

PHYSICS

Department Website: Physics (<https://www.gonzaga.edu/college-of-arts-sciences/departments/physics/>)

The Bachelor of Science in Physics is designed to prepare students for graduate study and careers in physics or closely related fields in STEM. Students are expected to declare their major in Physics in their first year of study. All students must declare a concentration. The five concentrations share a common broad base of physics classes, with specialization occurring during the final years of study.

The Bachelor of Arts in Physics is designed for students who do not intend to pursue further study in physics or closely related fields, although they may plan to pursue graduate studies in education, law, business, social sciences, the arts, or the humanities. It should be declared no later than the beginning of the second year of study and does not require a concentration. It offers a greater degree of flexibility than the Bachelor of Science, which enables students to pursue a second major, a teaching certification, or other interests.

The concentrations, as well as the B.A., allow students to closely align their course of study with their interests and career aspirations, whether that includes graduate or professional school or entering the workforce directly after their time at Gonzaga. Students who declare late, switch between concentrations, or plan to study abroad may be accommodated by arrangement with the department.

Lower and upper division courses are designed for students to gain proficiency in hands-on, experimental physics and theoretical physics. Majors in Physics will also acquire a familiarity with scientific computation and the use of computers to model and solve physical problems. Summer research opportunities within the department, as well as with other programs, such as Research Experience for Undergraduates (REU) programs, are encouraged.

More information is available on the Physics website (<https://www.gonzaga.edu/college-of-arts-sciences/departments/physics/>) and the department's MyGU website (<https://my.gonzaga.edu/physics/>).

Physics (BS) Major Program Requirements

Code	Title	Hours
Shared Physics Base		49
PHYS 121 & 121L	Physics I and Physics I Lab	5
PHYS 122 & 122L	Physics II and Physics II Lab	5
PHYS 180	Physics Skills Seminar	1
PHYS 280	Physics Pathways Seminar	1
MATH 157	Calculus and Analytic Geometry I	4
MATH 258	Calculus and Analytic Geometry II	4
CPSC 121	Computer Science I	3
PHYS 201	Mathematical Methods	3
PHYS 222	Electronics	2
PHYS 224	Modern Physics	3
PHYS 321	Classical Mechanics	3
PHYS 322	Electricity and Magnetism	3

PHYS 323	Statistical Mechanics	3
PHYS 324	Quantum Mechanics	3
PHYS 325	Computational Physics	2
PHYS 441	Advanced Laboratory I	2
PHYS 442	Advanced Laboratory II	2

Physics majors are also encouraged to take:

MATH 259	Calculus and Analytic Geometry III
MATH 260	Ordinary Differential Equation
MATH 339	Linear Algebra

Additional CPSC courses

Concentrations	
Select one of the following five concentrations:	13-18
Fundamental Physics	
Medical Physics	
Applied Physics	
Astrophysics	
Materials Physics	

Total Hours 111-116

Required Concentration (Choose 1): Fundamental Physics Concentration

Code	Title	Hours
CPSC 222	Introduction to Data Science	3
PHYS 424	Advanced Quantum Mechanics	3
PHYS 451	Fields, Oscs, and Relativity	3
Select two of the following:		6
PHYS 452	Optics	
PHYS 453	Solid State Physics	
PHYS 454	Nuclear and Particle Physics	
PHYS 455	Cosmology and Astrophysics	
PHYS 456	Biophysical Systems and Modeling	

Total Hours 15

Medical Physics Concentration

Code	Title	Hours
CHEM 101 & 101L	General Chemistry I and General Chemistry I Lab	4
BIOL 105 & 105L	Information Flow in Biological Systems and Information Flow in Biological Systems Lab	4
HPHY 241 & 241L	Human Anatomy and Physiology and Human Anatomy and Physiology Lab	4
PHYS 454	Nuclear and Particle Physics	3
PHYS 456	Biophysical Systems and Modeling	3

Total Hours 18

Recommended (not required): BIOL 106 Energy Flow in Biological Systems & HPHY 242 Human Anatomy and Physiology II / HPHY 242L Human Anatomy and Physiology Lab II

Astrophysics Concentration

Code	Title	Hours
PHYS 105	Astronomy	2
CPSC 222	Introduction to Data Science	3

PHYS 451	Fields, Oscs, and Relativity	3
PHYS 454	Nuclear and Particle Physics	3
PHYS 455	Cosmology and Astrophysics	3
Total Hours		14

Applied Physics Concentration

Code	Title	Hours
CPSC 222	Introduction to Data Science	3
MATH 321	Statistics for Experimentalist	3
PHYS 452	Optics	3
PHYS 453	Solid State Physics	3
PHYS 456	Biophysical Systems and Modeling	3
Total Hours		15

Materials Physics Concentration

Code	Title	Hours
CHEM 101 & 101L	General Chemistry I and General Chemistry I Lab	4
MENG 221	Materials Engineering	3
PHYS 424	Advanced Quantum Mechanics	3
PHYS 453	Solid State Physics	3
Total Hours		13

Physics (BA) Major Program Requirements

Code	Title	Hours
PHYS 121 & 121L	Physics I and Physics I Lab	5
PHYS 122 & 122L	Physics II and Physics II Lab	5
PHYS 180	Physics Skills Seminar	1
PHYS 280	Physics Pathways Seminar	1
MATH 157	Calculus and Analytic Geometry I	4
MATH 258	Calculus and Analytic Geometry II	4
CPSC 121	Computer Science I	3
PHYS 201	Mathematical Methods	3
PHYS 224	Modern Physics	3
PHYS 321	Classical Mechanics	3
PHYS 322	Electricity and Magnetism	3
PHYS 323	Statistical Mechanics	3
PHYS 324	Quantum Mechanics	3
PHYS 325	Computational Physics	2
PHYS 441	Advanced Laboratory I	2
PHYS 442	Advanced Laboratory II	2
Select two of the following:		5
PHYS 222	Electronics	
PHYS 424	Advanced Quantum Mechanics	
PHYS 451	Fields, Oscs, and Relativity	
PHYS 452	Optics	
PHYS 453	Solid State Physics	
PHYS 454	Nuclear and Particle Physics	
PHYS 455	Cosmology and Astrophysics	

PHYS 456	Biophysical Systems and Modeling	
Total Hours		52

Physics Minor Program Requirements

Code	Title	Hours
Lower Division		
PHYS 121 & 121L	Physics I and Physics I Lab	5
PHYS 122 & 122L	Physics II and Physics II Lab	5
PHYS 224	Modern Physics	3
MATH 157	Calculus and Analytic Geometry I	4
MATH 258	Calculus and Analytic Geometry II	4
Upper Division		
Select six credits of the following:		6
PHYS 222	Electronics	
PHYS 321	Classical Mechanics	
and above		
Total Hours		27

To satisfy the minor, at least one of the chosen electives must be a 300 or 400 level 3-credit course. With prior Department Chair approval, PHYS 390 Directed Study, PHYS 490 Advanced Directed Study, PHYS 497 Internship, and PHYS 499 Senior Project may count toward the minor. Additionally, with prior Department Chair approval, PHYS 201 Mathematical Methods may satisfy two credits toward the minor.

Courses

PHYS 104. Scientific Inquiry. (3 Credits)

This course is an integrated course and lab experience satisfying the Core Scientific Inquiry requirements. The course is designed and intended for non-science majors. The topics will be developed conceptually, with the required mathematics not exceeding high school algebra and trigonometry. The specific content will vary with instructor. The course title in Zagweb will identify the focus of the lecture course material. The integrated, open lab experience focuses on developing an understanding of the scientific method and the processes of science, including measurement, modeling, and analysis. The lab experience includes hands-on activities and experiments highlighting the covered processes and delivered in an open lab time format. The lab will be open and staffed on Tuesdays and Thursdays for students to come in and complete that week's lab on their own schedule. Fall and Spring.

Equivalent: PHYS 105

Course Fee: 80

PHYS 105. Astronomy. (2 Credits)

Introductory astronomy. An overview of the celestial objects found within the universe, such as stars, planets, and galaxies. For physics majors only and PHYS 105 does NOT fulfill the Core Scientific Inquiry requirement. Annually, upon sufficient demand.

Equivalent: PHYS 104

Course Fee: 80

Enrollment is limited to students with a program in Physics.

PHYS 106. Conceptual Physics. (3 Credits)

The basic principles of physics are covered in a descriptive (non-mathematical) manner. Designed for students not majoring in the natural sciences or those needing a very basic background in physics. Offered upon sufficient demand.

PHYS 106L. Conceptual Physics Lab. (1 Credit)

Taken concurrently with PHYS 106. Two hours of laboratory. Offered upon sufficient demand.

Corequisites: PHYS 106

Course Fee: 70

PHYS 107. Conceptual Physics II. (3 Credits)

The basic principles of physics are covered in a descriptive (non-mathematical) manner. Designed for students not majoring in the natural sciences or those needing a very basic background in physics. Offered upon sufficient demand.

PHYS 107L. Conceptual Physics Lab II. (1 Credit)

Taken concurrently with PHYS 107. Two hours of laboratory. Offered upon sufficient demand.

Corequisites: PHYS 107

Course Fee: 70

PHYS 111. General Physics I. (4 Credits)

Algebra-based introductory physics. Mechanics, including Newton's laws, conservation laws, fluids, oscillations, and waves. Five hours of lecture with experimental demonstrations and problems. Not accepted as a pre-requisite for any advanced work. Fall.

Course Fee: 80

PHYS 111L. General Physics I Lab. (1 Credit)

Taken concurrently with or after the lecture course PHYS 111. Three hours of laboratory. Fall.

Prerequisites: PHYS 111 (may be taken concurrently) with a minimum grade of D

Course Fee: 70

PHYS 112. General Physics II. (4 Credits)

Algebra-based introductory physics. Thermodynamics, electricity and magnetism, and optics. Five hours of lecture with experimental demonstrations and problems. Not accepted as pre-requisite for any advanced work. Spring.

Prerequisites: PHYS 111 with a minimum grade of D or PHYS 121 with a minimum grade of D or PHYS 101 with a minimum grade of D

Course Fee: 80

PHYS 112L. General Physics II Lab. (1 Credit)

Taken concurrently with or after the lecture course PHYS 112. Three hours of laboratory. Spring.

Prerequisites: (PHYS 111L with a minimum grade of D or PHYS 121L with a minimum grade of D) and PHYS 112 (may be taken concurrently) with a minimum grade of D

Course Fee: 70

PHYS 121. Physics I. (4 Credits)

Calculus-based introductory physics. Mechanics, including Newton's laws, conservation laws, fluids, oscillations, and waves. Five hours of lecture with experimental demonstrations and problems. Fall and Spring.

Prerequisites: Math 157 (can be taken concurrently).

Prerequisites: Prerequisites exist. Refer to Zagweb.

Course Fee: 80

PHYS 121L. Physics I Lab. (1 Credit)

Taken concurrently with or after the lecture course PHYS 121. Three hours of laboratory. Fall and Spring.

Prerequisites: PHYS 121 (may be taken concurrently) with a minimum grade of D

Course Fee: 70

PHYS 122. Physics II. (4 Credits)

Calculus-based introductory physics. Thermodynamics, electricity and magnetism, and optics. Five hours of lecture with experimental demonstrations and problems. MATH 258 Calculus & Analytic Geometry II, may be taken prior to or concurrently, and PHYS 121. Fall and Spring.

Prerequisites: Prerequisites exist. Refer to Zagweb.

Course Fee: 80

PHYS 122L. Physics II Lab. (1 Credit)

Taken concurrently with or after the lecture course PHYS 122. Three hours of laboratory. Fall and Spring.

Prerequisites: (PHYS 103L with a minimum grade of D or PHYS 121L with a minimum grade of D) and (PHYS 122 (may be taken concurrently) with a minimum grade of D or PHYS 204 (may be taken concurrently) with a minimum grade of D)

Course Fee: 70

PHYS 180. Physics Skills Seminar. (1 Credit)

Development of tools useful for success in the study of physics, as well as an understanding of the discipline and the resources available to students at Gonzaga. Fall, odd years.

PHYS 185. Introductory Special Topics. (1-4 Credits)

May be repeated for credit.

Topics to be determined by instructor.

PHYS 190. Introductory Directed Study. (1-4 Credits)

May be repeated for credit.

Directed study in approved topics. Requires completed form and departmental approval. Cannot be registered for via ZagWeb.

PHYS 193. FYS:. (3 Credits)

The First-Year Seminar (FYS) introduces new Gonzaga students to the University, the Core Curriculum, and Gonzaga's Jesuit mission and heritage. While the seminars will be taught by faculty with expertise in particular disciplines, topics will be addressed in a way that illustrates approaches and methods of different academic disciplines. The seminar format of the course highlights the participatory character of university life, emphasizing that learning is an active, collegial process.

PHYS 201. Mathematical Methods. (3 Credits)

Survey of mathematical techniques used in upper-division physics courses. Fall.

Prerequisites: PHYS 122 (may be taken concurrently) with a minimum grade of D or PHYS 204 (may be taken concurrently) with a minimum grade of D

PHYS 222. Electronics. (2 Credits)

This course is primarily a laboratory in which students learn basic concepts of linear electronics and laboratory techniques through passive components, DC and AC applications, use of test equipment, operational amplifiers, basic transistor circuits, and more. Two hours of lecture and one three-hour laboratory exercise per week. Fall, even years.

Prerequisites: PHYS 122L with a minimum grade of D or PHYS 204L with a minimum grade of D

Course Fee: 70

PHYS 224. Modern Physics. (3 Credits)

Special relativity, development, and an introduction to quantum mechanics and other selected topics. Spring.

Prerequisites: PHYS 122 with a minimum grade of D or PHYS 204 with a minimum grade of D

PHYS 280. Physics Pathways Seminar. (1 Credit)

Development of tools useful for success in the practice of physics, as well as an understanding of the discipline and the opportunities available to students during and after their time at Gonzaga. Fall, even years.

PHYS 285. Intermediate Special Topics. (1-4 Credits)

May be repeated for credit.

Topics to be determined by instructor.

PHYS 290. Intermediate Directed Study. (1-4 Credits)

May be repeated for credit.

Directed study in approved topics. Requires completed form and departmental approval. Cannot be registered for via ZagWeb.

PHYS 321. Classical Mechanics. (3 Credits)

Particle and rigid body statics and dynamics in a rigorous vectorial calculus treatment. A fundamental introduction to theoretical physics. Spring, even years.

Prerequisites: Prerequisites exist. Refer to Zagweb.

PHYS 322. Electricity and Magnetism. (3 Credits)

Electrical and magnetic phenomena leading to a development of Maxwell's equations and electromagnetic field theory. Fall, even years.

Prerequisites: Prerequisites exist. Refer to Zagweb.

PHYS 323. Statistical Mechanics. (3 Credits)

Study of thermal properties from microscopic and statistical viewpoints. Topics include: probability distributions, entropy, density of states, black body radiation. Spring, odd years.

Prerequisites: PHYS 122 with a minimum grade of D or PHYS 204 with a minimum grade of D

PHYS 324. Quantum Mechanics. (3 Credits)

Development of techniques to represent and solve the Schrödinger equation for various potential energy functions and measurements in quantum mechanical systems. Fall, odd years.

Prerequisites: Prerequisites exist. Refer to Zagweb.

PHYS 325. Computational Physics. (2 Credits)

An introduction to computational physics. Students will be introduced to many of the basic ideas, algorithms, and tools used by physicists to solve problems. Techniques learned here will be used in most upper-level courses. Spring, odd years. Prerequisite(s): MATH 258 and PHYS 121

Prerequisites: Prerequisites exist. Refer to Zagweb.

PHYS 385. Special Topics. (1-4 Credits)

May be repeated for credit.

Topics to be determined by instructor.

PHYS 390. Directed Study. (1-4 Credits)

May be repeated for credit.

Directed study in approved topics. Requires completed form and departmental approval. Cannot be registered for via ZagWeb.

PHYS 395. Research Assistantship. (0 Credits)

Undergraduate research assistantships are opportunities for student to earn a stipend while performing independent research in the laboratory of a Physics faculty member.

PHYS 424. Advanced Quantum Mechanics. (3 Credits)

Extension of techniques and concepts of Quantum Mechanics to systems with greater complexity, such as the inclusion of relativistic effects and the behavior of identical particles. Spring, even years.

Prerequisites: PHYS 324 with a minimum grade of D

PHYS 432. CIS. (3 Credits)

The Core Integration Seminar (CIS) engages the Year Four Question: "Imagining the possible: What is our role in the world?" by offering students a culminating seminar experience in which students integrate the principles of Jesuit education, prior components of the Core, and their disciplinary expertise. Each section of the course will focus on a problem or issue raised by the contemporary world that encourages integration, collaboration, and problem solving. The topic for each section of the course will be proposed and developed by each faculty member in a way that clearly connects to the Jesuit Mission, to multiple disciplinary perspectives, and to our students' future role in the world.

Prerequisites: Prerequisites exist. Refer to Zagweb.

PHYS 441. Advanced Laboratory I. (2 Credits)

Development of experimental and analytical techniques. Introduction to scientific writing and communication. Fall, odd years.

Prerequisites: PHYS 122L with a minimum grade of D

Course Fee: 70

PHYS 442. Advanced Laboratory II. (2 Credits)

Further development of experimental and analytical techniques. Refinement of scientific writing and communication. Spring, even years.

Prerequisites: PHYS 441 with a minimum grade of D

Equivalent: PHYS 310

Course Fee: 70

PHYS 451. Fields, Oscs, and Relativity. (3 Credits)

Study of advanced classical and relativistic systems, including orbital mechanics, coupled oscillations, electromagnetic waves, and relativistic transformations. Spring, odd years.

Prerequisites: PHYS 224 with a minimum grade of D and PHYS 321 with a minimum grade of D and PHYS 322 with a minimum grade of D

PHYS 452. Optics. (3 Credits)

Treatment of optical phenomena using the three major models for light: rays, waves, and photons. Spring, even years.

Prerequisites: Prerequisites exist. Refer to Zagweb.

PHYS 453. Solid State Physics. (3 Credits)

Study of solid materials using both macroscopic and microscopic quantum models from physics. Topics may include early models of solids, mechanical and thermal properties of materials, elasticity, chemical bonding, metals, crystal structure, phonons and vibrational modes, electric conductivity, band gap theory and semiconductors, transistors, magnetic properties of materials, and other selected solid state topics. Fall, odd years.

Prerequisites: Prerequisites exist. Refer to Zagweb.

PHYS 454. Nuclear and Particle Physics. (3 Credits)

Study of experimental and theoretical aspects of nuclear interactions as they apply to nuclear structures and elementary particle characteristics. Fall, odd years.

Prerequisites: PHYS 224 with a minimum grade of D or PHYS 205 with a minimum grade of D

PHYS 455. Cosmology and Astrophysics. (3 Credits)

Study of the global evolution of the universe, including the expansion rate of the universe, big bang nucleosynthesis, the cosmic microwave background radiation, inflation, relativity, and other selected astrophysics topics. Spring, odd years.

Prerequisites: Prerequisites exist. Refer to Zagweb.

PHYS 456. Biophysical Systems and Modeling. (3 Credits)

Study of biological systems using first principles, tools, and models from physics. Topics may include diffusion, membrane potentials, models of neural dynamics, information processing in biological systems, and other selected biophysics topics. Fall, even years.

Prerequisites: Prerequisites exist. Refer to Zagweb.

PHYS 485. Advanced Special Topics. (1-4 Credits)

May be repeated for credit.

Topics to be determined by instructor.

PHYS 490. Advanced Directed Study. (1-4 Credits)

May be repeated for credit.

Directed study in approved topics. Requires completed form and departmental approval. Cannot be registered for via ZAGWEB.

PHYS 497. Internship. (0-6 Credits)

May be repeated for credit.

Credit recognition of an internship or research experience, arranged by the student, directly related to the student's Physics Major and/or career plans, where said experience helps the student increase and develop practical physics knowledge and skills. Prior to registration, the student must secure participation in an internship or research experience, identify a faculty supervisor, complete and submit the Physics Department Internship Application form, and receive permission from the Physics Department.

PHYS 499. Senior Project. (0-3 Credits)

May be undertaken by B.S. Physics Majors in their senior year.

Permission from Physics Department required.