

CHEMISTRY AND PHYSICS

at Arcadia University

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

Faculty

Professor

Dr. Emanuele Curotto (Chair)
Dr. Chester M. Mikulski

Associate Professors

Dr. Peter Campbell

Dr. Linda M. Mascavage

Assistant Professor

Dr. Daniel Nkemzi

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 Medical Science (Physician
Assistant)

Master of Science in Forensic Science

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

Options

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.)

4+2 Assured Admission 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

Doctor of Physical Therapy

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 website 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 Associate Dean of International Affairs.

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 program with master's in Forensic Science

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- Preparation for teaching with secondary education certification
- Internship opportunities
- Opportunities to study abroad at some of the top universities around the world

Proven Formula for Inspired Learning

Sometimes our greatest power lies in the questions we ask rather than the answers we already know. As a Chemistry or Physics student at Arcadia, you'll tap into this scientific curiosity and enjoy unique opportunities to:

- Engage in publishable research.
- Perform customized lab work where you'll play a central role.
- Combine your science studies with other academic paths.

As you take your first college step toward a professional career, it's important to be challenged but also to know that your professors are by your side. You'll find this at Arcadia and discover the true scientist in yourself.

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, Cornell University, and the University of Notre Dame, 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.

Arcadia's 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.

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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 111, 112 Conceptual Chemistry or CH 101, CH 102
 - CH 201, 202 Organic Chemistry I, II: Structure, Mechanisms and Reactions
 - CH 203 Equilibrium and Analysis

2. Two courses in Physics from the following:
 - PH 201, 202 Fundamental Concepts of Physics I, II
 - or PH 211, 212 Conceptual Physics I, II
3. One course in Mathematics
 - MA 201 Calculus I
4. 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
 - PH 324 Atomic Physics
 - PH 325 Advanced Engineering Mathematics I
 - PH 326 Advanced Engineering Mathematics II
 - 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
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

Forensic Science (32 additional credits)

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

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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. Eleven courses in Chemistry
 - CH 111, 112 Conceptual Chemistry or CH 101, 102
 - 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
 - CH 389 Chemical Research
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 Capstone
 - CH 490 Chemistry Capstone
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 111, 112 Conceptual Chemistry or CH101, 102
 - CH 201, 202 Organic Chemistry I, II
 - CH 203 Equilibrium and Analysis
2. One 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 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

General Chemistry I

(4 credits; Fall, Spring)

This course is an 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. It 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

General Chemistry II

(4 credits; Fall, Spring)

This continuation of CH 101 introduces the principles of chemical energetics, chemical equilibrium, reaction mechanisms, chemical kinetics, electrochemistry, and radiation chemistry. It 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.

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111

Conceptual Chemistry I

(4 credits; Fall, Spring)

This course is an introduction to the principles of atomic structures, chemical bonding, states of matter, stereochemistry and their relations to the properties of selected inorganic and organic substances, with a greater emphasis on modern quantum theory concepts. It develops the methodology and philosophy of current understanding of transformations of matter and energy from an experimental point of view. The course is especially designed for Chemistry majors with an emphasis on quantitative analysis using college-level mathematics, including elementary calculus concepts. Three class hours and three laboratory hours weekly. Calculus is not a prerequisite.

112

Conceptual Chemistry II

(4 credits; Fall, Spring)

This continuation of CH 111 introduces the principles of chemical thermodynamics, chemical equilibrium, reaction mechanisms, chemical kinetics, electrochemistry, and radiation chemistry. It applies chemical principles to the reaction of selected inorganic and organic substances from a quantitative experimental point of view. The course is especially designed for Chemistry majors with an emphasis on quantitative analysis using college-level mathematics, including elementary calculus concepts. Three class hours and three laboratory hours weekly. Calculus is not a prerequisite.
Prerequisites: CH 111.

201

Organic Chemistry I: Structure, Mechanisms and Reactions

(4 credits; Fall, Spring)

This is a study of the correlation of acid-base theory, reaction mechanisms, molecular structure, chemical energetics, stereochemistry, and spectroscopy of organic functional groups, specifically alkanes, alkenes, alkynes, alkyl halides, alcohols and ethers. Laboratory work stresses the synthesis, separation, identification and analysis of selected organic compounds using both micro- and macro-scale techniques. ¹H NMR spectra are routinely acquired. 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; Fall, Spring)

This is a continuation of CH 201, specifically organometallic compounds, conjugated systems,

aromatics, aldehydes, ketones, carboxylic acid derivatives, amines and carbohydrates, and spectroscopy. Laboratory work stresses the synthesis, separation, identification and analysis of selected organic compounds using both micro- and macro-scale techniques. ¹H NMR spectra are routinely acquired. Three class hours and three laboratory hours weekly.

Prerequisite: CH 201; or permission of the Department Chair.

203

Equilibrium and Analysis

(4 credits; Spring)

This 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. It also introduces instrumental techniques of analysis.

Prerequisite: CH 102; or permission of the Chair.

301

Physical Chemistry I

(4 credits; Fall)

This course is a study of the limitations of the degree of completion of chemical reactions and physical processes by natural law. It 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)

This continuation of CH 301 considers the limitations on the rate of change by natural law. It 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)

This course is a 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

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304

Instrumental Methods of Analysis I

(4 credits; Fall)

This 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)

This is a survey of the representative and transition elements in the context of atomic and molecular structure. It 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)

This is advanced study of selected topics not covered in the introductory course: Hückel Molecular Orbital Theory; correlation of structure and activity by linear free energy relationships; acidity functions and Brønsted 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 is 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; co-listed as PH 333)

The principles of thermodynamics are investigated from a modern statistical point of view based upon ensemble theory in this course. 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; co-listed as PH 351)

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)

This part-time placement is 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.

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389

Chemical Research

(4 credits; Fall, Spring)

This is an introduction to chemical research, the chemical literature, creative thinking, experimental design, treatment of errors and oral and written communication of scientific results. It 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). It 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 Capstone

(2+2credits ; Fall and Spring)

Two-semester Capstone course involves career guidance activities; a library research paper; the completion of a faculty-supervised laboratory investigation, with those results delivered in an oral presentation, a written thesis and poster format; successful achievement on a diagnostic exam used to evaluate comprehensive undergraduate Chemistry knowledge; senior standing in Chemistry with a minimum GPA of 2.0 in the major.

Prerequisites: Senior standing.

Physics Courses (PH)

201

Fundamental Concepts of Physics I

(4 credits; Fall)

This 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. It includes laboratory experience, demonstrations, lectures and discussions. Three class hours and three laboratory hours weekly.

202

Fundamental Concepts of Physics II

(4 credits; Spring)

This continuation of PH 201 introduces the principles of light, electricity, magnetism. It 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)

This is a Calculus-based introduction to the principles of mechanics, heat and thermodynamics through laboratory experience, demonstrations, lectures and discussions. It is primarily for well-prepared science and engineering majors. Three class hours and three laboratory hours weekly.

Prerequisite: MA 202.

212

Conceptual Physics II

(4 credits; Spring)

This 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 are presented, 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. This course is 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)

This overview of the fundamentals, history and frontiers of astronomy introduces the planets, exobiology, structure and dynamics of stars, galaxies, the universe and cosmology. It 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)

This examination of the basic principles of atomic and nuclear physics includes laboratory experience, demonstrations, lectures and discussions. Offered in odd years.

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Prerequisites: MA 202 and either PH 201, 202 or 211, 212.

325

Advanced Engineering Mathematics I

(4 credits; Fall *alternate years)

Prerequisites: MA 203, MA 351, PH 212.

326

Advanced Engineering Mathematics II

(4 credits; Spring *alternate years)

Prerequisites: MA 325.

331

Engineering Mechanics

(4 credits; Fall)

This 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 odd years.

Prerequisite: PH 211.

333

Statistical Thermodynamics

(4 credits; Fall; co-listed as CH333)

341

Electronic Circuit Analysis I

Alternate years.

342

Electronic Circuit Analysis II

Alternate years.

345

21st Century Physics

(4 credits; Spring)

This is 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. The course 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.

351

Quantum Chemistry and Chemical Physics

(2 credits; Spring) Co-listed as CH 351

389

Physics Research

(4 credits)

Individualized study is 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.