II. Florida Agricultural and Mechanical University

Professional Education Unit

Tallahassee, Florida 32307

<table>
<thead>
<tr>
<th>COURSE SYLLABUS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course Number</strong>: CHM 1046</td>
</tr>
<tr>
<td><strong>Prerequisite(s)</strong>: CHM 1045 with passing grade</td>
</tr>
<tr>
<td><strong>Course Hours</strong>: 3 per week</td>
</tr>
<tr>
<td><strong>Department</strong>: Chemistry</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Faculty Name</strong>: Dr. Jesse Edwards</td>
</tr>
<tr>
<td><strong>Place and Time</strong>: Room 310, BLP CB 1:25-2:15 p.m. MWF</td>
</tr>
<tr>
<td><strong>Office Location</strong>: FHS (Science Research Building) Room 110</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Office Hours</th>
<th>Monday 9:15-12:00</th>
<th>Tuesday</th>
<th>Wednesday 9:15-12:00</th>
<th>Thursday 9:15-12:00</th>
<th>Friday 9:15-12:00</th>
<th>Saturday</th>
</tr>
</thead>
</table>

**Course Description**
A continuation of the study of the principles of chemistry and their applications. The topics include properties and interactions of matter from molecular viewpoint, solution properties, acids and bases, equilibrium, kinetics, descriptive chemistry of the elements, oxidation-reduction, nuclear chemistry/environmental chemistry and an introduction to organic chemistry.

**Course Purpose**
Required course for science and engineering majors.

**Online Material**
Constant use of the course website will have a major impact on your success in this course.
Most of the relevant course material (i.e., course outline, lecture notes, problem sets, quizzes, test/quiz grades, assignments, etc.) will be presented to you online via the website, and not in class. If you do not have access to a computer in your dormitory room you may use the computers located in the various facilities on campus such as Coleman Library.

WEBSITE 1: http://edugen.wiley.com/edugen/class/cls157279/

REFERENCES
2. Essential Algebra for Chemistry Students by David W. Ball, Paul M. Treichel, Gabriela C. Publisher: Brooks Cole
3. General Chemistry by Linus Pauling

Conceptual Framework

The Conceptual Framework in the Professional Education Unit (PEU) at Florida A&M University is an integrated approach to providing educational experiences that result in exemplary professional educators. The Framework is comprised of six themes with the mission of developing high quality classroom teachers, administrators and support personnel. The term “exemplary” refers to the kind of graduates the PEU strives to produce. The figure below provides a diagram of the Exemplary Professional Conceptual Framework:

![Diagram](image)

DIVERSITY

- CF 1
- Through this focal area, the FAMU professional education candidate will:

| CF: 1.5 (K, S) | Establish a comfortable environment in which all students can | F: 2, 7, 11 | I: 5 |
TECHNOLOGY

• CF 2
  • Through this focal area, the FAMU professional education candidate will:

| CF: 2.1 (S) | Use of available technology and software to support student learning. | F: 4,12 | I: 6 |
| CF: 2.2 (S) | Use technology to manage, evaluate and improve instruction. | F: 4,12 | I: 6,7 |
| CF: 2.7 (S) | Facilitate the use of technology by students. | F: 4,12 | I: 6 |

CRITICAL THINKING

• CF 4
  • Through this focal area, the FAMU professional education candidate will:

| CF: 4.3 (D) | Value critical thinking and self-directed learning as habits of mind. | F: 4 | I: 1,4 |
| CF: 4.5 (S) | Demonstrate the use of higher order thinking skills. | F: 8 | I: 4 |

PROFESSIONALISM

  • CF 5
  • Through this focal area, the FAMU professional education candidate will:

| CF: 5.1 (K) | Know the content | F: 8 | I: 1 |

National and State Standards Addressed in the Course

Interstate New Teacher Assessment and Support Consortium (INTASC) Standards

Standard 1: Subject Matter: The teacher understands the central concepts, tools of inquiry, and structures of the discipline(s) he or she teaches and can create learning experiences that make these aspects of subject matter meaningful for students.

1.10 Knowledge
1.12 The teacher understands how students' conceptual frameworks and their misconceptions for an area of knowledge can influence their learning.

1.13 The teacher can relate his/her disciplinary knowledge to other subject areas.

1.20 Dispositions
1.24 The teacher is committed to continuous learning and engages in professional discourse about subject matter knowledge and children's learning of the discipline.
1.30 Performances
1.35 The teacher develops and uses curricula that encourage students to see, question, and interpret ideas from diverse perspectives.

Standard 4: Instructional Strategies: The teacher understands and uses a variety of instructional strategies to encourage students' development of critical thinking, problem solving, and performance skills.

4.10 Knowledge
4.11 The teacher understands the cognitive processes associated with various kinds of learning (e.g. critical and creative thinking, problem structuring and problem solving, invention, memorization and recall) and how these processes can be stimulated.

4.12 The teacher understands the principles and techniques, along with advantages and limitations, associated with various instructional strategies (e.g. cooperative learning, direct instruction, discovery learning, whole group discussion, independent study, interdisciplinary instruction).

4.13 The teacher knows how to enhance learning through the use of a wide variety of materials as well as human and technological resources (e.g. computers, audio-visual technologies, videotapes and discs, local experts, primary documents and artifacts, texts, reference books, literature, and other print resources).

4.20 Dispositions
4.21 The teacher values the development of students' critical thinking, independent problem solving, and performance capabilities.

4.23 The teacher values the use of educational technology in the teaching and learning process.

4.30 Performances
4.31 The teacher carefully evaluates how to achieve learning goals, choosing alternative teaching strategies and materials to achieve different instructional purposes and to meet student needs (e.g. developmental stages, prior knowledge, learning styles, and interests).

4.33 The teacher constantly monitors and adjusts strategies in response to learner feedback.

4.34 The teacher varies his or her role in the instructional process (e.g. instructor, facilitator, coach, audience) in relation to the content and purposes of instruction and the needs of students.

4.36 The teacher uses educational technology to broaden student knowledge about technology, to deliver instruction to students at different levels and paces, and for advanced levels of learning.

Standard 5, Learning Environment
The teacher uses an understanding of individual and group motivation and behavior to create a learning environment that encourages positive social interaction, active engagement in learning, and self-motivation.

5.10 Knowledge
5.11 The teacher can use knowledge about human motivation and behavior drawn from the foundational sciences of psychology, anthropology, and sociology to develop strategies for organizing and supporting
5.12 The teacher understands how social groups function and influence people, and how people influence groups.

5.13 The teacher knows how to help people work productively and cooperatively with each other in complex social settings.

5.14 The teacher understands the principles of effective classroom management and can use a range of strategies to promote positive relationships, cooperation, and purposeful learning in the classroom.

5.15 The teacher recognizes factors and situations that are likely to promote or diminish intrinsic motivation, and knows how to help students become self-motivated.

5.20 Dispositions
5.21 The teacher takes responsibility for establishing a positive climate in the classroom and participates in maintaining such a climate in the school as a whole.

5.22 The teacher understands how participation supports commitment, and is committed to the expression and use of democratic values in the classroom.

5.23 The teacher values the role of students in promoting each other's learning and recognizes the importance of peer relationships in establishing a climate of learning.

5.24 The teacher recognizes the values of intrinsic motivation to students' life-long growth and learning.

5.25 The teacher is committed to the continuous development of individual students' abilities and considers how different motivational strategies are likely to encourage this development for each student.

5.30 Performances
5.31 The teacher creates a smoothly functioning learning community in which students assume responsibility for themselves and one another, participate in decision making, work collaboratively and independently, and engage in purposeful learning activities.

5.32 The teacher engages students in individual and group learning activities that help them develop the motivation to achieve, by, for example, relating lessons to students' personal interests, allowing students to have choices in their learning, and leading students to ask questions and pursue problems that are meaningful to them.

5.33 The teacher organizes, allocates, and manages the resources of time, space, activities, and attention to provide active and equitable engagement of students in productive tasks.

5.34 The teacher maximizes the amount of class time spent in learning by creating expectations and processes for communication and behavior along with a physical setting conducive to classroom goals.

5.35 The teacher helps the group to develop shared values and expectations for student interactions, academic discussions, and individual and group responsibility that create a positive classroom climate of openness, mutual respect, support, and inquiry.

5.36 The teacher analyzes the classroom environment and makes decisions and adjustments to enhance social relationships, student motivation and engagement, and productive work.
5.37 The teacher organizes, prepares students for, and monitors independent and group work that allows for full and varied participation of all individuals.

**Standard 6, Communication**
The teacher uses knowledge of effective verbal, nonverbal, and media communication techniques to foster active inquiry, collaboration, and supportive interaction in the classroom.

**6.10 Knowledge**
6.11 The teacher understands communication theory, language development, and the role of language in learning.

6.12 The teacher understands how cultural and gender differences can affect communication in the classroom.

6.13 The teacher recognizes the importance of nonverbal as well as verbal communication.

6.14 The teacher knows about and can use effective verbal, nonverbal, and media communication techniques.

**6.20 Dispositions**
6.21 The teacher recognizes the power of language for fostering self-expression, identity development, and learning.

6.22 The teacher values many ways in which people seek to communicate and encourages many modes of communication in the classroom.

6.23 The teacher is a thoughtful and responsive listener.

6.24 The teacher appreciates the cultural dimensions of communication, responds appropriately, and seeks to foster culturally sensitive communication by and among all students in the class.

**6.30 Performance**
6.31 The teacher models effective communications strategies in conveying ideas and information and in asking questions (e.g. monitoring the effects of messages, restating ideas and drawing connections, using visual, aural, and kinesthetic cues, being sensitive to nonverbal cues given and received).

6.32 The teacher supports and expands learner expression in speaking, writing, and other media.

6.33 The teacher knows how to ask questions and stimulate discussion in different ways for particular purposes, for example, probing for learner understanding, helping students articulate their ideas and thinking processes, promoting risk-taking and problem-solving, facilitating factual recall, encouraging convergent and divergent thinking, stimulating curiosity, helping stimulate students to question.

6.34 The teacher communicates in ways that demonstrate a sensitivity to cultural and gender differences (e.g. appropriate use of eye contact, interpretation of body language and verbal statements, acknowledgment of and responsiveness to different modes of communication and participation).

6.35 The teacher knows how to use a variety of media communication tools, including audio-visual aids and computers, including educational technology, to enrich learning opportunities.
**Standard 7, Planning Instruction**
The teacher plans and manages instruction based upon knowledge of subject matter, students, the community, and curriculum goals.

**7.10 Knowledge**
7.11 The teacher understands learning theory, subject matter, curriculum development, and student development and knows how to use this knowledge in planning instruction to meet curriculum goals.

7.12 The teacher knows how to take contextual considerations (instructional materials, individual student interests, needs, and aptitudes, and community resources) into account in planning instruction that creates an effective bridge between curriculum goals and students' experiences.

7.13 The teacher knows when and how to adjust plans based on student responses and other contingencies.

**7.20 Dispositions**
7.21 The teacher values both long term and short term planning.

7.22 The teacher believes that plans must always be open to adjustment and revision based on student needs and changing circumstances.

7.23 The teacher values planning as a collegial activity.

**7.30 Performance**
7.31 As an individual and a member of a team, the teacher selects and creates learning experiences that are appropriate for curriculum goals, relevant to learners, and based upon principles of effective instruction (e.g. that activate students' prior knowledge, anticipate preconceptions, encourage exploration and problem-solving, and build new skills on those previously acquired).

7.32 The teacher plans for learning opportunities that recognize and address variation in learning styles and performance modes.

7.33 The teacher creates lessons and activities that operate at multiple levels to meet the developmental and individual needs of diverse learners and help each progress.

7.34 The teacher creates short-range and long-term plans that are linked to student needs and performance, and adapts the plans to ensure and capitalize on student progress and motivation.

7.35 The teacher responds to unanticipated sources of input, evaluates plans in relation to short- and long-range goals, and systematically adjusts plans to meet student needs and enhance learning.

**Florida Educator Accomplished Practices (FEAP)**

**Accomplished Practice #2: COMMUNICATION**
2.1 The preprofessional teacher recognizes the need for effective communication in the classroom and is in the process of acquiring techniques which she/he will use in the classroom.

2.2 STANDARD: Communication -- Uses effective communication techniques with students and all other stakeholders.
2.a Establishes positive interactions in the learning environment that uses incentives and consequences for students.
2.b Establishes positive interactions between the teacher and student that are focused upon learning.
2.c Varies communication (both verbal and nonverbal) according to the nature and needs of individuals.
2.d Encourages students in a positive and supportive manner.
2.e Communicates to all students high expectations for learning.
2.h Practices strategies that support individual and group inquiry.
2.j Identifies communication techniques for use with colleagues, school/community specialists, administrators, and families, including families whose home language is not English.

**Accomplished Practice #4: Critical-thinking**

4.1 The pre-professional teacher is acquiring performance assessment techniques and strategies that measure higher order thinking skills in students and is building a repertoire of realistic projects and problem-solving activities designed to assist all students in demonstrating their ability to think creatively. (A) Uses appropriate techniques and strategies which promote and enhance critical, creative, and evaluative thinking capabilities of students.
1. Uses assessment strategies (traditional and alternate) to assist the continuous development of the learner. ASSESSMENT
4.2. Uses appropriate techniques and strategies which promote and enhance critical, creative, and evaluative thinking capabilities of students.
4.a Provides opportunities for students to learn higher-order thinking skills.
4.b Identifies strategies, materials, and technologies that she/he will use to expand students’ thinking abilities.
4.g Demonstrates and models the use of higher-order thinking abilities.

**Accomplished Practice #7: HUMAN DEVELOPMENT AND LEARNING**

7.1 Drawing upon well established human development/learning theories and concepts and a variety of information about students, the preprofessional teacher plans instructional activities.
7.a Recognizes developmental levels of students and identifies differences within a group of students.
7.d Communicates with students effectively by taking into account their developmental levels, linguistic development, cultural heritage, experiential background, and interests.
7.e Varies activities to accommodate different student learning needs, developmental levels, experiential backgrounds, linguistic development, and cultural heritage.
7.h Develops short-term personal and professional goals relating to human development and learning.

**Accomplished Practice #8: KNOWLEDGE OF SUBJECT MATTER**

8.2 Demonstrates knowledge and understanding of the subject matter.
8.b Increases subject matter knowledge in order to integrate the learning activities.
8.f Develops short- and long-term personal and professional goals relating to knowledge of subject matter.

**Accomplished Practice #11: ROLE OF THE TEACHER**

11.1 The preprofessional teacher communicates and works cooperatively with families and colleagues to improve the educational experiences at the school.
11.2 STANDARD: Role of the Teacher -- Works with various education professionals, parents, and other stakeholders in the continuous improvement of the educational experiences of students.
11.b Provides meaningful feedback on student progress to students and families and seeks assistance for self and families.

**Accomplished Practice #12: TECHNOLOGY**

12.b Uses technology tools on a personal basis.
12.c Demonstrates awareness of and models acceptable use policies and copyright issues.
12.d Identifies and uses standard references in electronic media.
12.i Selects and utilizes educational software tools for instructional purposes based upon reviews and recommendations of other professionals.
12.j Uses digital information obtained through intranets and/or the Internet (e.g., e-mail and research).
12.k Uses technology to collaborate with others.
12.l Develops professional goals relating to technology integration.

**National Science Teachers Association Standards (NSTA)**

**Standard 1: Content**

Teachers of science understand and can articulate the knowledge and practices of contemporary science. They can interrelate and interpret important concepts, ideas, and applications in their fields of licensure; and can conduct scientific investigations. To show that they are prepared in content, teachers of science must demonstrate that they:

a. Understand and can successfully convey to students the major concepts, principles, theories, laws, and interrelationships of their fields of licensure and supporting fields as recommended by the National Science Teachers Association.

b. Understand and can successfully convey to students the unifying concepts of science delineated by the National Science Education Standards.

c. Understand and can successfully convey to students important personal and technological applications of science in their fields of licensure.

d. Understand research and can successfully design, conduct, report and evaluate investigations in science.

e. Understand and can successfully use mathematics to process and report data, and solve problems, in their field(s) of licensure.

**B.2.** In relation to the physical sciences, science specialists at this level should have all of the competencies described for the elementary generalist, but also should be prepared in chemistry and physics to lead students to understand:

11. Potential and kinetic energies and concepts of work.
13. States of matter and bonding in relation to molecular behavior and energy.
15. Classifications of elements and compounds.
16. Solvents (especially water) and solutions.

**B.4.** To create interdisciplinary perspectives and to help students understand why science is important to them, elementary/middle level science specialists should have all of the competencies described for the elementary generalist, but also should be prepared to lead students to understand:

33. Use of technological tools in science, including calculators and computers.

**C.3.a. Core Competencies.** All teachers of chemistry should be prepared lead students to understand the unifying concepts required of all teachers of science, and should in addition be prepared to lead students to understand:

1. Fundamental structures of atoms and molecules.
2. Basic principles of ionic, covalent, and metallic bonding.
3. Physical and chemical properties and classification of elements including periodicity.

**Standard 10: Professional Growth**

Teachers of science strive continuously to grow and change, personally and professionally, to meet the diverse needs of their students, school, community, and profession. They have a desire and disposition for growth and betterment. To show their disposition for growth, teachers of science must demonstrate that they:

a. Engage actively and continuously in opportunities for professional learning and leadership that reach beyond minimum job requirements.
b. Reflect constantly upon their teaching and identify ways and means through which they may grow professionally.
c. Use information from students, supervisors, colleagues and others to improve their teaching and facilitate their professional growth.

**Professional Organization/Learned Society Standards**

National Society of Science Teachers Association
Florida Teacher Certification Examination (FTCE) Subject Area Examination (SAE) Competencies and Skills

**Professional Society / National and State Standards Addressed in the Course**

**American Chemical Society (ACS) Expected Outcomes:**
This course should ensure that students know basic chemical concepts such as stoichiometry, states of matter, atomic structure, molecular structure and bonding, thermodynamics, equilibria, and kinetics. Students need to be competent in basic laboratory skills such as safe practices, keeping a notebook, use of electronic balances and volumetric glassware, preparation of solutions, chemical measurements using pH electrodes and spectrophotometers, data analysis, and report writing.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Behavioral Objectives</th>
<th>INTASC Standards</th>
<th>FTCE SAE</th>
<th>FEAPS</th>
<th>NSTA</th>
<th>PEU Conceptual Framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework: Selected biochemistry problems from the textbook and additional instructor addendums Each homework assignment will address course content and is aimed at development of problem solving</td>
<td>Students will 1. Demonstrate knowledge of the lecture material, and 2. Develop and enhance the skill of analytical analysis and problem solving</td>
<td>1, 4, 5, 6, 7, 9</td>
<td>1.6</td>
<td>2, 4, 7, 8, 11, 12</td>
<td>1; 1. B.2.11, 1.B.2.13, 1. B.2.14, 1. B.2.15, 1.B.2.16; 1.B.4.33; 1.C.3.a.1, 1.C.3.a.2, 1.C.3.a.3, 1.C.3.a.6, 1.C.3.a.8, 10.a., 10.b, 10.c.</td>
<td>1.5, 2.1, 2.2, 2.7, 4.3, 4.5, 5.1</td>
</tr>
<tr>
<td>Quizzes</td>
<td>Develop critical thinking and written communication skills</td>
<td>1, 4, 5, 6, 7, 9</td>
<td>1.6</td>
<td>1, 4, 5, 6, 7, 9</td>
<td>1, 4, 7, 8, 11, 12</td>
<td>1.5, 2.1, 2.2, 2.7, 3.4, 4.3, 4.5, 5.1</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-----------------------------------------------------------</td>
<td>------------------</td>
<td>-----</td>
<td>------------------</td>
<td>-------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Selected biochemistry problems from the textbook and additional instructor addendums</td>
<td>Each homework assignment will address course content and is aimed at development of problem solving skills.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exams: Four one-hour tests, each test covering specific chapters. Final exam is comprehensive and will cover the material of Chapters 1-21.</td>
<td>Develop critical thinking and written communication skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Overall Goals of the Course**

The student should be developing a disciplined attitude toward learning and analytical reasoning skills, i.e., the ability to read, understand, and devise solutions to problems. The course objectives have been chosen in order to help students acquire a sound knowledge of inorganic chemistry.

**Academic Learning Compact (ALC) / Expected Outcome**

Specific outcomes of the Department of Chemistry for CHM1046 students can be summarized as follows:

1. **Communication**
   - Demonstrate the ability to effectively communicate chemical concepts and principles in written formats.

2. **Content knowledge**
   - Identify and apply the principles and concepts of basic chemistry. The principles and concepts will be covered in chapters 11-19 in part or their entirety.

3. **Quantitative Reasoning**
   - Analyze and solve chemical problems using basic chemical principles.
4. Critical Thinking
   Ability to analyze and solve chemical problems, read, evaluate and interpret numerical and
general chemical information.

5. Information Resources
   Ability to make effective use of information resources and technology in chemical
applications.

Specific Learning Objectives

CHAPTER 10. Gases (Review of needed material covered in CHM 1045)

CHAPTER 11. Intermolecular Forces in Liquids and Solids (Standards Addressed in this
chapter : FTCE 1.6, 2.3, 2.4 ACS)
   Upon completion of the chapter, the student should:
   • Know what a molecular dipole, induced, instantaneous, and permanent dipoles.
   • Know what type of molecules can engage in hydrogen bonding.
   • Realize that liquids and solids are non-compressible, while gases are compressible.
   • Be able to state what affects the rate of a liquid’s evaporation.
   • Understand dynamic and static equilibrium.
   • Know comparative rates of evaporation in various liquids and solids based on their physical and
molecular properties.
   • Be able to use and explain heating curve and cooling curve diagrams.
   • Be able to define $\Delta H_{\text{fus}}$, $\Delta H_{\text{vap}}$, and $\Delta H_{\text{sub}}$.
   • Be able to use the Clausius – Clapeyron equation, in both of its common forms.
   • Be able to apply Le Châtelier’s Principle to dynamic equilibrium systems.
   • Be able to read and understand phase diagrams and define triple point, critical point supercritical
fluid.
   • Know what is different about the phase diagram of water when compared to other substances.
   • Be able to tell the difference between simple, face-centered, and body-centered cubic lattice
structures.
   • Understand how the Bragg Equation relates to diffraction patterns.
   • Be able to estimate whether a crystalline, solid substance is an ionic, molecular, covalent, or
metallic crystal in its atomic structure.

CHAPTER 12. Properties of Solutions (Standards Addressed in this chapter : FTCE 1.4,
1.5.ACS)
   Upon completion of the chapter, the student should:
   • Be able to define solute and solvent. See that the tendency of any system to disorder is
one major driving force for the formation of solutions.
   • Be able to tell the difference between an exothermic and endothermic heat of solution,
$\Delta H_{\text{solv}}$, and solutions can be formed from all three states of matter as both solute and
solvent.
   • Know why a gas is less soluble in aqueous solution with increasing temperature, while
most solids are more soluble with increasing temperature.
   • Be able to use Henry’s Law, $C_g = k_g P_g$. 
- Be able to define freezing point depression and boiling point elevation.
- Be able to use Raoult’s Law, $P_{\text{solution}} = X_{\text{solvent}} \cdot P_{\text{solvent}}^o$. And explain deviations from Raoult’s Law.
- Be able to define osmosis and know what component of a solution flows through a semi-permeable membrane in an osmotic system.
- Be able to use the van’t Hoff equation.
- Be able to give examples of colligative properties of solutions.

**CHAPTER 13. Chemical Kinetics (Standards Addressed in this chapter: FTCE 4.8, 4.10, ACS)**

Upon completion of the chapter, the student should:
- Be able to define the term kinetics. Understand what factors affect reaction rate.
- Understand that all rates are functions of something per unit time.
- Be able to describe theories of reaction rate and articulate the main idea behind collision theory, and effective collisions.
- Have a thorough understanding of the Arrhenius Equation and know how to determine activation energy from an Arrhenius Equation.
- Be able to work with rate laws for elementary processes.
- Understand the difference between homo- and heterogeneous catalysts.

**CHAPTER 14. Chemical Equilibrium (Standards Addressed in this chapter: FTCE 1.6, ACS)**

Upon completion of the chapter, the student should:
- Know what a dynamic equilibrium is and be able to differentiate between static and dynamic equilibrium.
- Know how to determine mass action expressions for a reaction.
- Understand the relationship between $Q$ and $K$.
- Know when reaction order must be determined experimentally.
- Be able to convert reaction coefficients to equilibrium expression superscripts for equilibrium reactions.
- Be capable in manipulating equations for chemical equilibria.
- Know under what conditions $K_c$ can be converted into $K_p$.
- Understand the meaning of the magnitude of $K$.
- Understand the relationship $\Delta G^o = -RT\ln K$.
- Know the relationship of number of moles of gas to $K_c$ and $K_p$.
- Be able to determine conditions for computing $K$ in heterogeneous equilibria.
- Understand Le Châtelier’s Principle and know what conditions affect or shift a dynamic equilibrium.
- Know how to calculate $K_c$ from equilibrium concentrations and be able to establish concentration tables to determine an unknown concentration of reactant or product at equilibrium.
- Be able to calculate equilibrium concentrations when given a $K_c$ that is very small.

**CHAPTER 15. Acid-Base Equilibrium FTCE 1.6, ACS**

Upon completion of the chapter, the student should:
- Be able to identify a Bronsted acid and a Bronsted base.
- Understand the concept of conjugate acids and bases.
• Understand what is meant by complete and partial dissociation.
• Understand periodic trends in acid and base strengths.
• Have a thorough understanding of redox reactions.
• Understand what the term pH represents.
• Know the relationship between pH and pOH.
• Understand the mathematical relations between pH, [H⁺], pOH, and [OH⁻].
• Know what constitutes an acidic, basic, or neutral solution.
• Be able to define strong acid and strong base, and know the difference between them and weak acids or bases.

CHAPTER 16. Equilibria in solutions of Weak Acids and Bases (Standards Addressed in this chapter: FTCE 4.11,4.12,4.9, ACS)

Upon completion of the chapter, the student should:
• Be able to define strong acid and strong base, and know the difference between them and weak acids or bases.
• Understand what $K_a$ and $K_b$ are and know the relationship between $K_a$ and $pK_a$ (or $K_b$ and $pK_b$).
• Understand what constitutes a conjugate acid - base pair.
• Be able to calculate $K_a$ and $K_b$ from equilibrium concentrations.
• Realize that salts can also act as acids or bases be able to predict the acid or base characteristics of a salt.
• Know how to solve equilibrium calculations with the quadratic equation.
• Be able to define the term buffer and know what makes a buffer system different from a non-buffered one.
• Understand the idea of buffer capacity.
• Know if a titration endpoint will be acidic, basic, or neutral based on the strengths of the acid and base in the system.
• Understand that no polyprotic acid is a strong acid in both dissociations.
• Be able to determine pH for various salt solutions.
• Have a basic understanding of how acid - base indicators work.

CHAPTER 17.1. Solubility (Standards Addressed in this chapter: FTCE 2.1,2.2; ACS)

Upon completion of the chapter, the student should:
• Evaluate solutions and their colligative properties in detail.
• Evaluate problems relating to molar mass and solution concentrations.

CHAPTER 18. Chemical Thermodynamics (Standards Addressed in this chapter: FTCE 4.18, ACS)

Upon completion of the chapter, the student should:
• Have a feel for whether a change occurs naturally or not.
• Understand and be able to use the Three Laws of Thermodynamics.
• Know the relationship between heat, work, and energy change.
• Be able to define entropy.
• Be able to predict the sign of a $\Delta S$ at different temperatures, volumes, and $\Delta H$s.
• Know what Gibbs Free Energy is, and how it relates to enthalpy and entropy.
• Know how to work with standard free energies or reactions.
Understand that change in Gibbs Free Energy in an equilibrium situation is zero.

Know how to determine temperature for a phase change when enthalpy change and entropy change are known.

CHAPTER 19. Electrochemistry (Standards Addressed in this chapter: FTCE 4.16, 4.17, 4.21)
Upon completion of the chapter, the student should:

- Know what an electrochemical cell is.
- Be able to define anode and cathode.
- Understand that in aqueous electrochemistry, water may also undergo electrolysis.
- Know that a coulomb is 1 amp multiplied by 1 second.
- Be able to use conversion factors incorporating coulombs and moles of electrons.
- Have been exposed to the idea of industrial scale electrolysis for such elements and compounds as: aluminum, magnesium, sodium, copper, and brine.
- Understand that spontaneous electrochemical cells are essentially batteries.
- Know how to utilize SRP in determining cell potential for a given reaction.
- Be capable of predicting spontaneous redox cells.
- Be able to calculate free energy change for a reaction from its cell potential.
- Be able to calculate the equilibrium constant for a reaction from its cell potential.
- Have a working understanding of the Nernst equation.
- Understand the benefits of various types of galvanic cells (batteries) in specific situations.

Professional Organization/Learned Society Standards

National Society of Science Teachers Association
Florida Teacher Certification Examination (FTCE) Subject Area Examination (SAE) Competencies and Skills

Professional Society / National and State Standards Addressed in the Course

American Chemical Society (ACS) Expected Outcomes:
This course should ensure that students know basic chemical concepts such as stoichiometry, states of matter, atomic structure, molecular structure and bonding, thermodynamics, equilibria, and kinetics. Students need to be competent in basic laboratory skills such as safe practices, keeping a notebook, use of electronic balances and volumetric glassware, preparation of solutions, chemical measurements using pH electrodes and spectrophotometers, data analysis, and report writing.

Florida Teacher Certification Examination (FTCE) Subject Area Examination (SAE) Competencies and Skills

1 Knowledge of the Intermolecular Forces
1. Identify the forces of interaction between molecule.
2. Relate temperature and heat to kinetic molecular theory.
3. Interpret a phase diagram of a pure substance.
4. Interpret a heating/cooling curve of a substance.
5. Calculate thermal changes in chemical reactions, such as heats of reaction, heats of formation, and/or heats of combustion, from data.
6. Differentiate between pure substances, homogeneous mixtures, and heterogeneous mixtures.
7. Determine the effects of changes in temperature, volume, pressure, or quantity on an ideal gas.
8. Apply units of mass, volume, and moles to determine concentrations and dilutions of solutions.
9. Analyze the effects of physical conditions on solubility and the dissolving process.

2 Knowledge of Solution formation, properties and concentration units
1. Evaluate solutions and their colligative properties in detail
2. Evaluate problems relating colligative properties, molar mass, and solution concentrations
3. Analyze entropy changes during solution formation, phase changes, and chemical reactions.
4. Predict spontaneity of a chemical process given initial and final values of free energy, temperature, enthalpy, and/or entropy.
5. Analyze energy transformations in physical and biological systems (e.g., energy from the Sun to electricity, from food consumption to physical activity).

3. Knowledge of Chemical equilibrium and Kinetics
1. Calculate either the equilibrium constant or concentration of a reaction species at equilibrium (e.g., $K_a$, $K_b$, $K_{sp}$, $K_w$, $K_{eq}$).
2. Identify the characteristics of a chemical system in dynamic equilibrium.

4. Knowledge of Acid-Base Chemistry
1. Identify major characteristics of strong and weak acids or bases.
2. Evaluate the properties of buffer systems.
3. Interpret graphical and numerical titration data.
4. Solve problems related to pH of strong acids or bases.

5. Knowledge of Electrochemistry and Thermodynamics
1. Identify oxidation-reduction processes.
2. Balance incomplete redox equations in acidic and basic solutions.
3. Determine the spontaneity of a chemical reaction using standard reduction potentials.
4. Identify the characteristics of biochemical and fossil fuel combustion reactions.
5. Analyze electrolytic and/or voltaic cells.

**Topical Outline**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermolecular Attractions and Properties of Liquids and solids</td>
<td>11</td>
</tr>
<tr>
<td>Properties of Solutions</td>
<td>12</td>
</tr>
<tr>
<td>Chemical Kinetics: Interpret kinetic data and apply the principles of kinetics to reaction mechanisms.</td>
<td>13</td>
</tr>
<tr>
<td>Chemical Equilibrium</td>
<td>14</td>
</tr>
<tr>
<td>Explain the principles of equilibrium and calculate equilibrium constants.</td>
<td>14</td>
</tr>
<tr>
<td>Acids - Base Equilibrium : Nature of strong and weak acids and bases.</td>
<td>15</td>
</tr>
<tr>
<td>Equilibria in Solutions of Weak Acids and Weak Bases</td>
<td>16</td>
</tr>
<tr>
<td>Nature of acid-base buffers; calculation of pH, explore the conditions under which some compounds precipitate and others do not</td>
<td>16</td>
</tr>
</tbody>
</table>
Chemical Thermodynamics
Interpret the laws of thermodynamics as they apply to chemical reactions. 18

Electrochemistry
Solve problems dealing with electron-transfer reactions. 19

**Teaching Methodology**
Lecture Style, Use of Overheads and/or Slide Shows as Keynote or Powerpoint, Web-Based Instruction on Wiley Plus.

**WileyPlus:**
Students must enroll in WileyPlus. Class announcements, homework problems, quizzes, sample questions, answers to quizzes, past exams, study guides, and many chemical resources are posted on WileyPlus. Online graded homework or quizzes will only be obtainable on WileyPlus. Only on WileyPlus will student scores for homework, quizzes, and exams be posted.

**Course Schedule**

<table>
<thead>
<tr>
<th>Month / Week</th>
<th>Chap.</th>
<th>Lecture Topics</th>
<th>Assigned problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 10</td>
<td>10</td>
<td>Discussion of syllabus; Gathering student info; Ideal Gas Law, Partial pressure, mole fractions</td>
<td>All problems from 10.1 (pertaining to the topics covered in class whose answers are given) to Additional Exercise (labeled as OH) Quiz 1</td>
</tr>
<tr>
<td>Jan 11</td>
<td>11</td>
<td>Intermolecular Forces, Viscosity and Surface Tension, Phase Changes.</td>
<td>All problems from 11.1 (for which answers are given) and Additional Exercise (labeled OH) Quiz 2</td>
</tr>
<tr>
<td>Jan 12</td>
<td>12</td>
<td>The Solution Process, Saturated Solutions and Solubility, Factors Affecting Solubility</td>
<td>All problems from 12.1 (for which answers are given) and Additional Exercise (labeled OH) Quiz 3</td>
</tr>
<tr>
<td>Jan 12</td>
<td>12</td>
<td>Properties of solutions (continued) Review for Exam 1</td>
<td>Quiz 4</td>
</tr>
<tr>
<td>Feb 13</td>
<td>13</td>
<td><strong>EXAM-1 (Ch. 10-12)</strong> Chemical Kinetics: Reaction Rates, Factors that Affect Reaction Rates, Rate Law</td>
<td>Quiz 5</td>
</tr>
<tr>
<td>Feb 13</td>
<td>13</td>
<td>Rate Law (cont’d), Order of Reactions, Mechanism of Reactions</td>
<td>All problems from 13.1 (for which answers are given) and Additional Exercise (labeled OH). Quiz 6</td>
</tr>
<tr>
<td>Feb 14</td>
<td>14</td>
<td>Chemical Equilibrium, Equilibrium Constant, Heterogenous Equilibria.</td>
<td>All problems from 14.1 (for which answers are given) and Additional Exercise (labeled OH). Quiz 7</td>
</tr>
<tr>
<td>Feb 14</td>
<td>14</td>
<td>Equilibrium Constants Calculation, Application of Equilibrium Constants, Le Chatelier Principle.</td>
<td>Quiz 8</td>
</tr>
<tr>
<td>Date</td>
<td>Page</td>
<td>Exam or Quiz</td>
<td>Content</td>
</tr>
<tr>
<td>------------</td>
<td>------</td>
<td>--------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>March 1</td>
<td>15</td>
<td>EXAM 2 (Ch. 13-14)</td>
<td>Acids and Bases, pH scale, Strong Acids and Bases, Weak Acids and Bases</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>All problems from 15.1 (for which answers are given) and Additional Exercise (labeled OH). Quiz 9</td>
</tr>
<tr>
<td>March 8</td>
<td></td>
<td>Spring Break</td>
<td></td>
</tr>
<tr>
<td>March 15</td>
<td>15</td>
<td></td>
<td>Relationship Between Ka and Kb, Acid Base Properties of Salt Solutions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Quiz 10</td>
</tr>
<tr>
<td>March 15</td>
<td>16</td>
<td></td>
<td>The Common-Ion Effect, Buffered Solutions, Acid-Base Titrations</td>
</tr>
<tr>
<td>March 22</td>
<td>16</td>
<td>Equilibria in solutions of Weak acids and Bases</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17.1</td>
<td>Solubility</td>
<td></td>
</tr>
<tr>
<td>March 29</td>
<td>18</td>
<td>EXAM 3 (CH. 15,16,17.1)</td>
<td>Spontaneous Process, Entropy, Gibbs Free Energy.</td>
</tr>
<tr>
<td>April 5</td>
<td>18</td>
<td></td>
<td>Quiz 13</td>
</tr>
<tr>
<td>April 12</td>
<td>19</td>
<td>Oxidation-Reduction Reactions, Cell EMF, Spontaneity of Redox Reactions. Chemistry of</td>
<td></td>
</tr>
<tr>
<td>April 19</td>
<td>19</td>
<td>Electrochemistry (continued)</td>
<td></td>
</tr>
<tr>
<td>April 26</td>
<td></td>
<td>FINAL EXAM (Ch. 18,19)</td>
<td></td>
</tr>
</tbody>
</table>

**Course Evaluation**

Written quizzes and Exams, Homework, Multiple Choice Exam

**Grading**

**Exams**: There are three one-hour exams, given during the class period indicated on the syllabus. Attendance is required at all exams. Multiple quizzes (in class and online) will be given throughout the semester to evaluate your performance.

*No make-up quiz or exam will be given.* Note their scheduled dates and plan your calendar accordingly.

**Contribution to Final Grade:**

Exams: 80 % (4 @ 20 % each; 4 exams given)
Quizzes: 10% (15 total quizzes; 5 lowest scored quizzes will be dropped)
WileyPlus Homework 8%
Attending Study Sessions  2% ( participation for credit )

Final Grade %

A 88.0-100  B 75.0-87.99  C 65.0-74.99  D 55.0-64.99  F below 55

The instructor reserves the prerogative to change the grading scale and weighting of contributions of events to the final grade as may be indicated by the performance of the class. Any changes made invariably benefit the students’ final grade. It is the opinion of the instructor that exams scores should contribute the most to the final grade since exam scores represent the best examples of individual effort in this course. All exams will be of the multiple choice kind. Most questions will be taken from a test bank published by the authors of the textbook. Exam scores may be inflated to reflect the possibility that conditions during the taking of exams were not optimum and therefore prevented students from obtaining a higher score. Conditions could be but are not exclusive to shortage of time, poorly written questions, incorrect answers as choices, and/or exam key errors. The inflation percentage in usually based on the highest scores in the class for a particular exam.

Five of the lowest scored quizzes will be dropped so that the final quiz score will be based on ten quizzes.

Tentative Examination Schedule:
Activity Material Date (the week of)
Exam 1 Chapters 10, 11,12 Feb. 2
Exam 2 Chapters 13,14 Mar. 2
Exam 3 Chapters 15,16,17 Mar. 29
Final Exam Chapters 18,19 TBA

ALL EXAMS (EXCEPT THE FINAL EXAM) WILL BE GIVEN BETWEEN 6:00-8:00 PM ON THE WEDNESDAY OF THE WEEK DESIGNATED FOR EACH EXAM IN THE TENTATIVE SCHEDULE. Students must take the exam at this time. Students must arrange their schedule in order to take this exam. If a student can not take the exam at the designated time because of circumstances beyond their control , they must produce documentation to verify why the exam can not be taken. Another time before or after the designated time must be provided by the student at the instructor’s convenience for a makeup exam.

STUDENTS MUST TAKE THE FINAL EXAM AT THE OFFICIAL TIME DESIGNATED BY THE REGISTRAR. The Final Exam will be given at no other time. Travel plans which conflict with the Final Exam time will not be considered as an excuse for missing a FinalExam.

Course Policies

1. Classroom Behavior
   A) Cell Phones
      Once a class period has begun cell phones are not to be seen or heard in the classroom. Students will be warned about violation of this request. A persistent disregard for this request will result in a student being ask to leave the classroom and not returning until they have conferred with the Chair of the Chemistry Department.

   B) Etiquette, Behavior , and Attitude

      • Students are expected to enter the classroom, seat at their assigned seats, have notebooks or paper, and pencil or pen available, and ready to write when the instructor begins his/her lecture.
• Students should only be talking when they raise their hands to ask questions.
• Students may only leave the classroom after receiving permission from the instructor. During the class period, students should only ask for permission to leave to go to the lavatory or for medical reasons. If a student knows they need to leave early the student must ask for permission to leave before class begins.
• Cell phones should neither be seen nor heard during the class period. A student who violates this request more than once will be asked to leave the room and will be considered absent.
• A student should not come to class to read newspapers, read fiction books, study for other classes, finish assignments for other classes, listen to MP3 players, etc.
• Students who violate this request more than once will be asked to leave the room and will be considered absent.

2. Attendance Policy

All students are to be present before the scheduled beginning of each class session. Attendance will be recorded to assure that students are complying with the University Class Attendance Regulations. These regulations are fully given in the University General Catalog. A pertinent excerpt of the regulations follows:

"Class attendance is compulsory for all students. Students will be allowed one unexcused absence per credit hour of the course...... A student exceeding the number of unexcused absences will be dropped from the course and assigned a grade of "F". Students may be readmitted to the class with the dean's and the instructor's permission. The dean's letter will become part of the student's permanent record"

3. Exams

• Cell phones should neither be seen nor heard during an exam. If a student’s cell phone is seen, that student will receive an automatic 5% reduction in their exam score. For each time a cell phone is heard ringing during an exam, one extra question will be added to the exam for the entire class.
• On exam day students should enter the classroom, seat at their assigned seats, take out a pen and/or pencil(s), and a non-programmable calculator. (The calculator function of cell phones may not be used).
• Students should follow instructions about receiving exams and identifying themselves on the exams.
• When the instructor indicates that the exam has ended, students should have their names written on the exams and scantron sheets (if there are any). The students hand in their exams quickly and according to the instructor’s instructions.

4. Disputes Over Exam/Quiz Scores or Grades

If students wish to discuss/dispute exam or quiz scores, they must do so within two weeks of receiving a score (grade). After that time no discussion will be considered. Students must understand that an unrestricted window of opportunity for disputation will not be permitted.

5. Academic Honesty

It is your responsibility to know the university's policy on academic/intellectual dishonesty (Section 6C3-2.012(10)(s) of the FAMU Student Handbook). Any student caught cheating in any manner is awarded the grade of F. No warnings are given; it is your responsibility to do your own work. All persons collaborating in cheating will receive the grade of F.
6. Students with Disabilities

Students with disabilities that fall under the Americans with Disabilities Act should follow the following procedures:
1) Provide documentation of your disability to the FAMU student disability resource center
2) During the first week of class, provide your instructor with a statement from the FAMU student disability resource center indicating that you have registered with FAMU student disability services. The statement should indicate the disability and the special accommodations that will be required.

7. Non-discrimination policy statement

It is the policy of the University to assure that each student is permitted to attend classes in an environment free from any form of discrimination, including race, religion, color, age, handicap, sex, marital status, national origin and veteran status.

8. Conflict Resolution: In the event that you come into conflict with the instructor, complaining to your friends or other faculty, or staff will not solve the problem. You should follow the procedure below to resolve the conflict.

1. Contact the instructor and explain your complaint to see if a quick resolution to the problem can be achieved.
2. If you feel you cannot talk to the instructor or are not satisfied with the response of the instructor, contact the Chairman of the Department of Chemistry or submit written notification of problem to Chair.
3. Chair forwards student letter to instructor.
4. Instructor responds in writing to chair.
5. Chair meets with instructor and/or student if necessary.
6. If your discussions with the Chairman do not resolve the issue, the Chair forwards response/recommendation to Dean’s office.

Suggestions and Help for Doing well in CHM 1046

Chemistry is often a challenging subject for most students. It has been my experience that the main source of this difficulty is that most students do not put enough time and effort into the course. As such, I am giving you the following suggestions for how to do well in this course.

- Read the material in **detail** before coming to class. This will make it easier for you to understand the lecture and ask relevant questions.
- Come to class with **specific** questions about material that you don't understand.
- Stay on schedule with the lecture pace. You cannot afford to get behind in this class; we constantly build upon the information previously learned!!!!!
- Read each chapter at least **three** times prior to the exam.
- Form study groups with your classmates.
- Do the assigned homework problems well in advance of the exam. This will give you a chance to determine what concepts you need help on
- **Spend at least** 1 hour every day studying chemistry!!!!!
- Work out the problems in the book, work out the problems in the book, work out the problems in the book!!!!!!!!!!!
- **Find a chemistry tutor** if you are having problems, do not wait until it is too late to seek
help.

- Be prepared for each exam at least 2 days in advance. This will allow time for me to give you a one-on-one quiz to determine how well you really understand the material.
- I strongly encourage you to be prepared for each exam at least two days prior to the scheduled date so that you have time to resolve any questions that you may have.
- **Do not wait until the last minute to study!!!!**
- Last, but not least, work very hard in this course. This is a serious course that requires a lot of your attention. Do not think that you can cram or take shortcuts. IT WILL NOT WORK, TRUST ME.

If you follow these suggestions you should do well in the course. Conversely, if you find that at the end of the semester that you did not do as well as expected, ask yourself if you followed these suggestions.

**Problem-Solving Sessions:**
Problem-solving sessions will be held outside of class on a routine basis. Credit will be given for participation at these sessions. **Do not wait until you are struggling to request help!!!.**

**Tutorial Laboratory**
The Chemistry Department provides tutors in Rm. 126, Dyson Pharmacy Building for any student who is taking CHM 1031, CHM 1045, or CHM 1046 and needs help. The schedule for tutoring sessions is posted at Rm. 126, DPB or can be obtained from the Chemistry Department office in the Old DRS Building.