

# CHEMISTRY AND PHYSICS

## Department Description

The Department of Chemistry and Physics offers majors in chemistry, chemistry with a concentration in biochemistry, and physics. Minors in chemistry and physics are also offered. The courses of study are designed to meet the highest professional standards and are attuned to meet the needs of students with individual variations in preparation, interests, and career goals. Graduates of the chemistry and physics programs are well prepared to undertake careers in industry or teaching, graduate work in chemistry or physics, or advanced study in professional programs such as law or the health professions (including medicine, pharmacy, or dentistry). The majors in chemistry and physics also allow students to participate in the Five-Year Dual-Degree Engineering Program with the University of Notre Dame.

Some courses in chemistry and physics are offered as a service to the other departments that require backgrounds in chemistry or physics for their students. Other courses are specifically designed to fulfill the Sophia Program requirements in the natural sciences for students who are not science majors but who seek to understand scientific concepts and processes that affect their daily lives in a technology-dependent world.

## Study Abroad

Saint Mary's has a long history of providing quality international programs as an essential part of our educational mission—forming women leaders who will make a difference in the world. As this world becomes increasingly interdependent, the College offers an expanding range of semester, year, semester break, and summer study and service programs in a wide variety of countries, and encourages students to take advantage of them. Learn more about the various Study Abroad opportunities (<https://catalog.saintmarys.edu/undergraduate/academic-life/international-programs/>).

## Programs

- Biochemistry Concentration, Bachelor of Science - BIOC (<https://catalog.saintmarys.edu/undergraduate/programs/chemistry-physics/biochemistry-concentration-bachelor-science/>)
- Chemistry, Bachelor of Science - CHEM (<https://catalog.saintmarys.edu/undergraduate/programs/chemistry-physics/chemistry-bachelor-science/>)
- Chemistry, Minor - CHEM (<https://catalog.saintmarys.edu/undergraduate/programs/chemistry-physics/chemistry-minor/>)
- Physics, Bachelor of Arts - PHYS (<https://catalog.saintmarys.edu/undergraduate/programs/chemistry-physics/physics-bachelor-arts/>)
- Physics, Bachelor of Science - PHYS (<https://catalog.saintmarys.edu/undergraduate/programs/chemistry-physics/physics-bachelor-science/>)
- Physics, Minor - PHYS (<https://catalog.saintmarys.edu/undergraduate/programs/chemistry-physics/physics-minor/>)

## Department Chair

Christopher Dunlap  
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## Faculty

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## Physics Program Director

Ian Bentley  
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574-284-4662

## Faculty

I. Bentley, J. Mason

## Chemistry Courses

### CHEM 101 **Mystery, Mayhem, and Murder: Chemistry for the Citizen (3,4)**

A survey course for students majoring in disciplines other than the natural sciences. Application of fundamental chemical principles to selected inorganic, organic, and biological systems, with particular emphasis on topics of interest to citizens in a technological society. Offered in fall or spring semester for 4 credits (Three hours lecture and one two-hour laboratory) or summer session for 3 credits (Three hours lecture, no laboratory).

### CHEM 101L **Mystery, Mayhem, and Murder: Chemistry for the Citizen Laboratory (0)**

One two-hour laboratory per week. Corequisite: CHEM 101.

### CHEM 102 **Chemistry in Everyday Life (3)**

This course seeks to make the Saint Mary's College student aware of the chemicals that affect her directly as she lives her daily life. (Three lecture hours per week).

### CHEM 118 **Integrated General, Organic and Bio-Chemistry (5)**

An introduction to the fundamental concepts of general chemistry, organic chemistry and biochemistry with applications to the field of nursing. Laboratory experiments will closely correspond with the lecture material. (Four hours lecture and one two-hour laboratory) Prerequisite: One year high school chemistry and MATH 102 or concurrent enrollment in any higher level math course; or permission of the instructor.

### CHEM 118L **Integrated General, Organic and Bio-Chemistry Laboratory (0)**

One two-hour laboratory per week. Corequisite: CHEM 118.

### CHEM 121 **Principles of Chemistry I (4)**

This course is an introduction to chemical stoichiometry, atomic and molecular structure, and bonding. Laboratory will explore principles presented in lecture. (Three-hour lecture and one three-hour laboratory). Prerequisite: high school chemistry or permission of the instructor; students must be calculus-ready. For biology, chemistry, physics, and engineering intended majors. This course also satisfies the LO2 Critical Thinking Seminar.

### CHEM 121L **Principles of Chemistry I Laboratory (0)**

One three-hour laboratory per week. Corequisite: CHEM 121.

### CHEM 122 **Principles of Chemistry II (4)**

An introduction to chemical energetics, chemical equilibria, acid-base chemistry, and kinetics. Laboratory will explore principles presented in lecture. (Three hours lecture and one three-hour laboratory) Prerequisite: CHEM 121 or permission of instructor.

### CHEM 122L **Principles of Chemistry II Laboratory (0)**

One three-hour laboratory per week. Corequisite: CHEM 122.

**CHEM 221 Organic Chemistry I (3)**

A treatment of the properties, structures, preparations and reactions of the important classes of compounds of carbon with emphasis on foundational concepts illustrated primarily through the chemistry of aliphatic hydrocarbons. (Three hours lecture) Prerequisite: CHEM 122.

**CHEM 221L Organic Chemistry I Laboratory (1)**

A course in a variety of organic laboratory skills, including separation and purification techniques. One three hour lab per week. Corequisite: CHEM 221.

**CHEM 222 Organic Chemistry II (3)**

A treatment of the properties, structures, preparations and reactions of the important classes of compounds of carbon. Aromatic chemistry is introduced and representative functional groups are covered. Three hours lecture. Prerequisite: CHEM 221 and CHEM 221L.

**CHEM 222L Organic Chemistry II Laboratory (1)**

A course in organic chemistry laboratory skills, including emphasizing qualitative analysis using chemical and instrumental methods. One three hour lab per week. Corequisite: CHEM 222.

**CHEM 311 Thermodynamics (3)**

A detailed study of thermodynamics, statistical mechanics, and kinetics. This calculus-based course integrates concepts of chemistry and physics. Three hours lecture. Prerequisites: CHEM 122, PHYS 122; Recommended: CHEM 221.

**CHEM 312 Quantum Chemistry (3)**

A detailed study of quantum chemistry, including techniques and applications of quantum theory, atomic and molecular structure, bonding, symmetry, group theory, and spectroscopy. (Three hours lecture) Prerequisites: CHEM 122, MATH 231, PHYS 122. Recommended: CHEM 221.

**CHEM 324 Biochemistry (3)**

A study of the chemical reactions of cells, the major metabolic pathways, and the interrelationship of these pathways. (Three hours lecture per week) Prerequisites: CHEM 222.

**CHEM 332 Analytical Chemistry (3)**

Quantitative methods of analysis are explored. The theory and application of wet chemical techniques and modern instrumental techniques (spectroscopy, chromatography and electrochemistry) are introduced with a focus on method selection and underlying chemical concepts. Analytical chemistry uses of statistics and equilibrium are also discussed. (Three hours lecture per week). Prerequisites: CHEM 221, PHYS 122.

**CHEM 342 Bio-Inorganic Chemistry (3)**

This course explores the properties and bonding of inorganic elements that are important to biological systems and biologically-inspired inorganic materials. Students will apply chemical principles in understanding the endogenous roles of metals in charge balance, catalysis, and structure. Students will learn how inorganic chemists design metal-based drugs and imaging agents to solve problems in human health, and how reverse-engineering of bio-inorganic systems have led to revolutionary inorganic solid state- and nano-materials. (Three hours lecture per week) Prerequisite: CHEM 222.

**CHEM 361 Advanced Laboratory I (4)**

Laboratory methods in chemistry are explored. Students will learn how to design and conduct experiments and gain hands-on experience with various laboratory techniques within the overall context of answering chemical questions. They will learn the basic chemical and physical principles upon which these varied techniques are based, plus they will demonstrate and apply their overall chemical knowledge from their first through third years of courses and laboratories. Students will also learn scientific presentation and writing skills. (Two 4-hour laboratories per week). Prerequisite: CHEM 222.

**CHEM 362 Advanced Laboratory II (4)**

A continuation of CHEM 361, students will explore more advanced laboratory techniques, building upon their experience of the previous course. Students will also build their scientific writing and presentation skills. (Two 4-hour laboratories per week). Prerequisite: CHEM 361.

**CHEM 424 Advanced Biochemistry (3)**

Advanced topics in the chemistry and chemical mechanisms involved in intermediary metabolism and developmental processes with consideration of the biochemistry current in the literature. (Three hours lecture per week). Prerequisites: CHEM 324, CHEM 311, or permission of instructor.

**CHEM 431 Advanced Inorganic Chemistry (3)**

A study of modern inorganic chemistry with emphasis on the principles, properties, and chemical trends of coordination compounds, This course will also explore the essentials of structure, bonding, symmetry, spectroscopy, and reactivity. (Three hours lecture per week). Prerequisite: CHEM 342. Concurrent or Prerequisite: CHEM 312.

**CHEM 485 Research (1-3)**

Participation in original experimental or theoretical investigation in collaboration with a member of the faculty. Prerequisite: Permission of the department chair. May be repeated.

**CHEM 490 Topics in Chemistry (2,3)**

Topics in Chemistry not covered in the regular department offerings and selected according to the interests of the students and instructor. Offered according to student demand. (Two or three lectures per week) Prerequisite: Permission of the instructor. May be repeated for credit with a different topic.

**CHEM 497 Independent Study (1,2)**

Topics in Chemistry not covered in the regular department offerings and selected according to the interests of the students and instructor. Offered according to student demand. (Two or three lectures per week) Prerequisite: Permission of the instructor. May be repeated for credit with a different topic.

**CHEM 499 Chemistry Internship (1-4)**

Experience in a chemistry internship. Graded S/U. May be repeated. Prerequisites: Permission of department required.

## Physics Courses

**PHYS 102 Introductory Topics in Physics: Energy (3)**

An introduction to concepts, and applications of physics through the lens of energy. This course deals with the science of national and global energy concerns. The laboratory introduces fundamental principles of scientific investigation via experimental exploration. This course is intended for students not majoring in science. (Three hours lecture and a two-hour laboratory). Prerequisite: None.

**PHYS 105 Astronomy (3)**

A study of stars and galaxies within the Universe from our Earth based perspective. Scientific techniques and the history of scientific observation are included in addition to the properties of light and gravity. This course is intended for students not majoring in science or mathematics. (Three hours lecture). Prerequisite: None.

**PHYS 111 College Physics I: Mechanics and Waves (4)**

An introduction to mechanics, and waves. This is the first semester of a two-part algebra-based physics sequence designed primarily for students in life-sciences (biology, and neuroscience), communications sciences and disorders, and environmental studies. (Three hours of lecture and two hours laboratory.) Prerequisite: MATH 103.

**PHYS 111L College Physics I Laboratory (0)**

One two-hour laboratory per week. Corequisite: PHYS 111.

**PHYS 112 College Physics II: Temperature, Electricity, and Light (4)**

An introduction to thermodynamics, electricity, magnetism, and optics. This is the second semester of a two-part algebra-based physics sequence designed primarily for students in life-sciences (biology, and neuroscience), communications sciences and disorders, and environmental studies. (Three hours of lecture per week and a two-hour laboratory.) Prerequisite: PHYS 111.

**PHYS 112L College Physics II Lab (0)**

One two-hour laboratory per week. Corequisite: PHYS 112.

**PHYS 121 General Physics I: Mechanics and Waves (4)**

An introduction to mechanics, and waves. This is the first semester of a two-part calculus-based physics sequence designed for students in science, math, and engineering. (Three hours of lecture and two hours laboratory.) Prerequisite: either MATH 131, MATH 132, or MATH 133. (High school physics strongly recommended)

**PHYS 121L General Physics I Lab (0)**

One two-hour laboratory per week. Corequisite: PHYS 121.

**PHYS 122 General Physics II: Temperature, Electricity, and Light (4)**

An introduction to thermodynamics, electricity, magnetism, and optics. This is the second semester of a two-part calculus-based physics sequence designed for students in science, math, and engineering. (Three hours of lecture per week and a two-hour laboratory.) Prerequisite: PHYS 121; and either MATH 132 or MATH 133.

**PHYS 122L General Physics II Laboratory (0)**

One two-hour laboratory per week. Corequisite: PHYS 122.

**PHYS 215 Materials Science (3)**

A study of material properties at the intersection of physics, chemistry and engineering. Materials such as polymers, ceramics, and metals will be explored. This physics elective is intended for students interested in science and engineering. (Three hours lecture). Prerequisites: PHYS 122 and CHEM 122.

**PHYS 235 Nuclear Astrophysics (3)**

A study of the intersection of nuclear physics and astrophysics. This course includes a survey of astrophysics and the scientific, mathematical, and ethical issues concerning topics from nuclear physics. Concepts in nuclear medicine, nuclear power and nuclear weapons are discussed in detail. This physics elective is intended for students interested in science and engineering. (Three hours lecture). Prerequisites: PHYS 122 and CHEM 122.

**PHYS 253 General Physics III: Modern Physics (3)**

An introduction to the conceptual and mathematical foundations of elementary quantum physics, and the historical framework and methodology of twentieth century physics, including contributions of women scientists. Special relativity and atomic physics are also discussed. (Three hours lecture). Prerequisite: PHYS 112 or PHYS 122 and MATH 231.

**PHYS 272L Computational Physics Laboratory (1)**

Computational methods in physics are explored. This course covers computational topics in physics, primarily in astrophysics, biophysics, and quantum mechanics. Offered in the spring on a three-year rotation. (Three hours laboratory). Prerequisite: PHYS 122.

**PHYS 282L Modern Experimental Laboratory (1)**

Experimental methods in modern physics are explored. This course covers experimental topics primarily from modern physics and materials science. Offered in the spring on a three-year rotation. (Three hours laboratory). Prerequisite: PHYS 122.

**PHYS 292L Wave Mechanics Laboratory (1)**

Laboratory methods in physics are explored. This course covers experimental and computational topics related to wave mechanics in both mechanical phenomenon and circuit analysis. Offered in the spring on a three-year rotation. (Three hours laboratory). Prerequisite: PHYS 122.

**PHYS 321 Lagrangian Mechanics (1)**

This course will cover topics in classical mechanics including wave motion. The primary focus is the Lagrange formalism which is used to setup simple differential equations and solve for equations of motion. This course covers the same material as PHYS 323 but only lasts for the first third of the semester. This course is intended for students who are also required to take additional courses in mechanics. Typically offered fall of even-numbered years. (Three hours lecture). Prerequisite: PHYS 253.

**PHYS 323 Classical Mechanics (3)**

A detailed study of classical mechanics including Newton's laws, and conservation laws. Equations of motion are derived based on the Lagrange and Hamiltonian formalisms. Typically offered fall of even-numbered years. (Three hours lecture). Prerequisite: PHYS 253.

**PHYS 341 Statistical Mechanics (1)**

This course will cover topics in thermodynamics from a statistical mechanics viewpoint. Systems containing large numbers of particles will be analyzed using Boltzmann statistics. This course covers the same material as PHYS 343 but only lasts for the first third of the semester. This course is intended for students who are also required to take additional courses in Thermodynamics. Typically offered fall of odd-numbered years. (Three hours lecture). Prerequisite: PHYS 253.

**PHYS 343 Thermodynamics (3)**

A detailed study of statistical mechanics and thermodynamics. Systems containing large numbers of particles will be analyzed using Boltzmann statistics. The laws of thermodynamics will be introduced. Cyclic processes and other thermodynamic concepts will be developed. Typically offered fall of even-numbered years. (Three hours lecture). Prerequisite: PHYS 253.

**PHYS 424 Quantum Mechanics (3)**

A detailed physical and mathematical study of quantum mechanics including wave mechanics. Physical applications of quantum mechanics are also discussed. Typically offered fall of even-numbered years. (Three hours lecture). Prerequisites: PHYS 253 and MATH 326.

**PHYS 444 Electricity and Magnetism (3)**

A detailed physical and mathematical study of electricity and magnetism focusing on applications from vector calculus. Interactions between electric and magnetic fields are explored including the use of Maxwell's equations. Typically offered fall of odd-numbered years. (Three hours lecture). Prerequisites: PHYS 253 and MATH 326.

**PHYS 485 Research (1-3)**

Participation in original experimental or theoretical investigation in collaboration with a member of the faculty. Prerequisite: Permission of the department chair. May be repeated.

**PHYS 490 Special Topics in Physics (1-5)**

Topics in Physics not covered in the regular department offerings and selected according to the interests of the students and the instructor. Offered according to student demand. (Two or three lectures per week) Prerequisite: Permission of the instructor. May be repeated for credit with a different topic.

**PHYS 497 Independent Study (1-3)**

Enables properly qualified students to carry out independent study under the guidance of an instructor. Content dependent on student need and interest. Elective with permission of the department chair. Generally graded S/U; may be letter graded. May be repeated with a different topic.