Advanced Chemistry – Structure and Properties

Course Description:

This course places an emphasis on relating physical and chemical features (properties) of substances to their atomic, molecular, or ionic makeup (structure). The class is laboratory-based and allows students to actively engage in learning and applying fundamental chemical principles. Topics studied include molecular modeling, intermolecular forces, stoichiometry, states of matter, solutions, spectrophotometry, and chemical kinetics. The relationship of chemical principles to highly relevant issues will be highlighted where appropriate. Examples include topics as diverse as how polarity of molecules affects biological systems and climate to how salt lowers the freezing point of ice on roads but helps to cook spaghetti faster. 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:

Dr. Dave DeVol Office: B104B Phone: 5025	E-mail: ddevol@imsa.edu Office Hours: 11:45-12:45 on A and C days or by appointment
Dr. Joe Golab Office: B147 Phone: 5684	E-mail: jgolab@imsa.edu Office Hours: 10:00-11:00 on A and C days or by appointment
Dr. Melissa Tolla Office: B150 Phone: 5689	E-mail: mtolla@imsa.edu Office Hours: 11:00-11:50 on B days and 12:30-1:30 on C days or by appointment

Meeting Days and Time (all classes meet in A209):

Dr. DeVol	Dr. Golab	Dr. Tolla
AC Days Mods 3-4	BD Days Mods 1-2	AC Days Mods 7-8
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 – Structure and Properties:

Molecular Structure and Intermolecular Forces

Quantitatively and qualitatively relate wavelength of light in the H spectrum to energy levels (Bohr Model)

Write the electron configuration and orbital diagram of an atom or ion, given the atomic number of the element.

Write the four quantum numbers for each electron in an atom.

For a given sublevel, describe the shape of the electron cloud.

Explain the differences between the Bohr Model and Quantum Mechanical model of the atom.

Describe and interpret the following periodic trends: ionization energy, atomic radius, electronegativity.

Explain why atoms bond together and the formation of ionic, polar covalent, and covalent bonds

Name (given formula) or write formula (given name) of covalent and ionic compounds

Given the formula of a molecule showing primarily covalent bonding, describe the bond polarity, molecular polarity, draw the Lewis dot structure, and describe the shape or geometry including bond angles.

Construct models to determine molecular geometry.

Differentiate between intermolecular and intramolecular forces.

Given the formula of a molecule, identify the nature of the intermolecular force as London dispersion, dipole-dipole, or hydrogen bonding.

Given the formula of a solid, classify it as metallic, ionic, molecular or macromolecular. Also, be able to identify the basic units within, the force holding them together, and predict the physical properties of the substance.

Given an unknown solid substance, be able to determine enough information about its physical properties in the laboratory in order to classify it as metallic, ionic, molecular, or macromolecular.

Stoichiometry, Gas Laws, and Vapor Pressure

Calculate the molar mass and percent composition of a substance given its formula, or determine empirical and molecular formula given mass data or percent composition.

Given a chemical equation, calculate masses of reactants and products and determine excess and limiting reactants.

Use the ideal gas law and other gas laws to calculate pressure, volume, moles, or temperature.

Describe the main assumptions of the kinetic molecular theory for gases

Predict the effect of pressure changes on boiling and freezing points.

Experimentally determine vapor pressure and use the Clausius-Clapeyron equation to calculate ΔH_{vap}

Solutions, Colligative Properties, Spectrophotometry

Predict the solubility of a solute in different solvents.

Predict how changes in pressure and/or temperature affect solubilities of solids, liquids and gases.

Predict the vapor pressure, freezing point, boiling point, or osmotic pressure of a solution of known concentration.

Determine the molar mass of an unknown solute by freezing point depression or boiling point elevation.

Define electrolyte and be able to determine whether a solute is an electrolyte or a nonelectrolyte.

Compare colligative properties of nonelectrolytes to electrolytes.

Prepare a solution of known concentration and create a dilution series.

Use a spectrophotometer and/or colorimeter to create a standard curve, and determine the concentration of an unknown solution.

Kinetics

Predict the effect of changes in concentration, temperature, and the addition of a catalyst on the rate of reaction, and explain these effects using collision theory.

Be able to determine the order of a reaction, given the initial rate as a function of concentration of reactants, or reactants as a function of time.

Interpret a potential energy diagram and identify ΔH, Ea, Ea', the location of the activated complex, and the effect of a catalyst.

Generate or interpret graphic representations of zero, first, or second order reactions.

Determine whether a proposed mechanism is consistent with an observed rate law. If it is not, suggest a mechanism that is consistent.

<u>SSLs and Outcomes</u>

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.* This is done by examining models such as the Bohr Model and Lewis dot structures.

B. *Find and analyze ambiguities inherent within any set of textual, social, physical, or theoretical circumstances*. Models such as Bohr and Quantum theory are studied.

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 molecular structures, atomic structures, and how structures affect the properties of molecules.

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 by relating electronic structure to chemical formulas and periodic trends, and relating molecular structure to properties of substances.

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 – Structure and Properties 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.

Assessment Practices, Procedures, and Processes:

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 1 and quarter 2 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.

Sequence of Topics and Activities:

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