

## Chemistry 462 Inorganic Chemistry

Instructor: Dr. Timothy Hughbanks  
Time: MWF 1:50 – 2:40 PM Room 2122  
Office: Chemistry 330, Hours Tuesday 11:00 AM – 1:30 PM and as available

The course will provide an introduction to inorganic chemistry with some knowledge of physical and organic chemistry as prerequisites. An attempt will be made to balance theoretical and descriptive aspects of the subject.

Grades will be based on homework (100 points  $\approx$  25%), 2 midterms (100 points each) and a final exam (150 points). You are expected to make a serious attempt at every assigned homework problem before consulting with your peers; otherwise collaboration is permitted as long as all collaborators make significant contributions.

Text: “Inorganic Chemistry” 3<sup>rd</sup> Edition, by Du Shriver and Peter Atkins (SA)

### Other Useful Books:

- (1) Three “sophomore-level” texts (appropriate for a course now under development at TAMU) are “Descriptive Inorganic Chemistry” by Rayner-Canham, “Descriptive Inorganic, Coordination, and Solid-State Chemistry” by Rodgers, and “Descriptive Inorganic Chemistry” by House & House. All three of these books have much that we will cover, but the level of sophistication is a bit lower than appropriate for an upper-division course at TAMU.
- (2) “Inorganic Chemistry”, Catherine Housecroft and Alan Sharpe (HS)  
This text was used two years ago. The material in Chapters 2, 3, and 4 will be especially useful in the first month of the course. The descriptive chemistry is somewhat “encyclopedic”. A useful reference book for students going further in a field related to inorganic chemistry.
- (3) “Basic Inorganic Chemistry”, F. A. Cotton, G. Wilkinson, and P. L. Gaus (CWG) A standard textbook that was used last year in this course. Some problems may come from this book.
- (4) “Chemistry of the Elements”, N. N. Greenwood and A. Earnshaw (GE) Well written advanced book. There are many interesting applications of inorganic chemistry to the “real world”. Best single-volume reference for main-group chemistry.
- (5) “Modern Inorganic Chemistry”, Jolly. Chapters 7, 8, 9, 11, and 12 are good.
- (6) “Concepts and Models of Inorganic Chemistry” by Douglas, McDaniel, and Alexander. Good sections with more depth in “theoretical” inorganic chemistry.

## Course Outline

- i.* Introductory comments; scope of Inorganic Chemistry – contrasts with Organic Chemistry
- ii.* Chemistry Of the Elements – overview of the periodic table, SA: 1.1-1.3

### I. Fundamentals

1. Atomic and Molecular Structure (2-3 weeks)
  - a. Basic concepts from quantum theory
  - b. Atomic Structure — orbitals configurations, periodicity, electronegativity scales, etc.
  - c. Lewis Structures — octet rule, formal charges, resonance structures
  - d. Valence Bond Theory, Hybridization
  - e. Molecular orbitals (MOs) — diatomics
  - f. Donor-acceptor interactions — Lewis acid-base bonding, metal-ligand bonding

Sources: Handouts (posted on website), SA: Sections 1.4-1.8, Chapter 3

2. Molecular Shapes and symmetry (2-3 weeks)
  - a. The VSEPR model and basic shapes of main-group molecules
  - b. Methods of determining molecular structure; spectroscopy & diffraction
  - c. Symmetry point groups — symmetry elements and operations
  - d. Symmetry applications — polyatomic MOs normal modes
  - e. Structures of ionic and other solids — applications and limitations of ionic model
  - f. Bonding in solids — metals, semiconductors & insulators

Sources: Handouts, SA: Chapter 2, Chapter 4

### II. Systematics of Chemical Behavior

1. Acids and Bases (1-2 weeks)
  - a. Brønsted Acidity — aqueous equilibria, solvent leveling, periodic trends, oxoacids, anhydrous acids and bases, amphoterism, polyoxo ions, nonaqueous solvents
  - b. Lewis acidity — group 13 compounds, M-L dative bonding, superacids
  - c. Acid-base reactions — adduct formation, displacements, double displacements
  - d. 'Hard' and 'soft' acids and bases
  - e. Solvents as acids and bases

Sources: Handouts, SA: Chapters 5, 7 (selected ideas)

2. Oxidation and Reduction (2 weeks)
  - a. Redox reactions in metallurgical processes
  - b. Reduction potentials, thermodynamics, Nernst equation, cyclic voltammetry
  - c. Redox stability in aqueous solution, air oxidation
  - d. Latimer & Frost diagrams

Sources: Handouts, SA: Chapter 6

### III. Chemistry of the non-metals (3 weeks)

- a. Hydrogen and its compounds
- b. Boron compounds, other group 13 compounds, inorganic carbon, other group 14 chemistry
- c. Chemistry of groups 15 and 16
- d. The halogens

Sources: Handouts SA: Selections from Chapters 8, 10, 11, 12

### IV. Metal Chemistry; coordination complexes, clusters, and solids (3 weeks)

- a. Alkali and alkaline earth metals
- b. d-block metals — coordination complexes: ligands and geometries, isomerism, ligand field theory, magnetism, ligand substitution reactions, redox states, general periodic trends,  $\pi$ -donors,  $\pi$ -acceptors
- c. Metal-metal bonded compounds
- d.  $e^-$  transfer reactions — inner and outer sphere mechanisms
- e. Organometallics — representative molecules and reactivity
- f. Solid state chemistry of d-block compounds

Sources: Handouts, SA: Selections from Chapters 7, 9, 13, 14, 16

#### Americans with Disabilities Act (ADA) Policy Statement:

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities, in Room 126 of the Koldus Building or call 845-1637.

#### Academic Integrity Statement:

An Aggie does not lie, cheat, or steal or tolerate those who do.

Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning, and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the TAMU community from the requirements or the processes of the Honor System.

Honor Council Rules and Procedures on the web: <http://www.tamu.edu/aggiehonor>