

PHYSICS

College of Science, Health & Engineering • Department of Chemistry, Biochemistry and Physics

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BA	BAE	BS	Minors	General Science Endorsement

Faculty:

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UNDERGRADUATE PROGRAMS

Physics is the study of the physical environment and the laws governing the behavior of particles, fields and space/time. More specifically, physicists study mechanics, heat, light, electric and magnetic fields, gravitation, relativity, atomic and nuclear physics, physics and many other topics. In general, physics strives for a mathematical description of the laws of nature at the most fundamental level and is therefore the most mathematical of the basic sciences.

Employment opportunities have been plentiful for physicists in recent years, especially for those with strong backgrounds in electrical instrumentation and computer electronics. Careers in research and development are available in many companies and federal agencies. The armed forces recruit technically trained people, especially physicists, to become officers and offer further educational opportunities to those selected. Secondary teaching positions in math and science are readily available. Careers exist in technical sales. Many students go on to graduate school for advanced degrees before starting a career. Advanced degrees lead to community college and university faculty positions, as well as increased opportunities for leadership roles in research and management.

In addition to its degree programs, the department provides several components to the university community in general and to a wide variety of majors in other disciplines. Introductory Physics and General Physics are supporting courses for such degree programs as chemistry and geology and are required courses for schools of physical therapy and medicine. General Physics is required in all schools of engineering.

General Admissions and Preparation Information for Physics: Beginning physics students are advised to start the PHYS 151, 152, 153, 221 sequence as soon as possible. This can be done fall quarter if the student is also prepared to enroll in MATH 161. Otherwise the student should take MATH 105, 106 and MATH 161 their first year and be prepared to enroll in PHYS 151 the following fall quarter. Bachelor of Science majors should complete the required chemistry sequence and as much of the General Education Core Requirements as possible during the first two years.

Required courses in the following programs of study may have prerequisites. Reference the course description section for clarification.

BACHELOR OF ARTS (BA) IN PHYSICS

STUDENT LEARNING OUTCOMES – STUDENTS WILL:

- demonstrate knowledge of the basic concepts of physics (such as mechanics, thermodynamics and electricity and magnetism);
- make and interpret laboratory measurements in physics;
- write effectively using the language of physics.

PHYSICS MAJOR (45 CREDITS)

The Bachelor of Arts degree allows the student to acquire a physics degree with strong emphasis in one or more related fields of study. This degree is ideal preparation for graduate work in such areas as geophysics, biophysics and physical chemistry. Physics graduates also commonly enter graduate schools in engineering fields.

Note: two years of a single high school foreign language or one year of a single college level foreign language is required.

Required Courses (20 credits)

- PHYS 151 General Physics I (4)
- PHYS 152 General Physics II (4)
- PHYS 153 General Physics III (4)
- PHYS 161 Mechanics Lab (1)
- PHYS 162 Heat and Optics Lab (1)
- PHYS 163 Instrumentation Lab I (1)
- PHYS 164 Instrumentation Lab II (1)
- PHYS 221 General Physics IV (4)

Electives (25 credits)

Select in consultation with advisor; courses are subject to approval by the Physics Department.

<i>Required program credits</i>	20 credits
<i>Elective credits</i>	25 credits
Total credits for above major	45 credits

Note: the above major requires the completion of a minor.

BACHELOR OF ARTS IN EDUCATION (BAE)

STUDENT LEARNING OUTCOMES – STUDENTS WILL:

- demonstrate knowledge of the basic concepts of physics (such as mechanics, thermodynamics and electricity and magnetism);
- write effectively using the language of physics;
- make and interpret laboratory measurements in physics.

PHYSICS/SECONDARY MAJOR (69 CREDITS)

This major satisfies the endorsement for grades 5–12.

Required Courses (51 credits)

- CHEM 151 General Chemistry (5)
- CHEM 152 General Chemistry (5)
- PHYS 151 General Physics I (4)
- PHYS 152 General Physics II (4)
- PHYS 153 General Physics III (4)
- PHYS 161 Mechanics Lab (1)
- PHYS 162 Heat and Optics Lab (1)
- PHYS 163 Instrumentation Lab I (1)
- PHYS 164 Instrumentation Lab II (1)
- PHYS 221 General Physics IV (4)
- PHYS 371 Introduction to Quantum Physics (4)
- PHYS 390 Physics Teaching Methods (1)
- MATH 161 Calculus I (5)
- MATH 162 Calculus II (5)
- MATH 163 Calculus III (5)
- SCED 390 Secondary Science Teaching Methods (1)

Electives (18 credits)

Choose from any 300/400-level physics courses, except PHYS 497.

<i>Required program credits</i>	51 credits
<i>Elective credits</i>	18 credits
Total credits for above major	69 credits

Professional educational requirements/secondary education: 46–47 credits
See the Department of Education section of this catalog. Prerequisites may also apply.

Minimum total credits for above major and professional education 115 credits

Note: The above major does not require the completion of a minor. Students are encouraged to complete a secondary endorsement in at least one other subject area.

BACHELOR OF SCIENCE (BS)

STUDENT LEARNING OUTCOMES – STUDENTS WILL:

- write effectively using the language of physics;
- make and interpret laboratory measurements in physics;
- demonstrate knowledge of the basic concepts of physics (such as mechanics, thermodynamics and electricity and magnetism).

PHYSICS MAJOR (103 CREDITS)

The Bachelor of Science program is designed primarily for students preparing for graduate study in physics and for students planning a professional career in physics.

Required Courses (97 credits)

- CHEM 151 General Chemistry (5)
- CHEM 152 General Chemistry (5)
- CHEM 153 General Chemistry (5)
- MATH 161 Calculus I (5)
- MATH 162 Calculus II (5)
- MATH 163 Calculus III (5)
- MATH 241 Calculus IV (5)
- MATH 342 Topics in Applied Analysis II (4)
- MATH 347 Introductory Differential Equations (4)
- PHYS 151 General Physics I (4)
- PHYS 152 General Physics II (4)
- PHYS 153 General Physics III (4)
- PHYS 161 Mechanics Lab (1)
- PHYS 162 Heat and Optics Lab (1)
- PHYS 163 Instrumentation Lab I (1)
- PHYS 164 Instrumentation Lab II (1)
- PHYS 221 General Physics IV (4)
- PHYS 321 Advanced Physics Lab I (3)
- PHYS 322 Advanced Physics Lab II (3)
- PHYS 361 Classical Mechanics I (4)
- PHYS 362 Classical Mechanics II (4)
- PHYS 371 Introduction to Quantum Physics (4)
- PHYS 381 Atomic Physics (4)
- PHYS 401 Electromagnetism I (4)
- PHYS 402 Electromagnetism II (4)
- PHYS 403 Electromagnetism III (4)

Electives (6 credits minimum)

- PHYS 363 Special Relativity (4)
- or any 400-level physics courses except PHYS 497 may be selected as electives.

Required program credits

97 credits

Elective credits

6 credits

Total credits for above major

103 credits

MINORS

PHYSICS MINOR (20 CREDITS)

Required Courses

- PHYS 151 General Physics I (4)
- PHYS 152 General Physics II (4)
- PHYS 153 General Physics III (4)
- PHYS 161 Mechanics Lab (1)
- PHYS 162 Heat and Optics Lab (1)
- PHYS 163 Instrumentation Lab I (1)
- PHYS 164 Instrumentation Lab II (1)
- PHYS 221 General Physics IV (4)

Total credits for above minor

20 credits

PHYSICS/SECONDARY MINOR (24 CREDITS)

This minor satisfies the endorsement for grades 5–12.

Required Courses

- PHYS 151 General Physics I (4)
- PHYS 152 General Physics II (4)
- PHYS 153 General Physics III (4)
- PHYS 161 Mechanics Lab (1)
- PHYS 162 Heat and Optics Lab (1)
- PHYS 163 Instrumentation Lab I (1)
- PHYS 164 Instrumentation Lab II (1)
- PHYS 221 General Physics IV (4)
- PHYS 495 Internship (4)

Total credits for above minor

24 credits

Course Requirements for Teacher Certification/Add-on Endorsements (For students who currently possess a Washington State Teaching Certificate)

GENERAL SCIENCE/ADD-ON ENDORSEMENT (65 CREDITS)

To improve their marketability as science teachers, students may wish to complete this option in addition to their BAE in biology, chemistry, earth science or physics. This add-on satisfies the general science endorsement and allows teachers to teach any science grades 5–12.

Required Courses

- BIOL 171 Biology I (4)
- BIOL 172 Biology II (4)
- BIOL 173 Biology III (4)
- BIOL 270 Biological Investigation (3)
- BIOL 390 Biology Teaching Methods (1)
- CHEM 151 General Chemistry (5)
- CHEM 152 General Chemistry (5)
- CHEM 153 General Chemistry (5)
- CHEM 390 Chemistry Methods for the Secondary School (1)
- GEOG 314 Weather and Climate (5)
- GEOL 120 Physical Geology–The Solid Earth (5)
- GEOL 121 Physical Geology–Surficial Processes (5)
- GEOL/GEOG 390 Earth Science Teaching Methods (1)
- PHYS 121 Descriptive Astronomy (5)
- PHYS 131 Introductory Physics I (4)
- PHYS 132 Introductory Physics II (4)
- PHYS 161 Mechanics Lab (1)
- PHYS 162 Heat and Optics Lab (1)
- PHYS 390 Physics Teaching Methods (1)
- SCED 390 Secondary Science Teaching Methods (1)

Total credits for above add-on endorsement

65 credits

Physics Courses

Terms offered: fall, winter, spring, summer (FWSU). If no terms are indicated check with the department or EagleNET.

PHYS 100 Physical Science I (5)

Prerequisite: pre-university basic skills in mathematics.

[satisfies the GEGR for natural sciences, physics.]

Course covers the elementary aspects of physical science and astronomy. It operates in an informal laboratory mode with ample opportunity for discussion and individual assistance. No mathematics beyond basic arithmetic is used.

PHYS 115 Investigating Physical Science (5) W

Prerequisite: pre-university basic skills in mathematics.

[satisfies the GEGR for natural sciences, physics.]

For students planning to teach elementary school. Includes inquiry based physical science investigations that support science instruction outlined in the National Science Education Standards and Washington Essential Academic Learning Requirements.

PHYS 121 Descriptive Astronomy (5)

Prerequisite: pre-university basic skills in mathematics.

[satisfies the GEGR for natural sciences, physics.]

This course follows the development of astronomy from the earth-centered model of the early Greeks through the sun-centered model of Copernicus to the modern dynamic model of the universe incorporating the known laws of physics in its description. Topics covered in this development include a study of the solar system and a brief description of the physical laws used in astronomy. Additional topics such as distances, motions properties and evolution of stars lead to a study of galaxies, the structure of the universe and to modern cosmological models. Laboratory activities include naked-eye observation and measurement, planetarium sessions, Celestial Globe activities, computer simulations, as well as experiments in optics, spectra and the use of telescopes.

PHYS 131, 132, 133 Introductory Physics I, II, III

(4, 4, 4) F(131)W(132)S(133)

Prerequisites: MATH 106, concurrent enrollment in PHYS 161 for PHYS 131 is recommended; PHYS 131 for PHYS 132; and PHYS 132 for PHYS 133.

[The completion of PHYS 131, 161 satisfies the GEGR for natural sciences, physics; counts as one course. The completion of PHYS 131, 132, 161, plus any one of the following: 162, 163, 164 satisfies the GEGR for natural sciences, physics; counts as two courses.]

These courses are designed primarily for science students with mathematical preparation through algebra and trigonometry. No calculus is used. The topics covered are PHYS 131—kinematics, dynamics, conservation of momentum and energy and simple harmonic motion; PHYS 132—sound/waves, heat/thermo-dynamics, geometric optics; PHYS 133—electricity and magnetism, physical optics, modern physics. Each course consists of 4 credits of lecture and 1 credit of required instrumentation laboratory.

PHYS 151 General Physics I (4) F

Prerequisites: Concurrent enrollment in MATH 161. Concurrent enrollment in PHYS 161 is recommended.

[The completion of PHYS 151, 161 satisfies the GEGR for natural sciences, physics; counts as one course.]

Part of a four-quarter beginning sequence (151, 152, 153, 221) suitable for all students of natural science and mathematics. Topics covered include: one and multi-dimensional kinematics and dynamics, energy and momentum and oscillations.

PHYS 152 General Physics II (4) W

Prerequisites: PHYS 151 and concurrent enrollment in MATH 162.

[The completion of PHYS 151, 152, 161, plus any one of the following: 162, 163, 164 satisfies the GEGR for natural sciences, physics; counts as two courses.]

Part of a four-quarter beginning sequence (151, 152, 153, 221) suitable for all students of natural science and mathematics. Topics covered include: rotational motion, gravity, fluids, waves and thermodynamics.

PHYS 153 General Physics III (4) S

Prerequisites: PHYS 152 and concurrent enrollment in MATH 163.

Part of a four-quarter beginning sequence (151, 152, 153, 221) suitable for all students of natural science and mathematics. Topics covered include: electrostatics, direct current circuit theory, magnetism and geometric optics.

PHYS 161 Mechanics Laboratory (1) F

A laboratory course in mechanics, including one-dimensional motion, motion in a plane, dynamics, conservation of energy and momentum and oscillating motion.

PHYS 162 Heat and Optics Laboratory (1) W

A laboratory course suitable for use with either *Introductory* or *General Physics*. Experiments in optics include reflection and refraction, lenses and mirrors, microscopes and telescopes, optical spectra and microwave optics. Experiments in heat include heat and temperature, thermal expansion, mechanical and electrical equivalents of heat and a study of gas laws.

PHYS 163, 164 Instrumentation Laboratory I, II (1, 1) S(163)

This laboratory emphasizes the use of electronic instruments in the measurement of physical quantities.

PHYS 221 General Physics IV (4) F

Prerequisite: PHYS 153.

Part of a four-quarter beginning sequence (151, 152, 153, 221) suitable for all students of natural science and mathematics. Topics covered include: electromagnetism, alternating current circuit theory, Maxwell's equations, physical optics, quantization and nuclear physics.

PHYS 299 Special Studies (1-5) FWSU

PHYS 321, 322 Advanced Physics Lab I, II

(3, 3) alt

Prerequisite: junior standing or permission of the instructor.

A laboratory course dealing with classical experiments in all of physics as well as introducing many modern measurement techniques in atomic and nuclear physics.

PHYS 338 Discovering Women in Science (1)

The course uses several scientific themes to rediscover from the past and find in contemporary research, the women who have made significant contributions to science. (Cross-listed BIOL/CHEM/GEOL/HIST/PSYC/WMST 338)

PHYS 361, 362 Classical Mechanics I, II

(4, 4) alt

Prerequisites: PHYS 153, MATH 163.

A study of statics and dynamics from a mathematical point of view; an introduction to Lagrange's Equations.

PHYS 363 Special Relativity (4)

Prerequisites: PHYS 153, MATH 162.

An introduction to Einstein's theory of special relativity and its application to particle dynamics.

PHYS 371 Introduction to Quantum Physics (4) W

Prerequisites: MATH 163, PHYS 221.

An introduction to the origin and development of quantum theory with emphasis on the classical experiments leading to Schrodinger's Wave Mechanics and applications of Schrodinger's Equation to simple systems.

PHYS 381 Atomic Physics (4) S

Prerequisite: PHYS 371.

A study of the application of quantum theory to the description of the periodic table, to the interpretation of atomic and molecular spectra and to the behavior of X-rays.

PHYS 390 Physics Teaching Methods (1) F

Prerequisites: successful completion or concurrent enrollment in PHYS 132 or PHYS 152 and EDUC 341 and enrollment in a co-requisite SCED 390.

This course is for physics majors planning to teach junior or senior high school. Topics will include: organization of lesson materials, techniques, resources and evaluation.

PHYS 401, 402, 403 Electromagnetism I, II, III (4, 4, 4) F (401) alt W (402) alt S (403)

Prerequisites: MATH 163, PHYS 221.

A study of electric forces, fields, potentials, dielectric behavior, currents, magnetic forces and electromagnetic waves.

PHYS 411 Classical Thermodynamics (3)

Prerequisites: PHYS 153, MATH 163.

Introduction to elementary thermodynamics; first, second and third laws of thermodynamics; ideal gases; and kinetic theory.

PHYS 424 Astrophysics (4)

Prerequisites: PHYS 153, MATH 163.

Application of the physical principles of mechanics, fluid dynamics, thermodynamics, electromagnetism, optics, and relativity within the astronomical contexts of observational techniques/instrumentation, planetary science, stellar structure/evolution, galactic/extragalactic structure and cosmology. Computer-based laboratory exercises in orbital motions, rotational motion, photometry and spectroscopy are included.

PHYS 431 Solid State Devices Physics (3)

Prerequisites: MATH 163, PHYS 221.

A course dealing with crystalline semiconductors, carrier transport generation and recombination, p-n junctions, metal-semiconductor junctions, microwave devices, photonic devices like solar cells and semiconductor lasers.

PHYS 441 Solid State Physics (3)

Prerequisite: PHYS 431.

A course dealing with the quantum properties of electrons in solids, mechanisms of electron and hole conduction and the theory of operation of solid state devices.

PHYS 451 Optics (4) alt

Prerequisites: MATH 163, PHYS 153.

A study of the nature of light and its applications, with emphasis on physical optics and the electromagnetic wave theory of light. Topics selected from modern optics include Fourier optics, basics of coherence theory and aspects of the quantum nature of light.

PHYS 461 Nuclear Physics (3)

Prerequisite: PHYS 381.

A continuation of PHYS 381 which deals with properties of the nucleus, laws of radioactivity, nature of radiation, nuclear, X- and gamma rays and nuclear reactions.

PHYS 495 Internship (1-5) FWSU

Prerequisite: permission of the instructor, department chair and college dean.

PHYS 497 Workshops, Short Courses, Conferences (1-6) FWSU

PHYS 498 Seminar (1-2) S

PHYS 499 Directed Study (1-5) FWSU

Prerequisite: permission of the instructor, department chair and college dean.