CHEMISTRY AND PHYSICS

at Arcadia University

Global Perspectives…Personal Attention…Real-World Integrative Learning Experiences

Faculty

Professor
Dr. Chester M. Mikulski (Chair)

Associate Professors
Dr. Peter Campbell
Dr. Emanuele Curotto
Dr. H. Stephen Huber
Dr. Linda M. Mascavage

Degrees and Certificate

Bachelor of Arts in Chemistry
Chemical Professions
Health Professions
Forensic Science

Bachelor of Science in Chemistry
Biochemistry

Bachelor of Science in Chemistry and Business (See separate listing.)

Post-Baccalaureate Certificate in the Sciences

Option
3+2 Accelerated Forensic Science Program—Bachelor of Arts or Bachelor of Science in Chemistry with a Master of Science in Forensic Science (See separate listing.)
Secondary Education Certification (See Education.)

Minors
Chemistry
Physics

Related Graduate Study at Arcadia University

Master of Arts in Education with a Concentration in Chemistry

Master of Business Administration (M.B.A.) with an International Perspective

Master of Education with a Concentration in Secondary Education with Chemistry Certification

Master of Science in Forensic Science

Pathways to Study Abroad in Chemistry

Chemistry majors can elect to spend a semester or year studying abroad. In conjunction with their advisers and the Chair of the Department, students in the sophomore or junior year can enroll in classes at foreign universities. Credits for these courses transfer to Arcadia to fulfill Undergraduate Curriculum, including upper-level Chemistry, requirements.

Arcadia University's College of Global Studies has special arrangements with universities in England, Scotland, Wales and Northern Ireland, Australia, Ireland, Spain and New Zealand that offer chemistry and biochemistry courses. Visit the University's Web site for Pathways to Study Abroad (www.arcadia.edu/pathways) and suggested course sequences.

Since it is important that students plan ahead for study abroad, they should consult with their advisers as soon as possible and make their intentions known to the Department Chair and the Director of International Services.

About the B.A. and B.S. in Chemistry

- Preparation for chemical professions, including research careers
- Preparation for health professions, including medicine
- Preparation for graduate school
- 3+2 five-year Accelerated Forensic Science Program
- Preparation for teaching with secondary education certification
- Internship opportunities
- Accelerated preparation for Arcadia's master's program in Forensic Science
- Opportunities to study abroad at some of the top universities around the world

Degree options include a Bachelor of Arts in Chemistry, a Bachelor of Science in Chemistry, and a Bachelor of Science in Chemistry and Business.

The Bachelor of Arts in Chemistry features three concentrations. The Chemical

Professions Concentration prepares students for chemical allied professions. The Health Professions Concentration prepares students for medical, dental, osteopathic and veterinary graduate programs or paramedical professions. The Forensic Science Concentration is designed for students who intend to pursue graduate study in Arcadia's Forensic Science master's program.

Arcadia's programs include a variety of internship opportunities. The Chemistry program at Arcadia University is accredited by the American Chemical Society (ACS). Recent graduates have entered regional medical schools and graduate and doctoral programs at Princeton University, University of Maryland, University of Michigan and Cornell University, among others.

The Bachelor of Science in Chemistry consists of core courses in Chemistry, Mathematics and Physics. The program prepares students for graduate work in chemistry, forensic science or chemical allied sciences, for professional employment in industrial chemical research and development, for professional medical programs, and for secondary and post-secondary teaching.

The Bachelor of Science in Chemistry and Business is designed for students who have an interest in chemistry but do not want a research career. With a dual major in Chemistry and Business, graduates of the program are prepared for positions in management, marketing, advertising, sales or other business activities in chemical and pharmaceutical companies. A highlight of the program is the senior-level internship, which involves placement in a chemical or pharmaceutical firm. The program is designed to meet the M.B.A prerequisite courses for many graduate institutions.

These Chemistry programs provide a working knowledge of the concepts that underlie chemical and physical phenomena. Each course develops the ability to solve real scientific problems quantitatively using structural models, mechanisms and the integrated application of physicochemical principles. Technological and cultural scientific problems—such as environmental pollution, energy resources and conservation of natural resources—are explored, along with material in astronomy, geology, chemistry and physics.

Bachelor of Arts in Chemistry

The Bachelor of Arts includes three areas of concentration.

- **Chemical Professions Concentration:** Designed for students who expect to qualify for positions in chemistry, chemical allied professions such as information retrieval or scientific librarian, and secondary school teaching (with the courses required for certification).

- **Health Professions Concentration:** Designed for students interested in medicine, dentistry, veterinary medicine, podiatry, optometry and the paramedical professions.

- **Forensic Science Concentration:** Designed for students who intend to pursue graduate study in Arcadia's Forensic Science master's program.

Bachelor of Science in Chemistry

Bachelor of Science recipients who complete this program are certified by the American Chemical Society as having met that Society's high standards for an undergraduate degree in chemistry.

- **Biochemistry Concentration:** Specifically tailored to students who want to pursue advanced training in the health professions, often the program of choice for pre-medical students.

Minor in Chemistry

The minor in Chemistry is directed toward students who have an interest in chemistry but who do not want to pursue a career in chemistry. This course of study provides a background appropriate for students majoring in areas of science other than chemistry.

Minor in Physics

The minor in Physics is appropriate for students in Mathematics, Engineering or Chemistry, either to develop a stronger background in the physical sciences or to pursue advanced training in disciplines such as applied mathematics, engineering or theoretical chemistry.

Requirements for the B.A. in Chemistry

(56–64 credits as listed below, with Undergraduate Curriculum requirements and electives to total 128 credits)

Common Curriculum for All Concentrations

(32 credits. Substitutions in keeping with a student's intended career may be made with the approval of the Department Chair.)

1. Five courses in Chemistry

CH	101, 102	Modern Chemical Concepts I, II
CH	201, 202	Organic Chemistry I, II: Structure, Mechanisms and Reactions
CH	203	Equilibrium and Analysis

2. Three courses in Physics and Mathematics from the following:

PH	201, 202	Fundamental Concepts of Physics I, II
or PH	211, 212	Conceptual Physics I, II
MA	201	Calculus I
or MA	202	Calculus II

3. Recommended

CH	303	Biochemistry
CH	304	Instrumental Methods of Analysis I
CH	305	Inorganic Chemistry
CH	306	Advanced Organic Chemistry
CH	307	Polymers and Biopolymers
CH	333	Statistical Thermodynamics
CH	351	Quantum Chemistry and Chemical Physics
CH	389	Chemical Research
German or French to fulfill Modern Language requirement		
PH	223	Essentials of Physical Geology
PH	224	Frontiers in Astronomy
PH	324	Atomic Physics
PH	331	Engineering Mechanics
CS	104	The Computer as a Tool
MA	202, 203	Calculus II, III
MA	221	Linear Algebra
MA	352	Differential Equations
MA	356	Numerical Analysis
PL	160	Symbolic Logic

Additional Requirements

In addition to the common curriculum, students must select one of the following concentrations:

Chemical Professions (24 additional credits)

1. A minimum of four additional Chemistry electives, including CH 490 Chemistry Seminar

2. A minimum of two electives in other science fields

Health Professions (32 additional credits)

1. Six courses in Biology

2. A minimum of two additional Chemistry electives, including CH 490 Chemistry Seminar

Forensic Science (32 additional credits)

1. Six courses in Biology (including BI 101, BI 102, BI 204, BI 321, BI 325, and BI 333)

2. A minimum of two additional Chemistry electives (including CH 490 and either CH 303, CH 304, or CH 307)

Requirements for the B.S. in Chemistry

(52 credits as listed below, with Undergraduate Curriculum requirements and electives to total 128)

1. Ten courses in Chemistry

CH	101, 102	Modern Chemical Concepts I, II
CH	201, 202	Organic Chemistry I, II
CH	203	Equilibrium and Analysis
CH	301, 302	Physical Chemistry I, II
CH	303	Biochemistry
CH	304	Instrumental Methods of Analysis I
CH	305	Inorganic Chemistry

2. Two courses in Physics

PH	211, 212	Conceptual Physics I, II

3. Two courses in Mathematics

MA	201, 202	Calculus I, II

4. Chemistry Seminar

CH	490	Chemistry Seminar

5. Recommended Courses: See the list of recommended courses for the Bachelor of Arts.

Biochemistry Concentration: In order to satisfy the requirements for a Concentration in Biochemistry, students are expected to have successfully completed BI 101-102, BI 204, BI 325, and BI 333 in addition to CH 303.

Requirements for the Minor in Chemistry

(24 credits as listed below)

1. Six courses in Chemistry

CH	101, 102	Modern Chemical Concepts I, II
CH	201, 202	Organic Chemistry I, II
CH	203	Equilibrium and Analysis

2. One additional Chemistry elective at the 300 level

Requirements for the Minor in Physics

(20 credits as listed below)

1. Five courses in Physics

PH	201, 202	Fundamental Concepts of Physics I, II
or PH	211, 212	Conceptual Physics I, II
PH	324	Atomic Physics

2. Two additional Physics electives at the 300 level

Chemistry Courses (CH)

100
Language of Science
(2 credits; Fall)

This course covers basic quantitative methods for introductory science courses. Includes dimensional and unit analysis in the SI and US customary systems, elementary propagation of error analysis, problem solving with simultaneous equations, scientific notation, graphical analysis, and transcendental analysis.
Prerequisite: Placement in MA 110, a passing grade in MA 100 or permission of the instructor to take it concurrently with MA 100.

101
Modern Chemical Concepts I
(4 credits; Fall, Spring)

Introduction to the principles of atomic structure, chemical bonding, states of matter, stereochemistry and their relation to the properties of selected inorganic and organic substances. Presents the historical development, methodology and philosophy of current understanding of transformations of matter and energy from an experimental viewpoint. Three class hours and three laboratory hours weekly.
Prerequisite: CH 100 or placement exam.

102
Modern Chemical Concepts II
(4 credits; Fall, Spring)

Continuation of CH 101. Introduces the principles of chemical energetics, chemical equilibrium, reaction mechanisms, chemical kinetics, electrochemistry and radiation chemistry. Applies chemical principles to the reaction of inorganic and organic substances from a quantitative experimental point of view. Three class hours and three laboratory hours weekly.
Prerequisite: CH 101.

201
Organic Chemistry I:
Structure, Mechanisms and Reactions
(4 credits; Fall)

Study of the correlation of acid-base theory, reaction mechanisms, molecular structure, chemical energetics, and spectroscopy to the chemical and physical properties of organic functional groups. Chemistry and Physics laboratory work stresses the synthesis, separation, identification and analysis of selected organic compounds using both micro- and macro-scale techniques. Three class hours and three laboratory hours weekly.
Prerequisite: CH102; or permission of the Department Chair.

202
Organic Chemistry II:
Structures, Mechanisms and Reactions
(4 credits; Spring)

Study of the correlation of acid-base theory, reaction mechanisms, molecular structure, chemical energetics and spectroscopy to the chemical and physical properties of organic functional groups. Laboratory work stresses the synthesis, separation, identification and analysis of selected organic compounds using both micro- and macro-scale techniques. Three class hours and three laboratory hours weekly.
Prerequisite: CH 102; or permission of the Department Chair.

203
Equilibrium and Analysis
(4 credits; Spring)

Examination of the principles and theory of chemical equilibrium in the context of quantitative chemical analysis. Includes selected traditional analytical laboratory techniques frequently applied to analyses of systems of biological and environmental interest. Also introduces instrumental techniques of analysis.
Prerequisite: CH 102; or permission of the Chair.

301
Physical Chemistry I
(4 credits; Fall)

Study of the limitations of the degree of completion of chemical reactions and physical processes by natural law. Examines the gaseous state, liquid state, solid-state, thermodynamics, homogeneous chemical equilibria and phase equilibria from both experimental and conceptual viewpoints. Three class hours and three laboratory hours weekly.
Prerequisites: CH 203, PH 202 or 212, MA 202.

302
Physical Chemistry II
(4 credits; Spring)

Continuation of CH 301. Considers the limitations on the rate of change by natural law. Explores the concepts of solutions, heterogeneous equilibria, electrochemistry, chemistry kinetics, quantum mechanics and surface phenomena. Three class hours and three laboratory hours weekly.
Prerequisite: CH 301.

303
Biochemistry
(4 credits; Fall)

Study of the chemistry and metabolism of carbohydrates, lipids, proteins, nucleic acids, vitamins and hormones, along with selected topics in comparative biochemistry, cytochemistry and chemical genetics. Laboratory work emphasizes independent study and methods of biochemical research. Three class hours and four laboratory hours weekly.
Prerequisites: CH 202, CH 203 highly recommended.

304
Instrumental Methods of Analysis I
(4 credits; Fall)

Study of the theory and practice of instrumental analysis. Includes spectrophotometric, chromatographic and mass spectral methods as background for the separation, identification and analysis of chemical substances of clinical and biological importance. Three class hours and four laboratory hours weekly.
Prerequisite: CH 203. CH 301, 302 highly recommended.

305
Inorganic Chemistry
(4 credits; Spring)

Survey of the representative and transition elements in the context of atomic and molecular structure. Introduces organometallic and solid-state principles as the foundation for understanding coordination theory and the biochemistry of inorganic cations. Laboratory work emphasizes the preparation, properties and characterization of selected inorganic and bioinorganic compounds that employ low and high temperature, vacuum and physicochemical techniques, with both aqueous and non-aqueous systems. Three class hours and three laboratory hours weekly. Offered in odd years.
Prerequisites: CH 202, 203. CH 301, 302 highly recommended.

306
Advanced Organic Chemistry
(4 credits; Spring)

Advanced study of selected topics not covered in the introductory course: Huckle Molecular Orbital Theory; correlation of structure and activity by linear free energy relationships; acidity functions and Bronsted Catalysis Law; symmetry and stereochemistry; pericyclic, electrocyclic and sigmatropic reactions; kinetics and kinetic isotope effects; and application of spectroscopic techniques. Laboratory component involves individual multi-step syntheses and molecular modeling projects. Three class hours and four laboratory hours weekly. Offered in odd years.
Prerequisites: CH 202, 203. CH 301, 302 highly recommended.

307
Polymers and Biopolymers
(4 credits; Fall)

A coherent introduction to modern polymer chemistry designed for students interested in chemistry, physics, engineering and biochemistry. Specifically, this course aims to broaden the perspective of students in the different technical areas to the point where they can appreciate the scope and importance of polymers, biopolymers and contemporary polymer technology. Emphasis is placed on the nature and synthesis of polymers; biological polymers and their reactions; thermodynamics and kinetics of polymerization; and physical characterization, fabrication, testing and uses of both natural and synthetic polymeric materials. Four class hours weekly. Offered in even years.
Prerequisites: CH 201, 202.

333
Statistical Thermodynamics
(4 credits; Fall)

The principles of thermodynamics are investigated from a modern statistical point of view based upon ensemble theory. This includes Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics, transport phenomena, thermal interactions, kinetic theory and applications to a variety of molecular systems. Offered in odd years.
Prerequisites: CH 102, PH 212, MA 202, CH 301 and 302; or permission of the Chair if taken concurrently with CH 302.

345
Special Topics in Chemistry

Topics vary according to the needs and interests of students and faculty. Possibilities may include medicinal chemistry, practical spectroscopy and the history of chemistry.

351
Quantum Chemistry and Chemical Physics
(2 credits; Spring)

The foundations of quantum chemistry and its applications to chemical systems are explored. The Schrodinger wave equation, the harmonic oscillator, the hydrogen atom and matrix mechanics are examined. Special emphasis is placed on group theory and application to spectroscopy. Offered in even years.
Prerequisites: CH 102, PH 202 or 212, MA 202, CH 301 and 302; or permission of the Chair if taken concurrently with CH 302. MA 452 (previously #352) recommended.

370
Career Internship in Chemistry
(4 credits; Fall, Spring)

Part-time placement designed to test the business aspects of the chemical profession in a work setting and to bring practical knowledge of a functioning chemical or pharmaceutical business to the classroom.
Prerequisites: BA 340, 360, 380, senior standing in Chemistry and permission of the Department Chair.

389
Chemical Research
(4 credits; Fall, Spring)

Introduction to chemical research, the chemical literature, creative thinking, experimental design, treatment of errors and oral and written communication of scientific results. Provides an opportunity to work in a selected research area under the supervision of one or more staff members on campus (or in off-campus research facilities). Requires a minimum of 10 laboratory hours weekly. Prior to beginning the research project, three copies of project outline must be submitted to the Department Chair for approval.
Prerequisites: At least four courses in Chemistry and/or permission of the Department Chair.

490
Chemistry Seminar
(4 credits at the completion of the second semester; Fall, Spring)

Two-semester Capstone course that involves the oral presentation of a library research project; the completion of a laboratory investigation whose results shall be delivered in both a written paper and poster format; participation in departmental seminars; and career guidance activities.
Prerequisites: CH 201, 202.

Physics Courses (PH)

201
Fundamental Concepts of Physics I
(4 credits; Fall)

Introduction to the principles of mechanics, heat and sound. Presents historical development, methodology and philosophy of our current understanding of the physical universe from an experimental point of view. Includes laboratory experience, demonstrations, lectures and discussions. Three class hours and three laboratory hours weekly.

202
Fundamental Concepts of Physics II
(4 credits; Spring)

Continuation of PH 201. Introduces the principles of light, electricity, magnetism, atomic and nuclear physics. Includes laboratory experience, demonstrations, lectures and discussions. Three class hours and three laboratory hours weekly.
Prerequisite: PH 201.

211
Conceptual Physics I
(4 credits; Fall)

Calculus-based introduction to the principles of mechanics, heat and thermodynamics through laboratory experience, demonstrations, lectures and discussions. Primarily for well-prepared science and engineering majors. Three class hours and three laboratory hours weekly.
Prerequisite: MA 201.

212
Conceptual Physics II
(4 credits; Spring)

Continuation of PH 211. Examines waves, sound, light, electricity, magnetism and elementary electrodynamics. Three class hours and three laboratory hours weekly.
Prerequisites: PH 211, MA 202.

223
Essentials of Physical Geology
(4 credits; Spring)

Basic concepts of physical geology with an emphasis on the dynamic nature of the earth and the land-forming processes and cycles, which are constantly altering our environment. The laboratory demonstrates these processes and illustrates the principles developed in lectures. Primarily intended for non-science majors including those preparing for the teaching profession. Three class hours and three laboratory hours weekly. Evening students may enroll in only the lecture portion of the course for three credits.
Prerequisites: Satisfactory performance on the mathematics placement inventory or satisfactory completion of MA 100 is required.

224
Frontiers in Astronomy
(4 credits; Fall)

Overview of the fundamentals, history and frontiers of astronomy. Introduces the planets, exobiology, structure and dynamics of stars, galaxies, the universe and cosmology. Includes lectures, demonstrations, observations and discussions. Three class hours and three laboratory hours weekly. Evening students may enroll in only the lecture portion of the course for three credits.

324
Atomic Physics
(4 credits; Fall)

Examination of the basic principles of atomic and nuclear physics. Includes laboratory experience, demonstrations, lectures and discussions. Offered in odd years.
Prerequisites: MA 202 and either PH 201, 202 or 211, 212.

325
Mathematical Physics I
Not regularly scheduled.

326
Mathematical Physics II
Not regularly scheduled.

331
Engineering Mechanics
(4 credits; Fall)

Examination of the principles of mechanics with engineering applications. Includes vector treatment of forces, statics, centroids, moments of inertia, friction, kinematics and kinetics of particles and rigid bodies. Offered in even years.
Prerequisite: PH 211.

341
Electronic Circuit Analysis I
Not regularly scheduled.

342
Electronic Circuit Analysis II
Not regularly scheduled.

345
Special Topics in 21st Century Physics
(4 credits; Spring)

An intensive study in the seminar/laboratory style of selected topics of current interest in physics. Topics include but are not limited to areas in relativistic quantum mechanics, quantum electrodynamics, quantum field theories, high energy physics, elementary particle physics, cosmology, astrophysics, solid state physics and mathematical physics. May be taken several times by any student but must be on different topics each time. Offered in even years.
Prerequisites: PH 211, 212, 324, MA 201, 202. Interview with and permission by the instructor and Department Chair. Other prerequisites according to the topic.

389
Physics Research
(4 credits)

Individualized study tailored to suit the needs or interests of qualified juniors and seniors. Each student works under the guidance of a faculty adviser approved by the Department Chair. Suggested topics include quantum mechanics; nuclear, atomic and chemical physics; electrodynamics; advanced optics; mathematical physics; astrophysics; participation in ongoing research projects with faculty.
Prerequisite: Permission of the Chair.