecular Forces  
Dipole-dipole forces, dispersion forces, polarity and solubility, vapor pressures, solubility of gases, phase diagrams, the solid state, structures of metals, ionic solids, crystal structures. | Worksheet with review of significant figures and other gen chem I topics.  
Virtual discussion of qualitative analysis single salt analysis in collaborate. |
| 2 2/1   | Chapter 10, cont. | Virtual Lab 1: Synthesis of CaCO₃ |
| 3 2/8   | Chapter 11: Properties of Solutions  
Interactions between ions, vapor pressures of solutions, colligative properties, osmotic pressure | Qualitative analysis: Single salt analysis. |
| 4 2/15  | Chapter 11, cont. | Virtual Lab 2: Determining the Vant Hoff Factor. |
| 5 2/22  | Chapter 12: Chemical Kinetics  
Reaction rates, integrated rate laws, Arrhenius Equation, reaction mechanisms.  
Exam 1 – Thurs., Feb. 25 (Ch. 10, 11, 12) | Spectrophotometry of FD&C Red 40. |
| 6 3/1   | Chapter 12, cont. | Virtual Lab 3: Kinetics |
| 7 3/8   | Chapter 13: Chemical Equilibrium  
Dynamics of equilibria, equilibrium constants, Le Châtelier's Principle. | A Kinetic Study: The Reaction of Crystal Violet with NaOH? |
| 8 3/15  | Chapter 13, cont. | Lab Midterm Exam. |
| 9 3/22  | Chapter 14: Acid and Base Equilibria  
Strong and weak acids and bases, pH, pKb, pKa, pKw, acidic and basic salts.  
Exam 2 – Thurs., Mar. 25 (Ch. 13, 14) | A Kinetic Study Part II: Temperature Dependence and Activation Energy of the Rate of Reaction of Crystal Violet and NaOH. |
| 10 3/29 | Chapter 14, cont.  
Friday, April 2 spring holiday, no classes | Virtual Lab 4: Equilibrium. |
| 11 4/5  | Chapter 15: Equilibria of other Reaction Classes  
Common ion effect, buffer solutions, solubility product constant. | Analysis of Antacid Tablets. |
<table>
<thead>
<tr>
<th>Week Of</th>
<th>Class</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 4/12</td>
<td>Chapter 16: Thermodynamics</td>
<td>Virtual Lab 5: Identify a weak acid by using a titration curve.</td>
</tr>
<tr>
<td></td>
<td>Spontaneous process, entropy, free energy, chemical equilibrium.</td>
<td></td>
</tr>
<tr>
<td>14 4/26</td>
<td>Chapter 17: Electrochemistry</td>
<td>Lab final Exams.</td>
</tr>
<tr>
<td></td>
<td>Voltaic cells, standard potential, concentration cells, batteries, fuel cells, corrosion.</td>
<td></td>
</tr>
<tr>
<td>15 5/3</td>
<td>Chapter 17, cont.</td>
<td>Virtual Lab 6: Electrochemistry.</td>
</tr>
<tr>
<td>16 5/10</td>
<td>Final Exams</td>
<td></td>
</tr>
</tbody>
</table>

General Policies Related to This Course
All students are required to follow the policies and procedures presented in these documents:

- [Angelo State University Student Handbook](#)
- [Angelo State University Catalog](#)

**Academic Integrity**
Students are expected to maintain complete honesty and integrity in all work. Any student found guilty of any form of dishonesty in academic work is subject of disciplinary action and possible expulsion from ASU.

The College of Science and Engineering adheres to the university’s [Statement of Academic Integrity](#).

**Accommodations for Students with Disabilities**
ASU is committed to the principle that no qualified individual with a disability shall, on the basis of disability, be excluded from participation in or be denied the benefits of the services, programs or activities of the university, or be subjected to discrimination by the university, as provided by the Americans with Disabilities Act of 1990 (ADA), the Americans with Disabilities Act Amendments of 2008 (ADAAA) and subsequent legislation.
Student Disability Services is located in the Office of Student Affairs, and is the designated campus department charged with the responsibility of reviewing and authorizing requests for reasonable accommodations based on a disability. It is the student’s responsibility to initiate such a request by contacting an employee of the Office of Student Affairs, in the Houston Harte University Center, Room 112, or contacting the department via email at ADA@angelo.edu. For more information about the application process and requirements, visit the Student Disability Services website. The employee charged with the responsibility of reviewing and authorizing accommodation requests is:

Dallas Swafford  
Director of Student Disability Services  
Office of Student Affairs  
325-942-2047  
dallas.swafford@angelo.edu  
Houston Harte University Center, Room 112

E-mails
For conducting official ASU business please use your official ASU e-mail account. Please make sure that you check your ASU.EDU account on a regular basis. The instructor may send important announcements regarding this course, homework, and/or exams to your ASU e-mail account. You will not be able to use the excuse of not checking your e-mail with regard to assignments, tasks, or exams you missed. Any submitted e-mails are expected to be written in a professional format and impeccable English. For more information how to communicate by e-mail please see: https://www.wikihow.com/Email-a-Professor  
The instructor will refuse to read and/or respond to any messages that do not comply with such requirements. The instructor will respond to legitimate e-mails within 24 - 48 hours during the week and may not respond until after weekends or holidays if messages are received on any of such days.

Virtual communication
Office hours and/or advising may be done with the assistance of the telephone, Collaborate, Skype, Facetime, etc.

Incomplete Grade Policy
It is policy that incomplete grades be reserved for student illness or personal misfortune. Please contact faculty if you have serious illness or a personal misfortune that would
keep you from completing course work. Documentation may be required. See ASU Operating Policy 10.11 Grading Procedures for more information.

**Plagiarism**

Plagiarism is a serious topic covered in ASU’s Academic Integrity policy in the Student Handbook. Plagiarism is the action or practice of taking someone else’s work, idea, etc., and passing it off as one’s own. Plagiarism is literary theft.

In your discussions and/or your papers, it is unacceptable to copy word-for-word without quotation marks and the source of the quotation. It is expected that you will summarize or paraphrase ideas giving appropriate credit to the source both in the body of your paper and the reference list.

Papers are subject to be evaluated for originality. Resources to help you understand this policy better are available at the ASU Writing Center.

**Student Absence for Observance of Religious Holy Days**

A student who intends to observe a religious holy day should make that intention known in writing to the instructor prior to the absence. See ASU Operating Policy 10.19 Student Absence for Observance of Religious Holy Day for more information.

**Title IX at Angelo State University**

The University prohibits discrimination based on sex, which includes pregnancy, sexual orientation, gender identity, and other types of Sexual Misconduct. Sexual Misconduct is a broad term encompassing all forms of gender-based harassment or discrimination including: sexual assault, sex-based discrimination, sexual exploitation, sexual harassment, public indecency, interpersonal violence (domestic violence and/or dating violence), and stalking. As a faculty member, I am a Responsible Employee meaning that I am obligated by law and ASU policy to report any allegations I am notified of to the Office of Title IX Compliance.

Students are encouraged to report any incidents of sexual misconduct directly to ASU’s Office of Title IX Compliance and the Director of Title IX Compliance/Title IX Coordinator at:

Michelle Miller, J.D.
Special Assistant to the President and Title IX Coordinator
Mayer Administration Building, Room 210
325-486-6357
michelle.boone@angelo.edu
You may also file a report online 24/7 at www.angelo.edu/incident-form.

If you are wishing to speak to someone about an incident in confidence you may contact the University Health Clinic and Counseling Center at 325-942-2173 or the ASU Crisis Helpline at 325-486-6345.

For more information about Title IX in general you may visit www.angelo.edu/title-ix.

**Required Use of Masks/Facial Coverings:** As a member of the Texas Tech University System, Angelo State University has adopted the mandatory [Facial Covering Policy](#) to ensure a safe and healthy classroom experience. Current research on the COVID-19 virus suggests there is a significant reduction in the potential for transmission of the virus from person to person by wearing a mask/facial covering that covers the nose and mouth areas. Therefore, in compliance with the university policy students in this class are required to wear a mask/facial covering before, during, and after class. Faculty members may also ask you to display your daily screening badge as a prerequisite to enter the classroom. You are also asked to maintain safe distancing practices to the best of your ability. For the safety of everyone, any student not appropriately wearing a mask/facial covering will be asked to leave the classroom immediately. The student will be responsible to make up any missed class content or work. Continued non-compliance with the Texas Tech University System Policy may result in disciplinary action through the Office of Student Conduct.

**Modifications to the Syllabus**
This syllabus, including grade evaluation and course schedule, is subject to modification. In particular, the COVID-19 pandemic may require significant changes in course delivery and content on potentially short notice.

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**Student Learning Outcomes**

- **Learning Goal 1:** Students will be able to analyze complex chemical problems and draw logical conclusions.
Students will be able to use an understanding of atomic structure at the basic and atomic levels to analyze the structure and reactivity of substances and chemical species. 

Students will be able to use an understanding of how energy interacts with matter to predict stable chemical species, and perform thermodynamic calculations describing chemical reactions.

- **Learning Goal 2a:** Students will be able to understand and apply scientific reasoning in the chemical sciences.
  - Students will be able to use an understanding of ions and molecules at the atomic level to predict the behavior of reactions in aqueous solutions.
  - Students will be able to use the basic ideas of quantum mechanics to describe how molecular bonds form and to predict molecular shape and polarity. Molecular structure and polarity will be used to predict the forces between molecules and relate those forces to the states of matter and phase changes.

- **Learning Goal 2b:** Students will be able to employ mathematics in the analysis of chemical problems.
  - The mole concept, chemical formulas and balanced chemical equations will be used to do chemical calculations that relate macroscopic measurements to numbers of atoms, ions or molecules.
  - Students will be able to do calculations involving solution concentration and know how to prepare solutions of given concentrations.
  - Students will be able to quantitatively predict gas properties using gas law calculations.

- **Learning Goal 3:** Students will be able to demonstrate technical and analytical skills in chemistry.
  - Students will be able to use the periodic table to determine basic atomic information and to predict trends in atomic properties.
  - Students will be able to interconvert between chemical names and formulas to the extent that they can work problems given only one of those pieces of information.
  - Students will be able to classify common types of chemical reactions and predict the outcomes of reactions.

**Evaluation of Student Learning Outcomes**
Student learning outcomes will be evaluated by test questions or by the grading of in-classroom activities, as described by your instructor.

**Texas Higher Education Coordinating Board Natural Sciences Objectives**
The objective of the study of a natural sciences component of a core curriculum is to enable the student to understand, construct, and evaluate relationships in the natural sciences, and to enable the student to understand the basis for building and testing theories.

**Exemplary Educational Objectives**

1. To understand and apply method and appropriate technology to the study of natural sciences.
2. To recognize scientific and quantitative methods and the differences between these approaches and other methods of inquiry and to communicate findings, analyses, and interpretation both orally and in writing.
3. To identify and recognize the differences among competing scientific theories.
4. To demonstrate knowledge of the major issues and problems facing modern science, including issues that touch upon ethics, values, and public policies.
5. To demonstrate knowledge of the interdependence of science and technology and their influence on, and contribution to, modern culture.

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1. angelo.blackboard.com
3. https://www.angelo.edu/academics/catalog/
5. https://www.angelo.edu/current-students/disability-services/
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