



Faculty

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PHYSICS is the search for the fundamental physical laws of nature. In particular, physics is the study of forces and motion of physical entities, seeking to find basic relations that synthesize these phenomena. The goal is to discover ways to control and predict natural occurrences and to understand and explain the physical universe. To achieve this goal involves observation and experimentation from which physical and mathematical models are developed that suggest concepts and theories. Although modern science limits itself to a naturalistic view of reality and to experimental ways of obtaining knowledge, this department takes the view that physical phenomena are consistent with the concept of an intelligent Designer and divine Creator.

Degrees offered include a four-year B.S. in Physics designed primarily to prepare students for graduate work or applied research; a four-year B.S. in Biophysics, which is popular for pre-medical and pre-dental preparation but is also suitable for secondary education; and a four-year B.S. in Natural Science with an emphasis in physics, which is primarily for those preparing for secondary teaching.

This department houses the first two years of the engineering program that is affiliated with the School of Engineering at Walla Walla University.

Major in Physics, B.S.

A minimum of 107 hours (37 upper-division hours)

► Required Core Courses (95 hours):

ASTR 115	Astronomy	5
CHEM 111-112-113	General Chemistry	5-5-5
CPTR 115	Computer Programming	4
ENGR 216	Circuit Theory	4
MATH 131-132-133	Calculus I-II-III	4-4-4
MATH 265	Elementary Linear Algebra	4
MATH 267	Multivariable Calculus	4
MATH 269	Elementary Differential Equations	4
PHYS 211-212-213	Physics with Calculus	4-4-4
PHYS 314	Elementary Modern Physics	4
PHYS 341-342	Classical Dynamics	3-3
PHYS 361-362-363	Electromagnetic Theory	3-3-3
PHYS 396	Seminar (4 quarters)	.5-.5-.5-.5
PHYS 445	Thermal Physics	4
PHYS 461-462	Quantum Physics	3-3

► Required Core Electives (12 hours):

At least 6 hours from the following: 6
Upper-division PHYS courses laboratory, project and/or independent research

At least 6 hours from the following: 6
Additional non-service PHYS courses
CHEM 344 Nuclear Physics and Chemistry (3)

Recommended Proficiency:

Modern-language proficiency comparable to a one-year college course in French or German.

This course of study is adequate for the student who is preparing for graduate study in physics.

Physics and Engineering

Major in Biophysics, B.S.

A minimum of 107 hours (41 upper-division hours)

► Required Core Courses (99 hours)

BIOL 111-112-113	Biological Foundations	5-5-5
BIOL 320	Cellular and Molecular Biology	4
BIOL 348	Systems Physiology	5
CHEM 111-112-113	General Chemistry	5-5-5
CHEM 371-372-373	Organic Chemistry	4-4-4
CHEM 381	Biochemistry I	4
ENGR 216	Circuit Theory	4
MATH 131-132-133	Calculus I-II-III	4-4-4
PHYS 211-212-213	Physics with Calculus	4-4-4
PHYS 314	Elementary Modern Physics	4
PHYS 321-322	Biophysics	3-3
PHYS 396	Seminar (4 quarters)	.5-.5-.5-.5

At least one of the following options: 4

4 additional hours from upper-division PHYS courses including at least 1 hour of laboratory (3-1)

or

CHEM 344	Nuclear Physics and Chemistry (3)
PHYS 389L	Experimental Physics (1)

or

CHEM 451	Physical Chemistry: Thermodynamics (3)
CHEM 450L	Physical Chemistry Laboratory (1)

At least 8 hours from the following: 8

Additional non-service BIOL courses

Additional non-service PHYS courses

Additional CHEM courses chosen from the following:

CHEM 344	Nuclear Physics and Chemistry (3)
CHEM 450L	Physical Chemistry Laboratory (1)
CHEM 451	Physical Chemistry: Thermodynamics (3)
CHEM 452	Physical Chemistry: Dynamics (3)

Recommended Courses:

MICR 134	General Microbiology (5)
PHYS 256	Optics (4)
PHYS 389L	Experimental Physics (1)
CPTR 115	Computer Programming (4)

This program provides the additional emphasis in the physical sciences demanded for graduate study in biophysics, physiology, medicine, radiation biology and molecular biology, especially when a career in academic medicine or medical research is contemplated. This program is also recommended as a broad major for teaching at the secondary-school level.

Major in Natural Science, B.S. Physics Emphasis

A minimum of 100 hours (29 upper-division hours)

This major provides appropriate preparation for teaching science at the secondary level. The core requirement of 65 quarter hours of course work corresponds to science subjects commonly taught in California public schools, and the emphasis treats the subject matter at a depth more than adequate for teaching the higher-level secondary science courses in physics. Emphases may also be obtained in biology or chemistry. For further information, see the sections entitled "Biology" and "Chemistry" in this catalog.

► Required Core Courses (65 hours):

ASTR 115	Astronomy	5
ASTR 173	Meteorology	1
BIOL 111-112-113	Biological Foundations	5-5-5
BIOL 331	Marine Science	4
BIOL 450	Philosophy of Origins	3
CHEM 111-112-113	General Chemistry	5-5-5
GEOL 233	Geology	4
PHYS 211-212-213	Physics with Calculus	4-4-4
PHYS 390	History and Philosophy of Science	3

At least one of the following courses: 3

ENVR 360	Conservation Biology (3)
ENVR 361	Energy and Climate Change (3)
ENVR 362	Pollution and Environmental Quality (3)

Physics Emphasis (35 hours)

MATH 131-132-133	Calculus I-II-III	4-4-4
PHYS 314	Elementary Modern Physics	4

At least one of the following courses: 4

ENGR 216	Circuit Theory (4)
PHYS 256	Applied Optics (4)

At least 15 hours from the following: 15

(Including at least 12 upper-division hours)

Additional non-service PHYS courses

CHEM 344	Nuclear Physics and Chemistry (3)
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Teaching Credential

Students desiring to enter a program of studies leading to a California teaching credential in science with a concentration in physics should take the either the B.S. degree in Biophysics or the B.S. degree in Natural Science, Physics Emphasis. Students will need to pass the science (physics concentration) portion

of the CSET exam one quarter prior to doing full-time student teaching. Students are invited to discuss the program with their major advisor in the Physics Department.

Those who plan to teach on the secondary level should consult with the credential analyst in the Education Department and should become acquainted with the specific requirements for admission to and successful completion of the Teacher Education Program as outlined in the Education section of this catalog.

Minor in Physics

A minimum of 30 hours (12 upper-division hours) chosen from physics, astronomy, and engineering courses (except ENGR 105).

Engineering

Engineering courses are offered for those who wish to begin studies in engineering that meet the requirements of the first two years of the engineering degree of Walla Walla University. Faculty of the WWU School of Engineering visit Pacific Union

College regularly for guidance and counseling of students. The Bachelor of Science in Engineering degree, of which this program is a part, prepares the student to enter professional practice in civil, mechanical or electrical engineering. The following courses may be taken at Pacific Union College to satisfy the requirements of the affiliation plan:

CHEM 111-112-113	General Chemistry	5-5-5
CPTR 115	Computer Programming	4
ENGL 101-102	College English	4-4
ENGR 105	Introduction to Engineering	3
ENGR 131	Engineering Drawing	3
ENGR 211-212-213	Engineering Mechanics	3-3-3
ENGR 216	Circuit Theory	4
MATH 131-132-133	Calculus I-II-III	4-4-4
MATH 265	Elementary Linear Algebra	4
MATH 267	Multivariable Calculus	4
MATH 269	Elementary Differential Equations	4
PHYS 211-212-213	Physics with Calculus	4-4-4

Astronomy

LOWER-DIVISION COURSES:

ASTR 115 5 F, W Astronomy

An introduction for the general student to the basic elements of astronomy. Topics include models of the solar system, stars and their processes, clusters, galaxies, cosmology, and relevant physics topics such as light, spectroscopy, nuclear reactions, and relativity. Emphasizes the development of scientific ideas and models for the structure and contents of the universe and the effects of those ideas on western civilization. Laboratory activities emphasize personal observations of various astronomical objects, as weather permits. Four lectures and one evening laboratory per week. Prerequisite: MATH 096 or equivalent.

ASTR 173 1 F Meteorology

Helps explain various natural phenomena for a better understanding of the science of meteorology. Beginning with the basics of physics that control the atmosphere, the discussion extends to the causes of weather patterns, frost, snow, rain, sleet, tornadoes, and hurricanes.

UPPER-DIVISION COURSE:

ASTR 495 1-3 F, W, S Independent Study

With the approval of the department chair, qualified students may undertake the independent study of problems suited to their background and experience. Repeatable to a maximum of 3 credits.

Engineering

LOWER-DIVISION COURSES:

ENGR 105 3 F Introduction to Engineering

A survey of engineering as a profession: the main divisions; the work, functions and personal characteristics of the engineer; application of the sciences in engineering; design tools used by engineers; computer methods, basic skills for engineering problem-solving. Two lectures and one laboratory per week.

ENGR 131 3 F Engineering Drawing

Principles of and practice in engineering drawing. Applications to technical problems of CAD drafting techniques, orthographic, and pictorial views. Two lectures and one laboratory per week.

Physics and Engineering

ENGR 211-212-213 **3-3-3 F-W-S** **Engineering Mechanics**

Statics and dynamics. Detailed analysis of equilibrium, kinetics and kinematics of particles and rigid bodies. Examples and problems relate to real engineering applications. Prerequisites: MATH 131-132. Corequisite: PHYS 211.

ENGR 216 **4 S** **Circuit Theory**

Introductory circuit analysis for engineering and physics students. Circuit variables and parameters; Kirchoff's laws and network solution; equivalent circuits, network theorems; natural and complete response; sinusoidal steady-state, phasors and impedance; frequency characteristics; power and power factor. Three lectures and one laboratory per week. Prerequisite: MATH 131-132. Corequisite: MATH 133

Physics

SERVICE COURSES:

(Not applicable to a major or minor in this department)

PHYS 105 **5 S** **Introduction to Physics**

Emphasizes the ideas and concepts of conventional topics in physics with illustrations from everyday living. Assumes no previous physics course. (Students who need this course to meet a curricular requirement may also need to register for PHYS 106L.) Prerequisite: MATH 096 or equivalent.

PHYS 106L **1 S** **Introduction to Physics Laboratory**

A laboratory emphasizing physical measurements for those curricula requiring an introductory physics course with laboratory. One laboratory per week. Prerequisite or corequisite: PHYS 105.

PHYS 111-112-113 **4-4-4 F-W-S** **General Physics**

An introduction to the fundamental natural phenomena of the physical universe. Topics include Newtonian mechanics, waves, sound, heat, electricity and magnetism, optics, atomic and nuclear physics, special relativity, and elementary particles. Emphasis on fundamental principles and methods of physics. Suitable for preprofessional students and also acceptable as part of the general-education requirement in basic science. Three lectures and one laboratory per week. This sequence must be taken in order. Knowledge of algebra and trigonometry is required at the level provided by MATH 106, 130.

LOWER-DIVISION COURSES:

PHYS 211-212-213 **4-4-4 F-W-S** **Physics with Calculus**

A calculus-based introduction to the study of the physical universe. Intended primarily for students majoring in the physical sciences, engineering, or mathematics, but also appropriate for other students with the necessary background in mathematics. Topics include Newtonian mechanics, waves, electricity and magnetism, optics, thermodynamics, and an introduction to modern physics. Three lectures and one laboratory per week. This sequence must be taken in order. Prerequisite or corequisite: MATH 131-132-133.

PHYS 256 **4 S** **Applied Optics**

An intermediate-level treatment of theory and applications of electromagnetic waves in or near the optical region of the spectrum. Includes topics in geometrical, physical, and quantum optics and physical phenomena involved in laser action. Three lectures and one laboratory per week. Prerequisite: PHYS 113 or 213. Odd years.

UPPER-DIVISION COURSES:

PHYS 314 **4 F** **Elementary Modern Physics**

A continuation of PHYS 211-212-213. Offers an overview of the fundamentals of relativity and quantum physics and selected topics such as atomic and molecular physics, statistical mechanics, solid state physics, nuclear physics, and elementary particles. Three lectures and one laboratory per week. Prerequisites: MATH 269, PHYS 213.

PHYS 321-322 **3-3 W-S** **Biophysics**

For the upper-division physics student with adequate preparation in biology. Covers a variety of topics in which physical analysis is applied to living systems, and the interaction with living systems is studied. Prerequisites: BIOL 111-112-113, CHEM 113, PHYS 314. Even years.

PHYS 341-342 **3-3 F-W** **Classical Dynamics**

Classical mechanics including Newtonian mechanics and Lagrangian dynamics, which are used to solve problems associated with central-force motion, rigid object dynamics, oscillations, and wave motion. The theoretical bases of problems are emphasized, together with the development of different problem-solving techniques. Prerequisites: MATH 265, 267, 269, PHYS 213. Even years.

PHYS 361-362-363 **3-3-3 F-W-S** **Electromagnetic Theory**

Topics include electrostatics, magnetostatics, electromagnetism, electromagnetic radiation, and relativistic electrodynamics. The concepts of field and potentials are emphasized. Prerequisites: MATH 265, 267, 269, PHYS 213. Odd years.

PHYS 389L **1 F, W, S**
Experimental Physics

Provides experience with real science apparatus such as lasers, high field magnets, detectors, radioactive sources, and sophisticated electronics. Activities include experiments in mechanics, electromagnetism, optics, heat, and atomic and nuclear physics. One laboratory per week. Repeatable to a maximum of 6 credits. Prerequisites: ENGR 216. Corequisite: PHYS 314.

PHYS 390 **3 S**
History and Philosophy of Science
 (See also PHIL 390)

The historical roots of modern science, the nature of scientific knowledge, its development and methodology, the impact of science on culture (and vice versa), and the influence of philosophical and theological concepts on science. Prerequisites: PHYS 105 or CHEM 101, and PHIL 101. Even years.

PHYS 396 **.5 F, W, S**
Seminar

(See also BIOL 396, CHEM 396, CPTR 396, ENVR 396)
 Single topics of current interest in the natural sciences are presented by guest lecturers. To pass, a student must be on time and attend all five course sessions. Repeatable to a maximum of 3 credits. Graded S/F.

PHYS 445 **4 S**
Thermal Physics

A statistical description of a system of particles. Different ensembles and their associated partition functions are emphasized and applied to various thermal systems. Prerequisites: MATH 265, 267, 269; PHYS 314. Even years.

PHYS 461-462 **3-3 W-S**
Quantum Physics

Quantum mechanics and atomic physics. Topics include wave packets, Schrödinger's equation and its solutions, operator methods, angular momentum, matrix representation, spin, perturbation theory, the hydrogen atom, and radiation by atoms. Prerequisites: MATH 265, 267, 269; PHYS 314. Odd years.

PHYS 485 **3 S**
Issues in Science and Religion
 (See also PHIL 485)

The relationship and interaction between science and religion: epistemology, the methods, languages, scope and limitations of science and religion, problems of ethics and science. Two hours of credit may be applied toward the general-education requirement in religion. Prerequisites: PHYS 105 or CHEM 101, or equivalent, and PHIL 101 or permission of the instructor. Odd years.

PHYS 486 **1-4 Arr.**
Special Topics in Physics

A selected, physics-related topic of interest to the general student. Format and scheduling depend on the topic selected but usually consists of several lectures over a period of two or three weeks on a subject of current interest. Credit may be applied toward a physics major by approval of the department chair.

PHYS 495 **1-3 F, W, S**
Independent Study

Properly qualified students majoring in physics may, with the approval of the department chair, undertake an independent study of a topic suited to their background and experience. Repeatable to a maximum of 3 credits.

PHYS 499 **1-3 F, W, S**
Independent Research

Properly qualified students majoring in physics may, with the approval of the department chair, undertake a directed research problem suited to their background and experience. Repeatable to a maximum of 9 credits.

