

Physics

David Boness, PhD, Chair

Objectives

The Physics Department offers two degree programs, the bachelor of science (BS) and the bachelor of arts (BA). There are two versions of the BA program: the bachelor of arts with a major in physics, and the bachelor of arts with a major in physics and with a specialization in humanities for teaching (BAHT program).

For those who wish a career in physics, the bachelor of science in physics program takes the student from classical mechanics through quantum mechanics, including advanced laboratory work emphasizing modern physics. The curriculum is designed to prepare students for advanced work in pure and applied physics in graduate school or in industry, but the degree is also excellent preparation for careers in engineering or computer programming, or for admission to medical, dental, law, or business school. Graduates with the BS degree in physics work in industry, federally funded national laboratories, academic institutions, or other places where a strong problem solving background is valued.

The bachelor of arts program is ideal for those who desire a solid background in physics but who also want the flexibility to pursue other interests. Students planning to go on to teach at the high school level can enter teacher certification and master degree programs in education regardless of which physics degree is earned, but the BAHT program is specially designed for physics majors seeking a career in high school teaching. Note that the BAHT program does not by itself give state teacher certification; further work is needed.

Degrees Offered

Bachelor of Arts

Bachelor of Science in Physics

Majors Offered

Physics

Physics with specialization in Humanities for Teaching

Minor Offered

Physics

Bachelor of Arts Major in Physics

In order to earn the bachelor of arts degree with a major in physics, students must complete a minimum of 180 credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110	College Writing: Inquiry and Argument	5
PHIL 110	Introduction to Philosophy and Critical Thinking	5
	Choose one of the following two courses:	5
HIST 120	Origins of Western Civilization	
HIST 121	Studies in Modern Civilization	

ENGL 120	Introduction to Literature.....	5
Fine Arts (one approved 5 credit course; see course descriptions).....		5
PHIL 220	Philosophy of the Human Person.....	5
Social Science I	.....	5
Social Science II (different discipline from Social Science I).....		5
Theology and Religious Studies Phase II (200-299).....		5
Ethics (upper division).....		5
Theology and Religious Studies Phase III (300-399).....		5
Interdisciplinary	.....	3 to 5
Senior Synthesis	.....	3

II. Major Requirements

45 credits in physics, including:

PHYS 121	Mechanics.....	5
PHYS 122	Electricity and Magnetism.....	5
PHYS 123	Waves and Optics.....	5
PHYS 204	Relativity.....	2
PHYS 205	Introduction to Quantum Physics.....	3
PHYS 206	Modern Physics Laboratory.....	3
PHYS 230	Computing Tools for Physical Science.....	3
PHYS 250	Mathematical Methods for Physics.....	4
PHYS 310	Classical Mechanics.....	5
PHYS 330	Electromagnetic Field Theory.....	5
PHYS	Electives (300 level or above).....	5

III. Other Major Department Requirements

MATH 134	Calculus I.....	5
MATH 135	Calculus II.....	5
MATH 136	Calculus III.....	5
MATH 232	Multivariable Calculus.....	3
MATH 233	Linear Algebra.....	3
MATH 234	Differential Equations.....	4
Related science electives (approved by department).....		15

NOTE: No physics courses numbered 120 or below may be counted toward the major.

Bachelor of Arts

Major in Physics

Specialization in Humanities for Teaching

In order to earn the bachelor of arts degree with a major in physics and with a specialization in humanities for teaching, students must complete a minimum of 180 credits with a cumulative grade point average of 2.50, and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

HUMT 150	Composition: Language and Thought.....	5
HUMT 151	Composition: Language and the Arts.....	5
HUMT 152	Logic, Ethics, and Discernment.....	5
HUMT 161	Humanities: Introduction to Tutoring.....	2
HUMT 162	Humanities: Introduction to Tutoring.....	1

HUMT 163	Humanities: Introduction to Tutoring	1
HUMT 171	Proseminar: Humanistic Foundations of Education	5
HUMT 180	Socio-Cultural Transformations I.....	5
HUMT 181	Socio-Cultural Transformations II	5
HUMT 182	Socio-Cultural Transformations III	5
HUMT 273	Seminar on Secondary Education	5
HUMT 274	Supervised Internship in Secondary Education	5
HUMT 301	Perspectives on the Person I.....	5
HUMT 302	Perspectives on the Person II.....	5
HUMT 371	Education and the Polity.....	5
HUMT 372	Leadership and Teaching.....	5
HUMT 380	Cultural Interface.....	5
HUMT 400	Seminar on Contemporary Problems.....	5
HUMT 471	Jesuit Education.....	5
HUMT 472	Jesuit Education Practicum.....	5
CISS 120	Poverty in America.....	5

II. Major Requirements

48 credits in physics, including:

PHYS 121	Mechanics	5
PHYS 122	Electricity and Magnetism	5
PHYS 123	Waves and Optics.....	5
PHYS 204	Relativity.....	2
PHYS 205	Introduction to Quantum Physics	3
PHYS 206	Modern Physics Laboratory	3
PHYS 230	Computing Tools for Physical Science.....	3
PHYS 250	Mathematical Methods for Physics	4
PHYS 310	Classical Mechanics	5
PHYS 330	Electromagnetic Field Theory	5
PHYS 487	Senior Synthesis.....	3
PHYS	Electives (300 level or above).....	5

III. Other Major Department Requirements

MATH 134	Calculus I.....	5
MATH 135	Calculus II.....	5
MATH 136	Calculus III	5
MATH 232	Multivariable Calculus	3
MATH 233	Linear Algebra.....	3
MATH 234	Differential Equations.....	4
CHEM 121	General Chemistry I	4
CHEM 131	General Chemistry Lab I	1
CHEM 260	Laboratory Safety	2
Related Science Electives (approved by department).....		8

NOTE: For a secondary endorsement in general science, 5 credits of earth science and 5 credits of BIOL 161/171 will satisfy science electives. For a detailed description of this degree see the introductory pages for the College of Science and Engineering. Students interested in teaching should contact the Master in Teaching program (206) 296-5759 or visit the website seattleu.edu/coe/mit.

Bachelor of Science in Physics

In order to earn the bachelor of science in physics degree, students must complete a minimum of 180 credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110	College Writing: Inquiry and Argument	5
PHIL 110	Introduction to Philosophy and Critical Thinking	5
Choose one of the following two courses:		5
HIST 120	Origins of Western Civilization	
HIST 121	Studies in Modern Civilization	
ENGL 120	Introduction to Literature	5
Fine Arts (one approved 5 credit course; see course descriptions).....		5
PHIL 220	Philosophy of the Human Person.....	5
Social Science I	.....	5
Social Science II (different discipline from Social Science I).....		5
Theology and Religious Studies Phase II (200-299)		5
Ethics (upper division).....		5
Theology and Religious Studies Phase III (300-399)		5
Interdisciplinary	.....	3 to 5
Senior Synthesis	.....	3

II. Major Requirements

65 credits in physics, including:

PHYS 121	Mechanics	5
PHYS 122	Electricity and Magnetism	5
PHYS 123	Waves and Optics.....	5
PHYS 203	Thermodynamics.....	3
PHYS 204	Relativity.....	2
PHYS 205	Introduction to Quantum Physics	3
PHYS 206	Modern Physics Laboratory	3
PHYS 230	Computing Tools for Physical Science.....	3
PHYS 250	Mathematical Methods for Physics	4
PHYS 310	Classical Mechanics	5
PHYS 330	Electromagnetic Field Theory	5
PHYS 370	Advanced Physics Laboratory	4
PHYS 385	Quantum Mechanics	5
PHYS 410	Advanced Classical Physics.....	5
PHYS	Electives (300 level or above).....	8

III. Other Major Department Requirements.....

MATH 134	Calculus I.....	5
MATH 135	Calculus II.....	5
MATH 136	Calculus III	5
MATH 232	Multivariable Calculus	3
MATH 233	Linear Algebra.....	3
MATH 234	Differential Equations.....	4
Related Science Electives (approved by department).....		5

NOTE: No physics courses numbered 120 or below may be counted toward the major.

Minor in Physics

In order to earn a minor in physics, students must complete 30 credits in physics, including:

PHYS 121	Mechanics	5
PHYS 122	Electricity and Magnetism	5
PHYS 123	Waves and Optics	5
PHYS 205	Introduction to Quantum Physics	3
PHYS	Electives (200-level and above)	12

NOTE: No physics courses numbered 120 or below may be counted toward the minor.

See Policy for minors (84-1) for more information.

Physics Courses

NOTE: 1. PHYS 101, PHYS 102, PHYS 104, PHYS 105, PHYS 106, PHYS 107, PHYS 121, PHYS 122, and PHYS 123 combine lectures and discussion with laboratory sessions. Any of these satisfies the core Phase One laboratory science requirement. 2. Credit may be received for only one of the following series: PHYS 105/106/107 or PHYS 121/122/123.

PHYS 100 **From Quarks to the Cosmos** **2**

A non-mathematical introduction to some of the most interesting aspects of contemporary physics. Topics include the nature of space and time, the fundamental constituents of matter, and the evolution of the universe from the big bang to the present epoch of accelerated expansion. Evaluation in the course is based on class participation, essay exams, and a term paper. Grading is CR/F. There are no prerequisites. (fall)

PHYS 101 **Astronomy: The Solar System** **5**

An introduction to astronomy for non-science students that satisfies the Core laboratory science requirement. Topics considered include a description of the motions of celestial objects as seen from earth; explanation of the motions from the early Greeks through the moderns; a survey of the physical properties and origins of the solar system, including the latest findings of space probes. The course may include an astrobiology emphasis. Course includes laboratory component. Prerequisite: core mathematics or placement in MATH 120 or higher.

PHYS 102 **Astronomy: Stars, Galaxies, and Cosmology**..... **5**

An introduction to astronomy for non-science students that satisfies the Core laboratory science requirement. Topics include light and telescopes; the distance, motion, and brightness of stars; the birth and death of stars; black holes; normal and abnormal galaxies; the big bang, the expanding universe, curved spacetime, and the fate of the universe. Course includes laboratory component. Prerequisite: core mathematics or placement in MATH 120 or higher.

PHYS 104 **Science as a Human Process** **5**

How science is actually done by real people; history of physics; concepts of relativity and quantum physics and their effect on society; additional topics may include recent controversies in science, such as global warming, ozone depletion, or what caused the death of the dinosaurs. Course includes laboratory component. Prerequisite: core mathematics or placement in MATH 120 or higher.

PHYS 105 **Mechanics** **5**

A non-calculus survey of classical mechanics. Topics covered include kinematics in one and two dimensions; dynamics, Newton's laws and gravitation; work and energy; momentum, rotational motion, and equilibrium. Course includes laboratory component. Prerequisites: MATH 120, 121, or equivalent.

- PHYS 106 Waves, Sound, Electricity and Magnetism 5**
Continuation of the non-calculus survey of introductory physics. Topics covered include fluids; simple harmonic motion; mechanical waves and sound; electric charge, field, and potential; electric energy and capacitance; electric current and resistance; magnetic fields and electromagnetic induction. Course includes laboratory component. Prerequisite: PHYS 105. (winter)
- PHYS 107 Thermodynamics, Optics, and Modern Physics 5**
Completion of the non-calculus survey of introductory physics. Topics treated include temperature and kinetic theory; heat and the laws of thermodynamics; ray and wave optics; introduction to the ideas of quantum mechanics; radioactivity and radiation. Course includes laboratory component. Prerequisite: PHYS 106. (spring)
- PHYS 121 Mechanics 5**
An introduction to calculus-based physics for students of science and engineering. Topics treated include vectors; kinematics; force and Newton's laws; work, energy, and power; conservation of momentum and collisions; rotational dynamics and rigid body motion; gravitation. Course includes laboratory component. Prerequisite or co-requisite: MATH 135. (winter, spring)
- PHYS 122 Electricity and Magnetism 5**
Continuation of calculus-based physics for students of science and engineering. Topics covered include electric charge, forces, field, flux; Gauss' law; electric potential; conductors, dielectrics, capacitance; current, resistance, and DC circuits; magnetic forces and fields; Ampere's law; Faraday's law and inductance; Maxwell's equations. Course includes laboratory component. Prerequisites: PHYS 121, MATH 135. (fall, spring)
- PHYS 123 Waves and Optics..... 5**
Completion of the calculus-based survey of physics for students of science and engineering. Topics covered include harmonic motion; mechanical, and electromagnetic waves; electromagnetic properties of materials; reflection, refraction, dispersion, interference, diffraction, and polarization of waves. Course includes laboratory component. Prerequisites: PHYS 122, MATH 136. (fall, winter)
- PHYS 203 Thermodynamics..... 3**
An introduction to thermodynamics for students of science and engineering. Topics treated include temperature, work, heat, and internal energy; reversible processes; entropy and its interpretations; thermodynamic equilibrium; the laws of thermodynamics; ideal gases; kinetic theory and distributions; heat engines and refrigerators; phase transitions; application to physical systems. Prerequisites: PHYS 122, MATH 136. (winter)
- PHYS 204 Relativity..... 2**
An introduction to special relativity for students of science and engineering. Topics covered include the Lorentz transformation and its consequences; relativistic kinematics; relativistic dynamics, collisions, and conservation laws. Prerequisite: PHYS 123. (spring)
- PHYS 205 Introduction to Quantum Physics 3**
An introduction to quantum mechanics for students of science and engineering. Topics covered include evidence for the quantization of light, matter, and energy; the wave nature of matter; the Bohr model of the atom; wave-particle duality; the uncertainty principle; the Schrödinger equation and its applications; the Pauli exclusion principle and the periodic table of the elements. Prerequisites: PHYS 123, MATH 232. (spring)

- PHYS 206 Modern Physics Laboratory 3**
 A rigorous introduction to experimental physics through modern physics laboratory investigations. Emphasis is on experimental method, including experimental design, proper use of laboratory notebooks and record keeping, data acquisition, data analysis and interpretation, measurement statistics and uncertainty, quantitative support of conclusions, and presentation and dissemination of results. Physics topics for investigation emphasize 20th century physics. Prerequisite or co-requisite: PHYS 205. (spring)
- PHYS 230 Computing Tools for Physical Science..... 3**
 An introduction to scientific computer programming for students of science and engineering. Emphasis is on numerical and symbolic computation methods with applications in the physical sciences. Instruction in the use of programming languages or packages such as MATLAB, Fortran 95, and Mathematica are given at an elementary level. Elementary programming skills required for doing scientific computation, such as numerical evaluation and plots of functions, statistical analysis and plots of data, numerical computations and symbolic calculations are emphasized. Prerequisite: PHYS 122. (winter)
- PHYS 250 Mathematical Methods for Physics 4**
 A course to facilitate the understanding and use of mathematics in the physical sciences. Topics include applications of vector calculus; Fourier analysis; applications of differential equations; coordinate systems; special functions. Prerequisites: PHYS 123, MATH 234. (fall)
- PHYS 291-293 Special Topics..... 1 to 5**
- PHYS 296 Directed Study 1 to 5**
- PHYS 310 Classical Mechanics 5**
 Newtonian mechanics for students of physics. Topics include point-particle mechanics in 3-dimensions; oscillations; Newton's theory of gravitation; central force motion; dynamics of systems of particles; Lagrangian and Hamiltonian dynamics; dynamics of rigid bodies. Prerequisites: PHYS 230 or equivalent, PHYS 250. (winter)
- PHYS 330 Electromagnetic Field Theory 5**
 The theory of electromagnetism using vector calculus for students of physics and electrical engineering. Topics covered include static electric and magnetic fields in vacuum and linear isotropic media; time-varying fields and Maxwell's equations; the wave equation and boundary conditions; propagation of electromagnetic waves in non-conducting media. Prerequisites: PHYS 123, MATH 234. (fall)
- PHYS 340 Nonlinear Dynamical Systems and Chaos..... 4**
 An introduction to nonlinear dynamical systems. Topics include coupled linear and nonlinear difference equations; coupled linear and nonlinear ordinary differential equations; fixed points; equilibrium points; stability; bifurcations; limit cycles; logistic equation; Feigenbaum scaling; fractals; Hausdorff dimension; dissipative and Hamiltonian systems; Liapunov's method; strange attractors; nonlinear oscillations; perturbation theory; Lorenz equations; chaos; predictability; computer programming and graphics. Prerequisites: PHYS 123, PHYS 230 or equivalent, MATH 234. (winter)
- PHYS 362 Introduction to Astrophysics..... 4**
 An introduction to the physics of stars and galaxies. Topics include observational properties of stars; equations of stellar structure; physics of stellar interiors; birth, evolution, and death of stars; globular clusters; galaxies. Prerequisites: PHYS 203, PHYS 230 or equivalent, PHYS 250.
- PHYS 363 Introduction to Geophysics 4**
 An introduction to physics of the earth. Topics include earth formation; plate tectonics; geomagnetism; continuum mechanics; earthquakes and seismology; physical properties of the deep earth; high-pressure geophysics. Prerequisites: PHYS 203, PHYS 230 or equivalent, PHYS 250.

- PHYS 370 Advanced Physics Laboratory 4**
 Experimental physics laboratory to introduce students to the work of a professional experimental physicist. Students will design and execute a few experiments in depth in such areas as chaotic dynamical systems, laser diode spectroscopy, nuclear magnetic resonance, sonoluminescence, plasma physics, superconductivity, and nuclear physics, and will learn state-of-the-art computer-based data acquisition techniques, such as LabView. Students will present a talk in the style of a professional physics conference and prepare a paper in the style of a professional physics research journal. Prerequisites: PHYS 205, 206, MATH 234. (winter of alternate years)
- PHYS 385 Quantum Mechanics 5**
 A mathematical treatment of quantum mechanics using complex vector spaces, operators, wave functions, and abstract Dirac notation. Topics treated include wave-particle duality, the state function, the Schrödinger equation, one-dimensional problems, the operator formalism, matrices, central forces, angular momentum, spin, identical particles. Prerequisites: PHYS 205, 310. (spring)
- PHYS 391-393 Special Topics 1 to 5**
- PHYS 396 Directed Study 1 to 5**
- PHYS 410 Advanced Classical Physics 5**
 A course in advanced classical physics, emphasizing continuous matter and fields. Topics may include these: normal modes of finite and continuous systems; Laplace's and Poisson's equations; the heat/diffusion equation; the wave equation; equations of continuity; and Euler's and the Navier-Stokes equation. Prerequisites: PHYS 310, 330. (fall)
- PHYS 430 Modern Optics for Physicists and Engineers 4**
 Introduction to modern optics consisting of ray optics; scalar wave optics; diffraction; interferometry; vector wave optics and polarization; Gaussian beam optics; Fourier optics, including image processing, spatial filtering, and holography; optical waveguides and fibers; optical resonators; laser amplifiers and systems; semiconductor lasers and detectors; optical switching and computing. Optional labs in holography and fiber optics. Prerequisites: PHYS 330.
- PHYS 450 Atomic Physics 4**
 Introduction to modern atomic physics. Topics may include: single electron without spin in central potential, radiative transitions, spin and the fine structure of the hydrogen spectrum, two electron systems, independent electron approximation, shells, electronic configurations, spectroscopic notation, interaction with external fields, hyperfine structure, isotope shifts, optical and radiofrequency spectroscopy, atomic beam methods, measurement of atomic lifetimes and oscillator strengths, electronic and atomic collisions. Prerequisites: PHYS 330, 385.
- PHYS 470 Solid-State Physics 4**
 An introduction to the physics of solids for physics students. Topics covered include symmetry; crystal structure; x-ray and neutron diffraction; types of solids and bonding; vibrations in solids—phonons; electronic band structure; metals and semiconductors; p-n junctions. Prerequisite: PHYS 385.
- PHYS 480-483 Interdisciplinary Core Courses 3 to 5**
 Title and content change each term these courses are offered.
- PHYS 481 Origins: Cosmology and Culture 5**
 A study of the origin and evolution of the universe and the cultural and historical influences that have shaped our understanding of the cosmos. Satisfies the core interdisciplinary requirement. Does not count for physics elective credit. Prerequisite: junior standing.

PHYS 486	Particle and Nuclear Physics	5
An introduction to the physics of nuclei and elementary particles for physics students. Topics covered include an historical introduction to the elementary particles; symmetries and conservation laws; quantum electrodynamics; the weak interaction; introduction to quantum chromodynamics; properties of nuclei; nuclear radiations and their detection; nuclear structure and nuclear models. Prerequisites: PHYS 330, 385.		
PHYS 487	Senior Synthesis.....	3
Capstone course integrating physics and the humanities through investigation of one or more themes. Readings, classroom discussion, essays, and student presentations. Satisfies core senior synthesis requirement. Does not count for physics elective credit. Prerequisite: permission of chair.		
PHYS 491-493	Special Topics.....	1 to 5
PHYS 496	Independent Study	1 to 5
PHYS 497	Directed Reading	1 to 5
PHYS 498	Directed Research.....	1 to 5
PHYS 499	Undergraduate Research	1 to 6
Literature search and laboratory or computer investigation of a research problem in physics under the supervision of a faculty member. Prerequisite: permission of department chair.		