

Equinox Program

Course Title: Advanced Chemistry Honors

Course Description

Dig deeper into Chemistry Honors topics and get prepared for college-level courses in this advanced chemistry course focusing on subjects such as advanced stoichiometry, molecular structure, reaction prediction and net ionic equations, kinetics, equilibrium, thermodynamics, and electrochemistry. Laboratory work emphasizes increased competency in data acquisition, use of data in calculations and error analysis. Upon completion, students attain a deeper understanding of the more advanced chemistry fundamentals that often are not covered at the end of a first-year chemistry course. The course is designed to prepare those students with a good understanding of basic chemistry for a Advanced Placement and college-level chemistry courses.

Essential Questions

- How do the molecular structure of a compound and the strength of the bonds in the compound affect its physical properties?
- How can we quantify the rate of a chemical reaction, and how can we manipulate the conditions of the reaction in an effort to control the rate and determine the reaction pathway?
- How do we examine and discuss chemical reactions in which it is plausible that the reverse reaction is plausible?
- How do we know when an acid-base system establishes equilibrium, and what are the practical applications of the equilibria established?
- How can we predict whether a reaction will occur spontaneously?
- How can we use chemical reactions to power electrical devices, and how can we use electrical power to force non-spontaneous chemical reactions to occur?

Outcomes

Upon successful completion of this course, students will:

- Understand how molecular structure affects the physical properties and characteristics of liquids and solids.
- Understand how the principles that affect the rate of a chemical reaction.
- Understand how thermodynamics affects the plausibility of a chemical or physical process.
- Understand how chemical reactions are used to build batteries and power devices.
- Apply the principles of dynamic equilibrium to acids, bases, and insoluble salts.
- Identify unknowns through analysis of data and similarities to known chemical reactions.
- Effectively use concepts from class discussions to formulate and evaluate experimental procedures.

Instructional Strategies

A good deal of the work done in this course will be completed in collaborative learning groups. Science in the real world is rarely a solo effort, so students in this course will learn to share ideas and discuss problem-solving strategies on a daily basis. Some classes will follow a lecture and discussion format while others will be discussions of guided, inquiry-based demonstration experiments.

Resources and Materials

- **Textbook**

Chemistry: The Central Science, Brown, T., LeMay, H., Bursten, B., Pearson Prentice Hall, 10th edition 2006, ISBN# 0-13-193719-7.

- **Materials**

- a. Scientific graphing calculator, preferably TI-83(Plus) or TI-84(Plus)
- b. Laboratory notebook (provided by CTD)
- c. 3-ring binder for class notes, handouts, and graded materials

Student Assessment

- **Pre-Assessment**

This pre-assessment will be given Sunday night before the first day of class. It will be a collection of free-response problems and questions to gauge the student's familiarity with the seven central ideas in this course: molecular structure, properties of matter, stoichiometry, kinetics, equilibrium, acid-base systems, thermodynamics, and electrochemistry. Many of these topics will be new, so a student should not be alarmed if he or she cannot complete all of the problems.

- **CTD Grading Scale**

A+	100-97%	A	96-93%	A-	92-90%
B+	89-87%	B	86-83%	B-	82-80%
C+	79-77%	C	76-73%	C-	72-70%
D+	69-67%	D	66-63%	D-	62-60%
F	below 60%				

- **Breakdown of Final Grade**

Participation (5%): Students are expected to be active participants in class discussions each day. At least once during each unit, every student will complete and explain a problem in front of the class.

Homework quizzes (15%): These are multiple choice assessments given at the beginning of class (not on test days) to gauge the student's understanding of the concepts from the previous night's reading assignment.

Problem sets (20%): Students will complete a problem set for each unit. These assignments consist of conceptual problems from the textbook and problems from past AP Exams that focus on the key ideas of the current unit. These problem sets are graded using the NWNCNK policy: no work, no credit, no kidding.

Labs (20%): Laboratory experiments will be conducted daily. Students are required to wear long pants and closed-toed shoes and must wear a long-sleeved shirt in the lab to be in compliance with university safety standards. The work handed in will depend on the nature of the experiment. All students are required to maintain a laboratory notebook in which they record all data and observations and complete any calculations. For many of the experiments, students will prepare a full report that includes an abstract or introduction, procedural summary, data tables, sample calculations, data and error analysis, and a conclusion.

Tests (40%): Students will take a test at the end of each unit. Each test has two components – a multiple choice section and a free response section that consists mainly of old AP Chemistry problems.

- **Post-Assessment**

Students will complete an exam similar in nature to the pre-assessment. They will be asked to demonstrate their knowledge in the following areas: molecular structure, properties of matter, stoichiometry, kinetics, equilibrium, acid-base systems, thermodynamics, and electrochemistry.

Schedule

Date	Topic(s) /Assessments	In-class Activities	Assignments
Sunday		NO CLASS	<ul style="list-style-type: none"> Pre-assessment <i>Reading:</i> Chapter 3, especially section 3.5
Monday	Chemical reactions and stoichiometry	<ul style="list-style-type: none"> Demo: The chemistry of copper Review of chemical reactions and balancing equations; net ionic equations Stoichiometry and its use as an analytical tool Lab: Gravimetric Analysis of a Mixture 	<ul style="list-style-type: none"> <i>Reading:</i> Chapter 4. A good deal of this chapter is also review, but it is no less important. Pay special attention to Sections 4.2 and 4.3; these two sections present the bulk of the new material in the chapter. <i>Lab:</i> Complete the lab calculations and the analysis questions for today's lab. <i>Problem Set #1</i> is due Wednesday morning. You should begin it tonight.
Tuesday	Molecular structure and properties of matter	<ul style="list-style-type: none"> Drawing representations of molecules Valence bond theory 3-D shapes of molecules Molecular polarity and intermolecular forces Phase changes Gases and solutions Lab: Eight Test Tube Challenge 	<ul style="list-style-type: none"> <i>Reading:</i> Chapters 8 - 10, excluding sections 9.7 - 9.8. Chapter 11 (sections 11.1 - 11.7 only). Chapter 13 (sections 13.3 - 13.5 only) <i>Lab:</i> Begin the identification of the eight unknowns. It is due Thursday. <i>Problem Set #1</i> is due tomorrow!!
Wednesday	Test #1 (Reactions, Structure, and Properties of Matter) Kinetics	<ul style="list-style-type: none"> Inquiry exercise (lab): How do I monitor the rate of a reaction? Collision theory Rates of reaction Differential rate laws Lab: Eight Test Tube Challenge 	<ul style="list-style-type: none"> <i>Reading:</i> Chapter 14 (sections 14.1 - 14.3, 14.5 only) <i>Lab:</i> Complete the identification of the eight unknowns. <i>Problem Set #2</i> is due Friday. You should begin it tonight.
Thursday	Kinetics	<ul style="list-style-type: none"> Reaction mechanisms Lab: Kinetics of the Acid Decomposition of Thiosulfate Integrated rate laws 	<ul style="list-style-type: none"> <i>Reading:</i> Chapter 14 (sections 14.4, 14.6 - 14.7) <i>Lab:</i> You should be able to complete a great deal of the post-lab work on today's lab. However, it is not officially due until Monday. <i>Problem Set #2</i> is due tomorrow.
Friday	Test #2 (Kinetics) Principles of equilibrium	<ul style="list-style-type: none"> Dynamic equilibrium Heterogeneous and homogeneous Quantification of forward progress in reversible reactions Prediction of the effects of external stresses on systems at equilibrium Lab: Standardization of a Sodium Hydroxide Solution 	<ul style="list-style-type: none"> <i>Reading:</i> Chapter 15 <i>Lab:</i> Complete the post-lab work for the kinetics lab. Then use your data from today to calculate the concentration of your NaOH solution. <i>Problem Set #3</i> is due Tuesday. You should begin it tonight.
Monday	Acids and bases	<ul style="list-style-type: none"> Lab: Determining the value of an Equilibrium Constant Arrhenius, Bronsted-Lowry, and Lewis definitions of acid and bases Proton-transfer reactions Auto-ionization of water and pH calculations Equilibria for weak acids and bases pH of salt solutions 	<ul style="list-style-type: none"> <i>Reading:</i> Chapter 16. <i>Lab:</i> Begin the post-lab analysis for today's lab. This lab is calculation heavy so manage your time wisely. The final report is due Wednesday. <i>Problem Set #3</i> is due tomorrow.

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Tuesday	Test #3 (Equilibrium, acids, and bases) Applications of equilibrium: Buffer solutions	<ul style="list-style-type: none"> The common ion effect on weak acid-base equilibria Buffer capacity Titration problems Titration curves and indicators Lab: Identification of an Unknown Organic Acid 	<ul style="list-style-type: none"> <i>Reading:</i> Chapter 17 (sections 17.1 – 17.3) <i>Lab:</i> Complete the post-lab for the equilibrium constant lab. Calculate the molar mass of the unknown acid using today's data and determine the acid dissociation constant from the titration curve you plotted. <i>Problem Set #4</i> is due Thursday.
Wednesday	Applications of equilibrium: Solubility equilibrium	<ul style="list-style-type: none"> Heterogeneous equilibria of insoluble salts Calculation of the solubility equilibrium constant, K_{sp}, and molar solubility Lab: Determining the K_{sp} of Calcium Hydroxide The common ion effect and solubility The effect of complex ion formation on solubility Group lab exercise: Chemistry of complex ions 	<ul style="list-style-type: none"> <i>Reading:</i> Chapter 17 (sections 17.4 – 17.6) <i>Lab:</i> Complete the analysis questions for the unknown organic acid lab. Complete the calculations for the calcium hydroxide lab. <i>Problem Set #4</i> is due tomorrow!!
Thursday	Test #4 (Applications of equilibrium) Thermodynamics: heat transfer and enthalpy changes	<ul style="list-style-type: none"> Pressure-volume work Endothermic and exothermic processes Four ways to calculate enthalpy changes: bond energies, state function calculations, calorimetry, and Hess's law Lab: Hess's law 	<ul style="list-style-type: none"> <i>Reading:</i> Chapter 5 <i>Lab:</i> Complete the post-lab calculations for the Hess's law lab. <i>Problem Set #5</i> is due on Monday. You should start it tonight.
Friday	Thermodynamics: Gibbs free energy and equilibrium	<ul style="list-style-type: none"> Definition of a spontaneous process The second law of thermodynamics Prediction of entropy changes Calculating entropy changes Gibbs free energy and its relationships with spontaneity and equilibrium Lab: Thermodynamics of the Dissolution of Calcium Hydroxide 	<ul style="list-style-type: none"> <i>Reading:</i> Chapter 19 <i>Lab:</i> Complete the post-lab analysis for the thermodynamics lab. <i>Problem Set #5</i> is due next class.
Monday	Test #5 (Thermodynamics) Electrochemistry: Redox reactions and galvanic cells	<ul style="list-style-type: none"> Balancing redox equations in acidic and basic solutions Setting up galvanic cells Standard reduction potentials, the activity series, and electromotive force Cell potential and free energy Lab: Stoichiometry of a Redox Reaction, Part I 	<ul style="list-style-type: none"> <i>Reading:</i> Chapter 20 (sections 20.1 – 20.6) <i>Lab:</i> Determine the concentration of commercial bleach using today's lab data. <i>Problem Set #6</i> is due on Wednesday.

Date	Topic(s) /Assessments	In-class Activities	Assignments
Tuesday	Electrochemistry: Nonspontaneous reactions and electrolysis	<ul style="list-style-type: none"> Galvanic cells in batteries Forcing nonspontaneous reactions to occur Electrolysis reactions Stoichiometry of electroplating Lab Stoichiometry of a Redox Reaction, Part II 	<ul style="list-style-type: none"> <i>Reading:</i> Chapter 20 (sections 20.7 – 20.9) <i>Lab:</i> Complete the post-lab assignment for the redox stoichiometry lab. <i>Problem Set #6</i> is due tomorrow.
Wednesday	Test #6 (Electrochemistry)	<ul style="list-style-type: none"> Review for final exam Preliminary research for lab practical 	<ul style="list-style-type: none"> <i>Lab:</i> Prepare your lab notebook for the data you will collect for your lab practical. Study for final exam
Thursday	Final Exam and Lab Practical	<ul style="list-style-type: none"> Final exam Lab (Identification of 14 Unknowns) 	<ul style="list-style-type: none"> Complete the research questions for the lab practical. They will help you in the identification of your unknowns on the lab practical.
Friday	Completion of Lab Practical	<ul style="list-style-type: none"> Lab (Identification of 14 Unknowns) Parent-teacher conferences 	None!!

CTD Statement on Third-Party Web Sites

Instructors are required to thoroughly review any third-party web sites they intend to use in their courses for inappropriate content. However, because web content continuously changes, CTD disclaims any responsibility for any of the content contained on third-party web sites used in course materials. If you become aware of anything that may be inappropriate, please notify CTD staff immediately.