

AS.030 (CHEMISTRY)

AS.030.101. Introductory Chemistry I. 3 Credits.

The fundamental principles of chemistry, including atomic and molecular structure, bonding, elementary thermodynamics, equilibrium and acids and bases, are introduced in this course. Can be taken with Introductory Chemistry Laboratory – I unless lab has been previously completed.

Note: Students taking this course and the laboratory 030.105 may not take any other course in the summer sessions and should devote full time to these subjects. High school physics and calculus are strongly recommended as prerequisites. First and second terms must be taken in sequence. Students not enrolled in college (unless they are rising freshmen) may not take this course.

Area: Natural Sciences

AS.030.102. Introductory Chemistry II. 3 Credits.

Continuation of AS.030.101 emphasizing chemical kinetics, chemical bonding. Topics: energy levels and wave functions for particle-in-a-box and hydrogen atom and approximate wave functions for molecules including introduction to hybrid orbitals. Note: Appropriate adjusting caps should be used to ensure both sections are approximately the same size

Prerequisite(s): Students enrolled in AS.030.103 may not enroll in or receive credit for AS.030.102.;AS.030.101 OR AS.030.107

Area: Natural Sciences

AS.030.103. Applied Chemical Equilibrium and Reactivity w/lab. 4 Credits.

This course is designed for students who have scored a 4 or 5 on the AP Chemistry Exam or who have scored a 6 or 7 HL IB Chemistry Exam. This course will review an advanced introductory chemistry sequence in a single semester. Chemical equilibrium, reactivity and bonding will be covered. These topics will be explored through laboratory experiments and problem solving, and discussing these principles in the context of current research. For details on chemistry placement and exam credit policies, please see http://www.advising.jhu.edu/placement_chemistry.php Students who have previously enrolled in AS.030.101 or AS.030.105 may not earn credit for AS.030.103 and students enrolled in AS.030.103 may not enroll in or receive credit for AS.030.102/AS.030.106.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.

Area: Natural Sciences

AS.030.105. Introductory Chemistry Laboratory I. 1 Credit.

Laboratory work includes quantitative analysis and the measurement of physical properties. Open only to those who are registered for or have successfully completed Introductory Chemistry 030.101.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;Students must have completed or be enrolled in AS.030.101 OR EN.510.101 to register for AS.030.105.;Students enrolled in AS.030.105 may not enroll in AS.030.115, AS.030.103, or AS.030.107.

Area: Natural Sciences

AS.030.106. Introductory Chemistry Laboratory II. 1 Credit.

Laboratory work includes some quantitative analysis and the measurement of physical properties. Open only to those who are registered for or have completed Introductory Chemistry II (AS.030.102). Permission required for pre-college students.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;Students enrolled in AS.030.103 may not enroll in or receive credit for AS.030.106.;AS.030.107 OR (AS.030.105 AND (AS.030.101 OR EN.510.101))

Area: Natural Sciences

AS.030.107. Chemical Principles w/lab: An Integrated Studio Course. 4 Credits.

An introduction to the fundamental principles of chemistry. The main topics to be covered are fundamental chemical reactions, stoichiometry and the balancing of chemical equations, solutions, gas laws, chemical equilibrium, acids and bases, and elementary chemical thermodynamics. Laboratory experiments and laboratory techniques will be incorporated into the course. Course will be run in three 2 hour blocks per week some of which will be used for lab. This course is equivalent to AS.030.101 and AS.030.105.

Area: Natural Sciences

AS.030.109. Metals in Everyday Life. 3 Credits.

Metals are an integral part of the living kingdom and non-living world around us. Starting with the fundamental physical and chemical properties of metals, the course will encompass topics that include the environmental, biological, industrial and medicinal importance of metals, highlighting the interdisciplinary nature of their use. We will address the very basic questions that excite every child- what makes metals shiny, malleable and ductile and what makes them capable of conducting heat and electricity. Topics on coordination complexes and enzymes will help students understand the role of metals in biology. For the environmental chemistry aspect, we will focus on heavy metals and their toxicity, nuclear fission etc. Metals in industry, roles of metals in metabolism, disease prevention and development of medicinal drugs will be covered in the final weeks of the course. There will also be several opportunities for students to present independent research, engage in group discussion, and after taking this exciting course, they would be able to understand why metals are so unique and an indispensable part of everyday life.

AS.030.112. Chemistry with Problem Solving I.

This course is for students who have had moderate or limited exposure to the subject. Special emphasis is placed on scientific problem-solving skills. There are two discussion sections per week, including one devoted exclusively to interactive quantitative problem solving. A typical student may have taken a year of descriptive chemistry as a high school sophomore, but has not been exposed to the problem-solving mathematical approach used in university-level science courses. Taken concurrently with AS.030.101 and AS.030.102. Students who have received an AP4 or higher are not considered eligible for this course and should not enroll.

Prerequisite(s): AS.030.101 OR AS.030.102

AS.030.113. Chemistry with Problem Solving II.

This course is for students who have had moderate or limited exposure to the subject. Special emphasis is placed on scientific problem-solving skills. There are two discussion sections per week, including one devoted exclusively to interactive quantitative problem solving. A typical student may have taken a year of descriptive chemistry as a high school sophomore, but has not been exposed to the problem-solving mathematical approach used in university-level science courses. Taken concurrently with AS.030.101 and AS.030.102.

AS.030.114. Freshman Seminar: The Making of a Chemist. 3 Credits.

Students will be introduced to professional culture and practice in academic and industrial chemical research laboratories. Through reading and analysis of a few series of seminal papers from the 1800's to the present leading to Nobel Prizes in Chemistry or Physics, students will learn how scientific inquiry and writing has evolved over time. Through discussion and practice, students will learn how to communicate chemistry in social media, scientific publications, scientific talks, and public lectures.

Area: Natural Sciences

Writing Intensive

AS.030.115. Introduction to Forensic Chemistry: The Science of Crime-solving. 3 Credits.

In this course, Introduction to Forensic Chemistry: The Chemistry of Crime-solving, students will gain knowledge on the basic chemical principles and various methods of chemical analysis that are employed to answer legal questions and solve crimes. They will be introduced to major forensic chemistry divisions (Controlled Substances, Toxicology, Trace Evidence, Prints, DNA analysis and Firearms), and the wide-range of routine procedures instrumental in analyzing different forms of evidence. For example, students will learn how chromatography and spectroscopy translates to forensic applications such as trace evidence analysis, as well as understand the underlying principles of fingerprinting or DNA profiling. Furthermore, these will be discussed with accompanying real-life case examples and additional simple hands-on laboratory experiments to create a more engaging atmosphere.

AS.030.117. Chemistry in Art and Archaeology. 3 Credits.

From tracing trading routes to dating artifacts, explore the central science, chemistry, as it relates to the study of antiquities. Gain a general overview of non-destructive and destructive techniques for studying artifacts. Gain practical knowledge on how to implement quantitative and qualitative instrumentation in a laboratory and museum setting including. Visit a working museum laboratory to discuss the unique joys and challenges of archaeometry. Study recent advances with primary source analytical chemistry material and assess practical future implementation of new techniques. Learn to tune communication style based upon an audience within and without your main discipline.

Area: Natural Sciences

AS.030.118. The Science of Color. 3 Credits.

This course is designed to introduce students to the fundamental physical and chemical origins of color and how we perceive them - from the vivid palette provided by the natural world to the brightly colored clothing we wear. Beginning with the basic principles of light and color, we will embark on an interdisciplinary investigation of color, including, but not limited to: color chemistry; color in biology; the physiology of the eye; how color affects human psychology; the history of color and light; and the use of color in art. Discover the physical and chemical explanations behind several noteworthy phenomena such as sunsets, color-blindness, rainbows, fireworks, chameleons and the Aurora Borealis.

Area: Natural Sciences

AS.030.204. Chemical Structure and Bonding w/Lab. 4 Credits.

An introduction to the synthesis, structure, and reactivity of inorganic compounds. Modern approaches to chemical bonding, including molecular orbital, ligand field, and crystal field theories, will be applied to understanding the physical and chemical properties of inorganic materials. Other topics to be discussed include magnetic properties, electronic spectra, magnetic resonance spectra, and reaction kinetics. The integrated laboratory will cover basic synthetic, measurement, and calculation methods of inorganic chemistry.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.030.102 OR AS.030.103 OR an AP score of 5

Area: Natural Sciences

Writing Intensive

AS.030.205. Introductory Organic Chemistry I. 4 Credits.

The fundamental chemistry of the compounds of carbon. Methods of structure determination and synthesis. The mechanisms of typical organic reactions and the relations between physical and chemical properties and structures.

Prerequisite(s): AS.030.102 OR AS.030.103 OR EN.510.101 OR AS.030.204.

Area: Natural Sciences

AS.030.206. Organic Chemistry II. 4 Credits.

Continuation of AS.030.205 Organic Chemistry I with special emphasis on organic synthesis and related synthetic methods. Students may not simultaneously enroll for AS.030.212 and AS.030.206.

Prerequisite(s): AS.030.205

Corequisite(s): Students may not simultaneously enroll for AS.030.212 and AS.030.206.

Area: Natural Sciences

AS.030.207. Problem Solving Methodology in Organic Chemistry I. 2 Credits.

This course will focus on the skills and strategies often utilized for solving problems in organic chemistry. In a seminar-style format, we will focus on a variety of strategies and techniques that students are otherwise expected to discover independently. This optional course is designed to help students succeed in Organic Chemistry I. The course is graded on a pass/fail basis, and is designed to be fun (believe it or not). Students work together in groups to solve challenging problems, focusing on the strategies necessary to solve each problem. This course is not required in order to succeed in Organic Chemistry I, but students in the past have found it to be helpful in guiding their study efforts for Organic Chemistry I.

Area: Natural Sciences

AS.030.208. Problem Solving Methodology in Organic Chemistry II. 2 Credits.

This course will focus on the skills and strategies often utilized for solving problems in organic chemistry. In a seminar-style format, we will focus on a variety of strategies and techniques that students are otherwise expected to discover independently. This optional course is designed to help students succeed in Organic Chemistry II. The course is graded on a pass/fail basis, and is designed to be fun (believe it or not). Students work together in groups to solve challenging problems, focusing on the strategies necessary to solve each problem. This course is not required in order to succeed in Organic Chemistry II, but students in the past have found it to be helpful in guiding their study efforts for Organic Chemistry II.

Area: Natural Sciences

AS.030.212. Honors Organic Chemistry II with Applications in Biochemistry and Medicine. 4 Credits.

Second semester undergraduate organic chemistry from a more advanced prospective emphasizing connections to biochemistry (protein and DNA structure, chemical logic of metabolism, enzyme mechanisms) and medicine (how drugs work, their targets, infectious and genetic diseases). The standard topics of second semester organic chemistry (e.g. reactivity of aromatic and carbonyl-containing molecules) will all be covered, but amplified and enriched with topics as noted. Students may not simultaneously enroll in AS.030.212 and AS.030.206. Prereq: Must receive a B or better in the first semester (AS.030.205).

Prerequisite(s): Must receive a B or better in the first semester (AS.030.205)

Area: Natural Sciences

AS.030.213. Metalloproteins and Their Role in Human Disease. 3 Credits.

Many metal ions are essential elements for human life and health. Non-redox metals serve as charge carriers and are important in osmotic balance as well as proper protein folding and structure. Redox active transition metals, such as iron and copper are important in electron transfer, oxygen transportation, respiration, and neurotransmitter homeostasis. This course is designed to introduce students to the important biological roles of metal-protein interactions and possible diseases that may occur from their malfunction

Prerequisite(s): Introductory Chemistry I & II - AS.030.101 AND AS.030.102

AS.030.225. Introductory Organic Chemistry Laboratory. 3 Credits.

Laboratory work includes fundamental laboratory techniques and preparation of representative organic compounds. Open only to those who are registered for or have completed Introductory Organic Chemistry. Note: This one-semester course is offered each term. Introductory Organic Chemistry I/II requires one semester of the laboratory.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.030.205;(EN.510.101 OR (AS.030.101 AND AS.030.102) OR AS.030.107) AND (AS.030.105 AND AS.030.106)) OR AS.030.103 permission of instructor for freshmen.

Corequisite(s): Students may not simultaneously enroll for AS.030.225 and AS.030.227

Area: Natural Sciences

AS.030.227. Chemical Chirality: An Introduction in Organic Chem. Lab, Techniques. 3 Credits.

This is a project lab designed for Chemistry Majors who are concurrently enrolled in AS.030.205. Techniques for the organic chemistry laboratory including methods of purification, isolation, synthesis, and analysis will be explored through a project focused on chemical chirality. Students may not simultaneously enroll for AS.030.225 and AS.030.227.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.030.206 OR AS.030.212, students may enroll concurrently in either of these courses and AS.030.227, or take either of those courses prior to enrolling in AS.030.227.;AS.030.205

Corequisite(s): Students may not simultaneously enroll for AS.030.225 and AS.030.227.

Area: Natural Sciences

AS.030.228. Intermediate Organic Chemistry Laboratory. 3 Credits.

Lab skills already acquired in AS.030.225 will be further developed for synthesis, isolation, purification, and identification of organic compounds. Spectroscopic techniques, applications will be emphasized. Recommended Course Background: AS.030.225

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.030.205 AND (AS.030.225 OR AS.030.227);(AS.030.206 OR AS.030.212)

Area: Natural Sciences

AS.030.245. Quantitative Analytical Laboratory. 3 Credits.

This is a 3 credit lab that will serve as an introduction into analytical techniques and quantitative methods. There will be a 1 hour of pre-lab lecture component to this course to discuss the lab for that day.

Prerequisite(s): ((AS.030.101 & AS.030.102) OR AS.030.103) AND AS.030.205

Writing Intensive

AS.030.301. Physical Chemistry I. 3 Credits.

The laws of thermodynamics, their statistical foundation, and their application to chemical phenomena. Students should have knowledge of general physics, general chemistry, and calculus (two semesters recommended). Freshmen by permission only.

Area: Natural Sciences

AS.030.302. Physical Chemistry II. 3 Credits.

Introduction to quantum mechanics, its application to simple problems for which classical mechanics fails. Topics: Harmonic oscillator, hydrogen atom, very approximate treatments of atoms and molecules, and theoretical basis for spectroscopy. Recommended Course Background: AS.030.301

Area: Natural Sciences

AS.030.305. Physical Chemistry Instrumentation Laboratory I. 3 Credits.

This course is designed to illustrate the principles of physical chemistry and to introduce the student to techniques and instruments used in modern chemical research. Chemistry majors are expected to take this sequence of courses, rather than AS.030.307. Chemistry majors only.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module..

Area: Natural Sciences

AS.030.306. Physical Chemistry Instrumentation Laboratory II. 3 Credits.

Designed to illustrate the principles of physical chemistry, introduce the student to spectroscopic techniques and instruments used in modern chemical research. Chemistry majors are expected to take this course rather than 030.307.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.030.301 OR AS.030.302;AS.030.305

Area: Natural Sciences

AS.030.307. Experiments in Physical Chemistry for Engineers. 3 Credits.

This is a one-semester course which selects experiments that are most relevant to chemical engineering. Chemical Engineering majors only. Recommended Course Background: AS.030.301-AS.030.302 or equivalent.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class.

Area: Natural Sciences

AS.030.315. Biochemistry I. 4 Credits.

Foundation for advanced classes in Biophysics and other quantitative biological disciplines. Lecture and computer laboratory. This class is the first semester of a two semester course in biochemistry. Topics in Biochemistry I include chemical and physical properties of biomolecules and energetic principles of catabolic pathways. Computer labs include extensive use of molecular graphics and modelling of reaction kinetics and pathway flux. Co-listed with AS.250.315

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.030.206 OR AS.030.212

Area: Natural Sciences

AS.030.316. Biochemistry II. 3 Credits.

Biochemical anabolism, nucleic acid structure, molecular basis of transcription, translation and regulation, signal transduction with an emphasis on physical concepts and chemical mechanisms. Format will include lectures and class discussion of readings from the literature.

Prerequisite(s): AS.030.315 OR AS.250.315 OR AS.020.305

Area: Natural Sciences

AS.030.356. Advanced Inorganic Lab. 3 Credits.

Laboratory designed to illustrate the principles and practice of inorganic chemistry through the synthesis and characterization of transition metal and organometallic compounds. Methods used include vacuum and inert atmosphere techniques. Instrumental approaches and modern spectroscopic techniques are applied to the characterization of compounds generated. It is strongly recommended that students have taken or are taking one of the following courses: AS.030.204, AS.030.442, AS.030.449, or AS.030.472.

Prerequisite(s): AS.030.228

Area: Natural Sciences

AS.030.370. Biophysical Chemistry. 4 Credits.

Course provides working understanding of physical chemistry of the cell, emphasizing problem solving. Topics include classical and statistical thermodynamics, thermodynamics of proteins and nucleic acids, protein folding, calorimetry, ligand binding thermodynamics, linkage, cooperativity and anticooperativity, allosteric models, lattice statistics, helix-coil transition, and polymer theory. When appropriate, students visit the laboratory to set up data collection and learn to analyze the resulting data computationally, using nonlinear least-squares methods.

Prerequisite(s): (AS.171.101 OR AS.171.103 OR AS.171.107) AND (AS.171.102 OR AS.171.104 OR AS.171.108) AND (AS.030.103 OR AS.030.102) AND (AS.110.106 OR AS.110.108) AND (AS.110.107 OR AS.110.109)

Area: Natural Sciences

AS.030.371. Chemistry for Connoisseurs. 3 Credits.

This course will survey the structural and physical properties of chemicals often considered as part of the "finer things in life" including topical discussions of the chemistries of food, drink, art, cosmetics and clothing, among others. Despite the pretentious name, the general theme of the course is to put chemical identities onto the things we interact with on a daily basis but most likely take for granted at a molecular level. Current event topics in consumer chemistry will also be covered as they arise. Students will have the chance to research topics of interest. The course material will be enriched by the contributions from special guest lecturers and occasional field trips.

Prerequisite(s): AS.030.205 or equivalent

Area: Natural Sciences

Writing Intensive

AS.030.402. Experimental Methods in Physical Chemistry. 3 Credits.

This course introduces the student to experimental methodologies used in gas phase physical chemistry. Topics to be covered include vacuum technology, charged particle optics, lasers, mass spectrometry, data acquisition, detectors, measurement of temperature and pressure, and design and fabrication of scientific apparatus. These topics will be tied together with examples of specific experimental studies.

Area: Natural Sciences

AS.030.403. Optoelectronic Materials and Devices: Synthesis, Spectroscopy, and Applications. 3 Credits.

This course provides an introduction to the vast chemistry and physics of solid-state materials. The course begins with a fundamental description of bonding in crystalline solids and calculation of electronic band structure. We then extend our discussion to methods for the synthesis of low-dimensional materials and hierarchical structures, including quantum dots (0D), nanowires (1D), graphene and graphene analogs (2D), and thin-film superlattices. An in-depth discussion of spectroscopic and characterization techniques for solid-state materials will follow and focus on some of the foundational studies of quantum devices and cooperative phenomena. At this stage we will describe recent advances in electron-microscopy (e.g. aberration-corrected and energy filtered TEM, atom-probe tomography) that are revolutionizing the structural, compositional, and electronic characterization of materials. The course will conclude with a survey of contemporary topics in solid-state and nanomaterials science, including functional devices and circuits, assembly, energy conversion and catalysis, and biological sensing. Recommended Course Background: AS.030.301 and AS.030.402 are preferred, but instructor approval may be granted in lieu of these courses.

Area: Natural Sciences

AS.030.404. Electrochemical Systems for Energy Conversion and Storage. 3 Credits.

This course will be focused on the fundamentals and applications of electrochemical methods in catalysis, charge transport, and energy conversion and storage. Topics that will be covered are basic electrochemical techniques, homogenous and heterogeneous (photo)electrocatalysis, fuel cells, and charge storage devices. The class will conclude with a group report and presentation on a recent development in the field of energy catalysis, conversion, and storage. Course topics include: 1) Fundamentals of electrochemistry, 2) Potential sweep methods and current-controlled techniques, 3) Impedance analysis, 4) Electrochemistry coupled with other characterization methods, 5) Electrocatalysis and photoelectrochemical catalysis, 6) Basics in fuel cells and current technologies (alkaline, polymer exchange membrane, solid oxide...), 7) Basics in batteries and current technologies (Pb acid, Li-based, other metals...) Recommended Course Background: AS.030.204 or AS.030.449 or AS.030.472, or instructor approval for undergraduate students. No pre-requisites for graduate students Area: Natural Sciences

AS.030.405. Introduction to Computational Chemistry. 3 Credits.

This course provides an introduction to the state-of-the-art computational chemistry. The course integrates the basics about molecular electronic structure theories and the corresponding computational aspects and practice in chemical applications. The discussions of theories cover the modern quantum-chemical methods, ranging from mean-field methods (Hartree-Fock method and density-functional theory) to post mean-field methods for treating electron-correlation effects (configuration interaction and coupled cluster). Demonstrative calculations and computer lab practice are designed to deal with the computation of energetic properties (e.g., heat of formation, bond dissociation energy, reaction activation energy, etc) and structural properties (geometry, vibrational frequencies, etc) of representative molecular systems using standard quantum chemistry program package (the Gaussian program, most probably). The class will conclude with a report and presentation on a piece of recent computational work pertinent to the student's research interests.

AS.030.407. Modeling Matter at Nanoscales: An Introduction to Theoretical and Computational Approaches. 3 Credits.

The course allows students to become familiar with the essentials of concepts for modeling the structure of matter at nanoscales and the depending properties, as well as the way that they relate with measurements at human scales. Concepts on modeling, computer representation of nanosystems, origin of interactions between bodies at nanoscales and the different ways of finding the corresponding potential energy surfaces, including both classical and quantum mechanical procedures and described and even detailed when relevant. Applications can be on life materials, or other nanoscopic environments. It is designed for advanced undergraduate and graduate students in Chemistry, Physics, Biology, Pharmacy and Biochemistry, as well as physicians and engineers. Attendants must handle an essential ground in Mathematics, General Physics, Chemistry and related matters.

AS.030.408. Theoretical Foundations of Computational Chemistry. 3 Credits.

The course allows students to become familiar with the essential concepts for modeling the structure and properties of matter at nanoscales, as well as the way that they relate with the corresponding experimental determinations. Concepts on modeling, computer representation of nanosystems, origin of interactions between bodies at nanoscales and the different ways of finding the potential energy surfaces, including both classical and quantum mechanical procedures are described and even detailed when relevant. Recent approaches and procedures as those based in Artificial Intelligence are outlined in the framework of the theoretical grounds of this kind of modeling. Applications can mostly be to life and material sciences, spectroscopy, as well as other fields. It is designed for advanced undergraduate and graduate students in Chemistry, Physics, Biology, Pharmacy and Biochemistry, as well as physicians and engineers. Attendants must handle an essential ground in Mathematics, general Physics, Chemistry and related matters. Test calculations will be performed for selected methods during lab times, normally at the student's laptops.

AS.030.415. Bioinorganic and Organometallic Chemistry. 3 Credits.

This course will cover key concepts of Bioinorganic chemistry (including metalloenzymes, synthetic catalysts, drugs, and molecular sensors) and Organometallic Chemistry (types of ligands, interactions with metals) and their applications in catalysis and bioinorganic chemistry. A background in organic chemistry and physical chemistry I is strongly recommended. **Prerequisite(s):** (AS.030.101 AND AS.030.102) AND (AS.030.205 AND AS.030.206)

AS.030.421. Data Science Tools for the Chemical and Materials Sciences. 3 Credits.

Advances in measurement techniques and simulations have driven an explosion in the variety, quality, and quantity of data collected when investigating chemical and materials processes. Advances in computing have led to the practicality of machine learning (ML) and related analytical methods to explore and extract meaning from this cornucopia of data, and data science has been called the fourth pillar of the scientific method. This course will provide an introduction to modern tools of data science, including the Python programming language, Jupyter notebooks, ML algorithms and their practical implementation, and high performance computing, with specific emphasis on applying these tools to data of chemical relevance, including UV/Vis, IR and NMR spectra, 3-D micro computed tomography, and physical property data including specific heat, magnetization, and resistivity.

AS.030.423. Nucleic Acids in Chemistry and Biotechnology. 3 Credits.

This course will explore nucleic acid chemistry, biochemistry, and biology from a chemical biology perspective. Our studies will always be grounded in the fundamental chemistry of nucleic acids. We will explore the structure, function, and reactivity of nucleic acids, as well as the mechanisms by which DNA is damaged and repaired, and how the chemistry governing nucleic acids dictates their biological activities. We will examine how nucleic acid chemistry is integrated into cutting edge biotechnologies and therapeutics, and how this impacts society. The knowledge gained from this course will allow for a broader understanding of how chemistry governs all aspects of our genetic code. **Prerequisite(s):** AS.030.205 OR AS.030.206 OR AS.030.212

AS.030.441. Spectroscopic Methods of Organic Structure Determination. 3 Credits.

The course provides fundamental theoretical background for and emphasizes practical application of ultraviolet/visible and infrared spectroscopy, proton and carbon-13 nuclear magnetic resonance and mass spectrometry to the structure proof of organic compounds.

Area: Natural Sciences

AS.030.442. Organometallic Chemistry. 3 Credits.

An introduction to organometallic chemistry beginning with structure, bonding, and reactivity and continuing into applications to fine chemical synthesis and catalysis. Recommended Course Background: AS.030.449 or equivalent. Level: Upper level Undergraduate AND Graduate Students

Area: Natural Sciences

AS.030.446. Mathematica as a Tool for Chemists. 3 Credits.

A systematic, hands-on introduction to Mathematica. Covers Mathematica's basic 'language,' analytic and numerical calculations, data manipulation, graphical representation, interactivity, programming, and document production. Prerequisite: Calculus (including power series)

Area: Natural Sciences

AS.030.449. Chemistry of Inorganic Compounds. 3 Credits.

Physical and chemical properties of inorganic, coordination and organometallic compounds are discussed in terms of molecular orbital, ligand field and crystal field theories. Emphasis on structure and reactivity of these inorganic compounds. Other topics: magnetic properties, electronic spectra, magnetic resonance spectra, reaction kinetics.

Area: Natural Sciences

AS.030.451. Spectroscopy. 3 Credits.

Spectroscopy and structure of molecules starting from rotational, vibrational and electronic spectra of diatomic molecules and extending to polyatomic molecules as time permits. Recommended Course Background: AS.030.302 or permission of instructor.

Area: Natural Sciences

AS.030.452. Materials & Surface. 3 Credits.

The chemistry associated with surfaces and interfaces as well as a molecular level understanding of their essential roles in many technological fields. The first half of this course addresses various analytical techniques used to study surfaces including X-ray, photoelectron spectroscopy, and scanning tunneling microscopy. The second half of this course uses a number of case studies to illustrate the application of surface analytical techniques in contemporary research.

Area: Natural Sciences

AS.030.453. Intermediate Quantum Chemistry. 3 Credits.

The principles of quantum mechanics are developed and applied to chemical problems.

Prerequisite(s): (AS.030.301 OR AS.030.370 OR AS.250.372) AND AS.030.302

Area: Natural Sciences

AS.030.456. Chemical Applications of Group Theory. 3 Credits.

The theory of the representations of finite and continuous groups will be applied to problems in chemistry.

Area: Natural Sciences

AS.030.501. Independent Research in Physical Chemistry I. 3 Credits.

Research under the direction of members of the physical chemistry faculty.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.502. Independent Research in Physical Chemistry. 0 - 3 Credits.

Research under the direction of members of the physical chemistry faculty.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.503. Independent Research in Inorganic Chemistry I. 3 Credits.

Research under the direction of members of the inorganic chemistry faculty.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.504. Independent Research in Inorganic Chemistry. 0 - 3 Credits.

Research under the direction of members of the inorganic chemistry faculty.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.505. Independent Research in Organic Chemistry I. 3 Credits.

Research under the direction of members of the organic chemistry faculty.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.506. Independent Research in Organic Chemistry I. 0 - 3 Credits.

Research under the direction of members of the organic chemistry faculty.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.507. Independent Research in Biochemistry. 3 Credits.

Research under the direction of members of the biochemistry faculty.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.509. Independent Research in Biochemistry II. 3 Credits.

Research under the direction of members of the biochemistry faculty. Recommended Course Background: AS.030.507-AS.030.508 and permission of instructor.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.510. Independent Research in Biochemistry II. 0 - 3 Credits.

Research under the direction of members of the biochemistry faculty. Recommended Course Background: AS.030.507-AS.030.508 and permission of instructor.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.511. Independent Research in Materials Chemistry. 0 - 3 Credits.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.512. Independent Research in Materials Chemistry. 0 - 3 Credits.

Research under the direction of the materials chemistry faculty.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.513. Independent Research in Medical Science. 3 Credits.

Research under the direction of members of the medical faculty.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.514. Independent Research in Medical Science. 3 Credits.

Research under the direction of members of the medical faculty.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.516. Independent Research in Chemical Biology II. 1 - 3 Credits.

Research under the direction of Chemical Biology faculty. Permission of instructor required.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.
Writing Intensive

AS.030.521. Independent Research in Inorganic Chemistry II. 3 Credits.

Research under the direction of the inorganic chemistry faculty.
Recommended Course Background: AS.030.503-AS.030.504 and permission of instructor.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.522. Independent Research in Inorganic Chemistry II. 0 - 3 Credits.

Research under the direction of the inorganic chemistry faculty.
Recommended Course Background: AS.030.503-AS.030.504 and permission of instructor.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.523. Independent Research in Physical Chemistry II. 3 Credits.

Research under the direction of the physical chemistry faculty.
Recommended Course Background: AS.030.501-AS.030.502 and permission of instructor.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.525. Independent Research in Organic Chemistry II. 3 Credits.

Research under the direction of the organic chemistry faculty.
Recommended Course Background: AS.030.505-AS.030.506 and permission of instructor.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.526. Independent Research in Organic Chemistry II. 0 - 3 Credits.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.527. Independent Study. 3 Credits.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.530. Independent Research in Inorganic and Materials Chemistry. 1 - 3 Credits.

Research under the direction of members of the Inorganic Chemistry faculty.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.540. Independent Research in Solid State and Materials Chemistry. 1 - 3 Credits.

Research under the direction of members of the Physical Chemistry faculty.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.551. Internship-Chemistry. 1 Credit.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.593. Research-Organic Chemistry I. 3 Credits.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.597. Research - Summer. 3 Credits.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration & Online Forms.

AS.030.601. Statistical Mechanics.

An introduction to statistical mechanics of cooperative phenomena using lattice gases and polymers as the main models. Covered topics: phase transitions and critical phenomena, scaling laws, and the use of statistical mechanics to describe time dependent phenomena.

AS.030.610. Chemical Kinetics.

The molecular mechanism of elementary physical and chemical rate processes will be studied. Topics such as elastic scattering, collisional vibrational and rotational energy transfer, chemically reactive collisions, and the theory of unimolecular decay will be covered.

AS.030.613. Chemistry-Biology Interface Program Forum I.

Chemistry-Biology Interface (CBI) program students and faculty will meet weekly in a forum that will host presentations from CBI faculty and students as well as invited guest speakers. These meetings will serve as a valuable opportunity for students to develop presentation skills and interact with CBI students and faculty. Enrollment is required for first- and second-year CBI students, and is recommended for advanced-year graduate students.

AS.030.614. Chemical-Biology Program Interface Forum II.

Chemistry-Biology Interface (CBI) program students and faculty will meet weekly in a forum that will host presentations from CBI faculty and students as well as invited guest speakers. These meetings will serve as a valuable opportunity for students to develop presentation skills and interact with CBI students and faculty. Enrollment is required for first and second year CBI students, and is recommended for advanced year graduate students.

AS.030.615. Bioinorganic Chemistry.

AS.030.619. Chemical Biology I.

Parts I and II constitute the core course of the Chemistry-Biology Interface (CBI) Program. An introduction to the structure, synthesis, reactivity, and function of biological macromolecules (proteins, nucleic acids, carbohydrates, and lipids) will be provided using the principles of organic and inorganic chemistry. Discussion will incorporate a broad survey of molecular recognition and mechanistic considerations, and introduce the tools of molecular and cellular biology that are utilized in research at the interface of chemistry with biology and medicine. Recommended Course Background: AS.030.206 or equivalent.

AS.030.620. Chemical Biology II.

Selected topics of current importance in chemical biology are covered. They include protein engineering and proteomics, cell signaling, protein-nucleic acid interactions (e.g. replication, transcription, DNA repair), catalytic RNA and the ribosome, biosynthesis of natural products, mechanisms of drug action, combinatorial chemistry and chemical genetics, and in vitro selection. Recommended Course Background: AS.030.619 or permission required.

AS.030.621. Literature–Organic Chemistry.**AS.030.622. Seminar: Literature of Chemistry.**

Seminars are presented by advanced graduate students on topics from current chemical journals. Most first-year graduate students are expected to attend for credit. Undergraduates may take the course on a satisfactory/unsatisfactory basis.

AS.030.623. Molecular Synthetic Biology.

Principles and methods for the design and optimization of new biological systems, from a molecular perspective. Topics include: introduction to genetic parts and modern methods for their assembly; synthesis and incorporation of nucleic acids at the level of nucleotides, genes, and genomes; design of genetic programs; library generation and screening; directed evolution and its application to create new proteins and metabolic pathways; computational design of protein and RNA?using physical and bioinformatic approaches; non-canonical amino acids and genetic code expansion. This course will also feature critical evaluation of the primary literature in this fast-paced field, and practical experience with relevant software and computational tools.

AS.030.625. Advanced Mechanistic Organic Chemistry I.

The course covers the application of techniques in physical chemistry to the study of organic reaction mechanisms. Topics include chemical bonding and structure, stereochemistry, conformational effects, molecular orbital theory, methods to determine reaction mechanisms, reactive intermediates, and photochemistry. Recommended Course Background: AS.030.205-AS.030.206

AS.030.626. Advanced Mechanistic Organic Chemistry II.

This course covers advanced organic reactions and their mechanisms. Emphasis is given both to methods of postulating mechanisms for rationalizing reaction results and to the use of mechanistic thinking for designing reactions and reagents. This course is intended to be taken in sequence with AS.030.425. Recommended Course Background: AS.030.205-AS.030.206

AS.030.630. Molecular Photophysics and Photochemistry.

This course will introduce fundamental physical, chemical, and analytical concepts underlying light-induced chemical and (molecular-based) material processes. The final weeks of this course will build from these core concepts to survey molecular photoresponses and their consequences or applications in environmental chemistry, chemical biology, and materials science.

Area: Natural Sciences

AS.030.634. Topics in Bioorganic Chemistry.

Selected topics in modern bioorganic chemistry will be treated in greater depth emphasizing natural products chemistry, biosynthetic reaction mechanisms and drug design. Carbohydrates, lipids, polyketides, polypeptides, terpenes and alkaloids will be discussed. Specific examples of drug design will be introduced throughout and methods of synthesis, combinatorial synthesis and genetics will be described.

AS.030.635. Principles of Magnetic Resonance.

This course develops the basic theoretical concepts underlying the fields of NMR (Nuclear Magnetic Resonance) and EPR (electron spin/paramagnetic resonance). From this foundation, a broad range of different applications will be surveyed. This includes applications to multidimensional solution state NMR spectroscopy, EPR spectroscopy, as well as hybrid electron/nuclear magnetic resonance applications such as dynamic nuclear polarization (DNP).

AS.030.652. A Theoretical and Experimental Approach to X-ray Crystallography.

The X-ray course will provide a complete approach to X-ray structure to determination (mostly concerned with small molecules) and its uses in Chemistry. The first segment of this course will cover all theoretical aspects of X-ray crystallography, i.e. crystals and crystallization, the nature of X-rays, the diffraction phenomenon of X-rays by crystals, symmetry and space groups, crystal structure analysis. Additionally, the course will provide laboratory experience for the students, involving hands-on instrumentation, experimental methodology to X-ray structure determination, structure solution/refinement, data analyses and publishing data. The course is aimed for graduate students with a strong interest in organic/inorganic chemistry, materials sciences, and physics. Undergraduate students with a major in chemistry are also encouraged to participate.

Area: Natural Sciences

AS.030.677. Advanced Organic Synthesis I.

The reactions and principles involved in the synthesis of simple and complex organic compounds. Discussion of famous natural product syntheses and practice in developing rational designs for organic syntheses. Problems in the design of syntheses and in the use of chemical literature.

AS.030.678. Advanced Organic Synthesis II.

Advanced discussion of organic stereochemistry & its application to problems in asymmetric reactions and catalysis will be presented. Emphasis will be placed on the latest reports in the literature, especially with respect to the development of new catalytic, asymmetric processes.

AS.030.691. Hardware, Software and Materials Chemistry.

The course is designed to provide the essential principles and concepts underlying the modern study of the structure and properties of solids in bulk crystals, thin films, and nanoscale objects. Topics include basic crystallography, structure determination by x-ray, neutron, and electron diffraction, fundamental concepts of bonding in solids, lattice dynamics, electronic band structure, magnetism, and strongly correlated electron behavior. Particular emphasis is placed on the impact of the structure, dimensionality, and electron count on electrical and magnetic properties (electric conduction, superconductivity, thermoelectricity, etc). More course info available at <http://occamy.chemistry.jhu.edu>. Cross-listed with Physics and Astronomy

AS.030.693. Methods in Time-Resolved Spectroscopy.

In this course we will survey common time-resolved spectroscopic methods used to interrogate the dynamic and static properties of chemical systems. We will explore theoretical treatments both of key molecular processes (e.g. radiative and non-radiative transitions, solvation, coherence dephasing) and the spectroscopic tools used to interrogate them. Furthermore, we will survey the technical developments that are now allowing us to capture events that occur on ever faster timescales (currently down to the attosecond regime) and across the electromagnetic spectrum (from X-rays to Terahertz). Previous or concurrent concentrated study of Quantum Mechanics (graduate level or from a physics course) would be helpful, but not strictly required. Recommended Course Background: AS.030.301-AS.030.302

AS.030.802. Independent Research.

Research under the direction of the chemistry faculty.

AS.030.897. Dissertation Research.

Open to AS Chemistry Graduate Students only.