Advanced Chemistry-Chemical Reactions

Course Description:

This course places an emphasis on learning fundamental chemical concepts by exploring chemical reactions. The class is laboratory-based and allows students to actively engage in learning and applying fundamental chemical principles. Topics studied include chemical equilibrium, acids and bases, thermochemistry, and electrochemistry. The relationship of chemical principles to highly relevant issues will be highlighted. Examples include diverse topics such as how acid-base buffers play important roles in biological systems, how the calorie content of foods is measured, and the theory behind how batteries work. In keeping with the philosophy of the academy, students are expected to construct an understanding of chemistry concepts through laboratory experiences, collaborative work, and asking questions.

Instructors:

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Meeting Days, Time and Room:

Dr. DeVol	Dr. Golab	Dr. Tolla
AC Days Mods 3-4	AC Days Mods 7-8	BD Days Mods 1-2
BD Days Mods 3-4	BD Days Mods 7-8	

Text/Materials:

The textbook is Chemistry, 9th edition, by Steven Zumdahl and Susan Zumdahl.
Required materials are a laptop/tablet for labs, a notebook, calculator, and pens/pencils.

Student Learning Objectives for Advanced Chemistry – Chemical Reactions

Equilibrium

Explain the nature of dynamic equilibrium in terms of reaction rates, concentrations of reactants and products.

Write equilibrium expressions using the Law of Mass Action.

For a reaction at equilibrium, calculate K knowing either equilibrium concentrations of all species or original concentrations of all species and an equilibrium concentration of one species.

Using Le Chatelier's Principle, predict the effect of a change in the number of moles, volume, or temperature upon the position of a system at equilibrium.

Given the value of K, predict:

a) the direction of a reaction after finding Q from original concentrations.
b) the equilibrium concentration of one specie given those of all others.
c) the equilibrium concentration of all species given their original concentrations.

Calculate Ksp knowing solubility or calculate solubility knowing Ksp

Acid/Base Chemistry and Buffers

Given a chemical equation describing acid-base equilibria:

a) Write an equation showing how a molecular or ionic substance behaves as an acid or base in water.
b) Write an equation showing the dissociation of water.
c) Write a net ionic equation to describe the reaction of a strong or weak acid with a strong or weak base.
d) Given an equation for an acid-base reaction, select Bronsted-Lowry acid and base, the Lewis acid and base, and the conjugate acid-base pair.

Calculate one of two quantities knowing the other:

a) K_a or K_b for a weak acid/conjugate base
b) $[H^+]$, $[OH^-]$ and/or pH for acids and bases

Understand the concept of acid and base strength.

Understand what a buffer is and how it works

Choose an acid-base pair and calculate concentrations of each to make a buffered solution at a given pH value.

Calculate the $[H^+]$, $[OH^-]$, and pH in

a) a mixture of a strong acid and base
b) a mixture of strong acid and weak base or strong base and weak acid
c) a buffered solution
d) a buffered solution to which strong acid or base is added

Use a pH meter or probe to find unknown $[H^+]$ and then generate a titration curve.

Given a titration curve of a weak acid determine: the equivalence point, pKa, and a suitable indicator.

Thermochemistry

Be able to calculate heat flow from calorimetric data obtained from either a coffee-cup or bomb calorimeter.

Given a series of thermochemical equations that occur in a stepwise fashion, use Hess's Law to determine ΔH and calculate the magnitude of ΔH for a specific amount of reactant or product.

Given a table of bond energies (enthalpies), estimate ΔH of reaction.

Define entropy and explain the significance of positive and negative changes in entropy.

Define and apply the first, second, and third laws of thermodynamics.

Use a table of calculated values to determine ΔH, ΔS, and ΔG at standard conditions.

Describe how the sign of ΔH, ΔS, and ΔG relate to the spontaneity of a reaction.

Use the Gibbs-Helmholtz equation to calculate ΔH, ΔS, ΔG, or T given three of the four variables.

Predict the spontaneity of precipitation reactions two ways:

a. Using solubility rules
b. Using free energy change

Electrochemistry

Be able to identify a redox reaction, assign oxidation numbers to each element in the reaction, determine what species is oxidized and reduced, identify the oxidizing and reducing agents, and properly balance the equation in acid or base solutions.

Carry out a redox titration in order to determine an equivalence point.

Given a diagram of a voltaic or electrolytic cell, be able to determine the net balanced redox reaction, identify the anode and cathode, determine the direction the ions and electrons move, and the standard potential of the cell.

Properly use a table of standard reduction potentials to determine relative strengths of oxidizing and reducing agents, cell voltages, and spontaneity.

Use the Nernst equation to calculate how changes in concentration will affect the voltage of a cell.

Relate the number of electrons or coulombs passing through an electrolytic cell to the amounts of products formed at the electrodes.

Relate cell voltage to ΔG and cell spontaneity

SSLs and Outcomes

I. Developing the Tools of Thought
A. Develop automaticity in skills, concepts, and processes that support and enable complex thought. This is done through lab observations, data collection, graphing, analysis, use of significant figures, and using lab equipment properly.
B. Construct questions which further understanding, forge connections, and deepen meaning. This is done by analyzing data to draw conclusion and relate it to the concept.
C. *Precisely observe phenomena and accurately record findings.* This is done through laboratory observations, data collection and analysis, using estimated digits and significant figures.
D. *Evaluate the soundness and relevance of information and reasoning.*
This is done by drawing conclusions from laboratory data.

II. Thinking About Thinking
A. *Identify unexamined cultural, historical, and personal assumptions and misconceptions that impede and skew inquiry.* The development of acid-base theory from the Arrhenius to the Bronsted-Lowry theory is an example.
B. *Find and analyze ambiguities inherent within any set of textual, social, physical, or theoretical circumstances*. This is done by analyzing experimentally collected data and noting discrepancies between collected data and theoretical data (i.e. error analysis).

III. Extending and Integrating Thought
A. *Use appropriate technologies as extensions of the mind*. This is done by the use of calculators and computers.
B. *Recognize, pursue, and explain substantive connections within and among areas of knowledge.* This is done by making historical connections to scientists, mathematical connections, and connections among various topics within chemistry.
C. *Recreate the beautiful conceptions that give coherence to structures of thought*. This is done through analyzing and learning about concepts such as equilibrium which can be related to a variety of complex systems.

IV. Expressing and Evaluating Constructs
A. *Construct and support judgments based on evidence.* This is done by laboratory exploration, constructing laboratory reports as well as forming conclusions and making generalizations.
B. *Write and speak with power, economy, and elegance.* This is done through lab practicals and reports, written answers to questions, and demonstrating understanding through discussions.
C. *Identify and characterize the composing elements of dynamic and organic wholes, structures, and systems.* This is done, for example, by studying chemical equilibrium and the underlying processes of equilibrium and changes that can be imposed on a chemical system at equilibrium.
D. *Develop an aesthetic awareness and capability*. This is done by drawing attention to links between current content and the world around them.

V. Thinking and Acting With Others
B. *Make reasoned decisions which reflect ethical standards, and act in accordance with those decisions.* This is done by not manipulating data to fit conclusions and preventing plagiarism in lab reports.

Teaching and Learning Methodology and Philosophy:

The Advanced Chemistry – Chemical Reactions curriculum at IMSA provides a learning environment that is competency-driven, based on previous experiences, laboratory-based, and integrative. Students are expected to construct their own knowledge under the facilitation of a teacher who is committed to creating these learning opportunities. Consistent with the expectation that students construct their own knowledge, the majority of the student's time is spent on laboratory activities that, when appropriate, include the use of technology to gather and analyze data. Students are expected to ask questions, make observations, collect data, look for evidence and draw conclusions. Students share their findings by writing laboratory reports and/or by applying their findings to new situations. The classroom environment is collaborative and student-centered, where students have the opportunity to ask questions, discuss concepts and teach each other.

Student Expectations:

The experience you have in this course will be directly related to your level of participation!! One cannot choose to be a nonparticipant and expect to reap all of the possible benefits. Therefore, some guidelines for a successful experience are listed below.

1. You **must** be on time and ready for class - both mentally and physically. Refer to the Student Handbook for specific effects of excessive tardies and absences.

2. Have all the materials you will need for the class WITH YOU! A list of required materials is on the first page of this syllabus.

3. Turning work in late will adversely affect your grade. When an assignment has been collected, it may be submitted for late credit at a 10% penalty per day. Once the teacher has returned material that has been assessed, it cannot be submitted for late credit. There will be NO credit awarded for make-up work due to unexcused absences. It is the responsibility of each student to arrange for make-up work due to excused absences (preferably in advance!).

4. Your computer should only be on when being used for class activities. No iPODs, MP3/CD players, sunglasses, or cell phones on in class. No food/drinks ingested in the lab.

5. Collaboration is encouraged throughout all facets of this course. Academic dishonesty, however, is not. It is expected that students will discuss laboratory results, and partners will share common data. It is also expected that all reports/work reflect individual thought and other sources will be referenced appropriately.

6. Follow all lab safety procedures. Keep your work/lab area neat and clean.

7. If, at any point, you are experiencing some confusion - get help ***immediately*.** Concepts cannot build upon each other if one is not understood. Do not wait until office hours occur. Schedule an appointment for a mutually convenient time.

<u>Assessment Practices, Procedures, and Processes:</u>

Your grade in this course will be a reflection of all aspects of the course. Points will be earned for lab experiments, lab reports and lab quizzes, problem solving, homework assignments, quizzes, and tests.

Quarter grades will be weighted as follows: 70% of the quarter 3 and quarter 4 grades will be based on tests and non-lab quizzes, 30% of the quarter grades will be determined by all other points (what we call the "miscellaneous" grade category). The miscellaneous grade category will include lab reports, lab quizzes, homework assignments, and any other grades that do not fall under the test and quiz category.

The semester grade will be determined as follows: 80% of the semester grade will be based on the cumulative grade (a running total of weighted points) from both quarters. A comprehensive final semester exam will count for 20% of the semester grade. Quarter and semester grades will be assigned according to the following percentages:

A = 90%		B = 80%		C = 70%

A curve, if necessary, is only applied at the end of the semester to the final exam.

<u>Sequence of Topics and Activities:</u>

A detailed calendar, showing daily activities for the semester, is posted on Moodle.