

# PHYSICS MAJOR

## MAJOR DESCRIPTION

*"Physics is the liberal arts education for a technological society."*—Joseph Pimbley

Participation in research and proficiency in the main subject areas of physics are the twin goals of the physics program. The major program is designed to develop competency in quantum theory, electromagnetism and optics, thermodynamics and statistical mechanics, classical dynamics, and condensed-matter physics. Preparation in mathematical and computational methods is an integral part of the program.

Interested and qualified students may pursue several opportunities for advanced work, including graduate courses and participation with graduate students and faculty in research. The department encourages its students to "do physics" at the earliest opportunity by making arrangements to work with one of the research groups or by arranging an independent research tutorial. Research may be experimental or theoretical and may, but need not, result in a senior honors thesis. Most majors who intend to write a thesis begin research no later than the junior year and continue it through the summer into the senior year. Current research interests include quantum computing, single molecule biophysics, soft condensed-matter physics, charge transport in photovoltaic devices, fluid dynamics, laser plasmas, spectroscopy, collision studies involving excited atoms and molecules, and wave transport in complex media.

Many students also take advantage of Wesleyan's computing facilities in their research or coursework. The University has a large computer cluster available to all who are doing research.

Each semester, opportunities exist to serve as a teaching apprentice, course assistant, or department assistant in one of the introductory or intermediate-level courses. Many physics majors have found that this is a stimulating way to learn more about the fundamentals of the discipline and how to teach them. The Cady Lounge in the department serves as a focus for the major by providing a place where students can study and discuss physics. There is also a study room where students in the introductory courses can come to get help and to work together. Students are encouraged to attend the weekly colloquium series and to participate in the weekly research seminars in atomic and molecular physics, chemical physics, condensed-matter physics, and theory. The Society of Physics Students is also a great resource for sharing ideas and questions with like-minded students.

## ADMISSION TO THE MAJOR

The appropriate course for students considering a physics major depends primarily on their preparation. There are four common gateways into the major beginning in the fall semester.

- PHYS113 is a calculus-based introductory mechanics course requiring one semester of calculus, taken in either secondary school or in college, at about the level of MATH121. A student who has had no calculus should discuss with a member of the physics faculty whether to take calculus during the first year, then PHYS113 in the first semester of the sophomore year, or whether to try PHYS113 simultaneously with the first calculus course.
- Students who have had a strong preparation in physics and calculus may take PHYS215/PHYS219. These courses are intended for majors but are available to first-year or other students who have had both integral and

differential calculus at about the level of MATH121/MATH122 and a solid course in mechanics with calculus at the level of PHYS113.

- Students from both of the above gateways merge into the electricity and magnetism course, PHYS116, in the spring. Students intending to major in physics should complete either track no later than the end of their sophomore year and preferably by the end of their first year.
- Exceptionally well-prepared students may begin with PHYS213. Students who feel that they fall into this category should consult with a member of the physics faculty.

**Laboratory courses.** The PHYS113/PHYS116 sequence has associated laboratory courses, PHYS123 in the fall and PHYS124 in the spring. These laboratory sections are half-credit courses associated with the lecture courses. PHYS124 is part of the required gateway to the major. We encourage students to take the laboratory courses for a firsthand opportunity to observe, both qualitatively and quantitatively, some of the physical phenomena discussed in the lectures.

## MAJOR REQUIREMENTS

To major in physics, you must complete the requirements shown in the table below. The sequence of gateway courses described above provides the foundation for the core major courses. Students should complete PHYS116 no later than the end of your sophomore year; if you can complete it by the end of your first year, it will give you more flexibility to construct your major. You should also have completed MATH121, MATH122, MATH221, and MATH222 by the end of your sophomore year. It is desirable for those students who are considering graduate work in physics or those who wish to pursue an intensive major to also complete PHYS213 and PHYS214 by the end of the sophomore year. You should note that a few of the advanced courses may not be offered every year, and you should plan your program of study accordingly.

To fulfill the major in physics, a student must complete eight lecture courses and two laboratory courses. The lecture course requirement includes (a) four core physics courses which must be taken graded (A-F): PHYS213, PHYS214, PHYS316, and PHYS324; and (b) an additional four elective lecture credits at the **200**, **300**, or **500** level. At least one of the elective courses must be a PHYS lecture course at the 300 level, usually PHYS313 or PHYS315. The two laboratory courses can be chosen from PHYS342, PHYS345, PHYS340, or a 1-credit research tutorial with a physics faculty member. One of the two laboratory courses must be an advanced experimental laboratory class, currently PHYS342 or PHYS345.

Students planning graduate study in physics should take a minimum of 14 credits at the **200** level or higher in physics, mathematics, and computer science. PHYS313, PHYS315, and PHYS358 are essential. In addition, the department strongly recommends PHYS565, MATH226, and MATH229. Graduate physics courses may be elected with permission, and experience in computer programming is also extremely valuable.

Students not planning graduate study in physics and who are interested in applying their knowledge of physics to other areas of the curriculum may substitute upper-level lecture courses from other departments to satisfy requirement (b) above. This must be done in consultation with the physics major advisor, and the selections must constitute a coherent, coordinated program of study. Substitution of more than two courses requires approval from the department. Preapproved tracks that satisfy requirement (b) are available here.

## PHYSICS MAJOR REQUIREMENTS

COURSE CODE	COURSE TITLE
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<b>Gateway courses:</b>	The necessary foundation for the physics major.
PHYS113	General Physics I

PHYS116 and PHYS124	General Physics II and General Physics Laboratory II
MATH221 or MATH223	Vectors and Matrices or Linear Algebra
MATH222	Multivariable Calculus

**Core Courses:** Four required courses which must be taken graded (A-F)

PHYS213	Waves and Oscillations
PHYS214 (prerequisite MATH221 or MATH223. Math requirement can be taken concurrently)	Quantum Mechanics I
PHYS324 (prerequisite PHYS124 and MATH222)	Electricity and Magnetism
PHYS316	Thermal and Statistical Physics

**Electives:** Four credits from the following list of lecture courses. \* **One of the four needs to be a 300-level physics course.**

PHYS207	Introduction to Biophysics
PHYS215 (half credit)	Special Relativity
PHYS217	Nonlinear Dynamics and Chaos
PHYS219 (half credit)	Introduction to Contemporary Physics
PHYS313	Classical Dynamics
PHYS315	Quantum Mechanics II
PHYS358 (Pre-requisite PHYS315)	Condensed Matter Physics

**Laboratory Courses:\*\*** Two laboratory courses

PHYS342 (half credit)	Experimental Optics
PHYS345 (half credit)	Electronics Lab
PHYS340 (half credit)	Computational Physics
PHYS423/PHYS424 (1 credit)	Research Seminar, Undergraduate

\* It is possible for elective credits to be substituted by upper-level lecture courses in other departments. This must be done in consultation with the physics major advisor, and the selections must constitute a coherent, coordinated program of study. Preapproved tracks that satisfy the elective lecture course requirement are available.

\*\* One of the laboratory courses must be an advanced experimental lab, currently either PHYS342 or PHYS345.

## COURSES FOR NON-MAJORS

The Physics Department offers two two-semester survey courses covering many of the main subject areas of physics (mechanics, electromagnetism and optics, thermodynamics, and kinetic theory). PHYS111/PHYS112 uses less calculus and is often the choice for students studying physics for life science applications. PHYS113/PHYS116 uses more calculus and is the foundation for future work in physics, engineering, and related fields. Associated laboratory courses, PHYS121/PHYS122/PHYS123/PHYS124, are also offered. Either of these two-semester course sequences (with the lab) should satisfy the physics requirement for admission to most schools of medicine, dentistry, or architecture, but occasionally schools require the calculus-based series, so attention to these details is necessary.

## GENERAL EDUCATION

There are no General Education requirements imposed by the Physics Department for either the physics major or honors in physics; the Department strongly encourages students to fulfill the Wesleyan expectation.

## STUDENT LEARNING GOALS

The course of study leading to the BA in physics is designed to provide students the skills to extend the description of natural phenomena to include the precision and predictive qualities of mathematics. Proficiency with these skills in the main subject areas of physics, along with the appreciation of experimental observation through research, are the twin goals of the physics program. The major program is designed to develop competency in quantum theory, electromagnetism and optics, thermodynamics and statistical mechanics, classical dynamics, and condensed-matter physics. Preparation in mathematical and computational methods is an integral part of the program.

## STUDY ABROAD

The Physics Department encourages study abroad as an opportunity to provide our majors an appreciation of their potential as citizens of the world scientific community. Careful planning in consultation with a physics advisor is recommended to determine the optimum semester for a study abroad experience to ensure that requirements for the major can be fulfilled.

More information on study abroad ([https://www.wesleyan.edu/physics/about/study\\_abroad.html](https://www.wesleyan.edu/physics/about/study_abroad.html)) can be found on the physics website as well as under programs (<https://www.wesleyan.edu/physics/about/Study%20Abroad%20-%20list%20of%20programs.html>) for a list of study abroad options that are most compatible with physics.

## ADVANCED PLACEMENT

Students may receive a maximum of two physics AP credits; one with a score of 5 on the AP Physics C, Mechanics exam, and one with a score of 5 on the AP Physics C, Electricity and Magnetism exam, though special regulations apply with regard to other physics credits. Please check with the registrar or a departmental advisor.

## PRIZES

**Bertman Prize** - Awarded to a senior majoring in physics who emulates the qualities that made Bud Bertman a valuable friend and respected colleague, e.g., physical insight and intuition, enthusiasm, resourcefulness, perseverance, and eagerness to help others.

**Van Dyke Prize** - Awarded to students majoring in physical science who show outstanding academic achievement and a promise of productivity in a professional career.

**Outstanding Contribution to Science Education Award** - Awarded to a senior who has demonstrated exceptional skills as an undergraduate course assistant.

**Johnston Prize** - In recognition of those first-year students or sophomores whose performance in their first two semesters of physics shows exceptional promise.

## TRANSFER CREDIT

Up to two outside credits for physics courses may be applied toward the physics major from another institution. Prior permission must be obtained from both your physics advisor and the departmental liaison Professor Brian Stewart (bstewart@wesleyan.edu) to ensure creditability of the specific courses.

## RELATED PROGRAMS OR CERTIFICATES

**Dual-degree programs in science and engineering.** Wesleyan maintains dual-degree programs with Columbia University, the California Institute of Technology, and Dartmouth College for students wishing to combine the study of engineering with a broad background in the liberal arts. For all options, participating students receive two degrees: a BA from Wesleyan and a BS or BE in engineering from our partner school. In the most popular option, the so-called 3-2 program, students spend their first three years at Wesleyan, followed by two years at the engineering school. Only at the end of the fifth year and after completing all degree requirements from both schools do students receive the two bachelor degrees. During the first three years, prospective 3-2 students complete the minimal requirements of their elected Wesleyan major and, in addition, fulfill science and mathematics requirements for the first two years of the engineering school and engineering major of their choice. During the two years at the engineering school, students follow the regular third- and fourth-year curriculum in whatever field of engineering they selected. During that time, other courses may also have to be taken to satisfy the degree requirements of Wesleyan and/or the engineering school.

**Two other options exist to pursue an engineering degree.** For Columbia University, the so-called 4-2 option allows students to complete four years at Wesleyan before pursuing the engineering degree. Otherwise, requirements are the same as those for the 3-2 program. Dartmouth offers a so-called 2-1-1-1 option in which students spend their junior year at Dartmouth, return to Wesleyan for their senior year and graduation, and then spend the fifth year to finish the engineering degree. Contact the dual-degree advisor for further information. Please also consult with your class dean to ensure that you can meet all Wesleyan University requirements for graduation.

**Certificate Program in Informatics and Modeling.** The Certificate Program in Informatics and Modeling enhances student choices and options and is an ideal supplement for interested physics majors. The certificate program provides students with a coherent set of courses and practical instruction in two pathways: (1) integrative genomics science and (2) computational science and quantitative world modeling.

## ADDITIONAL INFORMATION

**Colloquia** - This series of seminars features distinguished scientists from other institutions and/or the workplace who present lectures on their research findings. One objective of these seminars is to relate material studied in courses, tutorials, and research to current scientific activity. These seminars are usually held on Thursdays at noon in Exley 058 and are open to all members of the University community. Undergraduates are especially welcome.

**Society of Physics Students (SPS)** - Wesleyan's SPS is a chapter of a national association of undergraduates who are interested in sharing their physics experience with others. They meet to support each other in the scientific community, plan events each semester to bring the department members

together, and plan community outreach activities. Chapter Mentor: Professor George Paily (gpaily@wesleyan.edu)

## BA/MA PROGRAM

This is a curricular option for those students who, along with their research mentor, desire an intensive research experience that an additional year of study can afford. During the additional year, the student will complete additional coursework and write an MA thesis based on original research. Students interested in this possibility should consult their research mentor as early as possible.

## HONORS

To be a candidate for departmental honors in physics, a major must submit a thesis describing the investigation of a special problem carried out by the candidate under the direction of a member of the Physics Department. In addition, the candidate must have attained a minimum average in the eight lecture courses applied to the major, except those taken in the final semester of the senior year, of B (85.0) for honors and B+ (88.3) for high honors. Honors status is voted by the faculty on the basis of the student's thesis work.

## CAPSTONE EXPERIENCE

The Physics Department offers the following capstone experiences:

- Two-semester senior thesis
- Seminar in atomic and molecular physics (PHYS507/PHYS508)
- Seminar in condensed matter physics (PHYS505/PHYS506)
- Seminar in theoretical physics (PHYS509/PHYS510)