Physics and Physics Courses

What is physics?

Physics is concerned with the most basic principles that underlie phenomena in the universe. Physicists ask: "How do things work?" Physicists seek understanding of the behavior of collections of particles ranging from quarks in nuclei and electrons in atoms to stars in galaxies; they strive for insights into the nature of space and time; and they explore the behavior of matter and energy. On a more human scale, physicists explore the behavior of matter and energy including devices of modern electronics, complex biological molecules, the atmosphere, and forms of energy and its uses. The principles of physics are the basis for much of engineering and technology. Studying physics can prepare students to push back the boundaries of knowledge in this most fundamental of the natural sciences; it can provide invaluable training in the concepts and methods of science for application in many professional areas; it can develop one's capacity for clear analytical thought that is crucial in many fields, or it can simply increase one's knowledge and appreciation of the wonders of the world around us.

Overview of Courses Sequences in Introductory Physics

The Physics Department offers a wide range of courses and course sequences in introductory physics available to students with no previous preparation in physics. Most physics majors take PHYS 1420/2410 (Introductory Physics 1/2). Most engineering students take PHYS 1425/2415 (Introductory Physics for Engineers 1/2). Most students on the pre-health track fulfill the requirements of Medical School with PHYS 2010/2020 (Principles of Physics for Pre-Health Students 1/2). Chemistry, biology or Environmental Science majors are found in all of those, depending on the importance of a comprehensive physics background in their specialization. All of these Introductory Physics courses are accompanied by workshops to gain hands-on experience.

Introductory Physics Courses that satisfy pre-health requirements

The two-semester sequence, PHYS 2010-2020, provides a comprehensive introduction to physics without the use of calculus. These courses, together with the workshops PHYS 2030-2040, satisfy the usual requirements of medical schools. This sequence is normally taken by students who do not expect to take more advanced courses in physics.

PHYS 2010, 2020 - Principles of Physics for Pre-Health Students [credits: 3,3] These courses provide an introduction to mechanics, heat, electricity and magnetism, optics and topics in modern physics. They do not require calculus, but they assume knowledge of algebra and

trigonometry. Taken with the associated laboratory courses, Physics 2030, 2040, they satisfy the physics requirements for medical and dental schools.

Introductory Physics Courses for Science and Engineering

The following course sequences provide a basis for taking more advanced courses in physics and for entering a physics major.

PHYS 1420, 2410 - Introductory Physics [credits: 3,3] This two-semester calculus-based sequence is designed to provide a broad background in introductory physics for potential physics majors. Calculus II and III (MATH 1320 and 2310) are taken concurrently with Physics 1420 and 2410, along with the associated workshop courses, PHYS 1419 and 2419. Topics covered in PHYS 1420/2410 include kinematics and Newton's laws, conservation principles, gravitation, frames of reference, thermodynamics, waves, sound and optics, and electricity and magnetism. PHYS 1420 and PHYS 2410 cover material similar to PHYS 1425 and PHYS 2415, but from a more fundamental perspective.

PHYS 1425, 2415 - Introductory Physics for Engineers [credits: 3,3] This is a two-semester calculus-based introductory sequence designed for engineering students, but also suitable for other science majors. It covers mechanics, electricity and magnetism, heat and thermodynamics, and optics. Calculus II and III are usually taken concurrently with PHYS 1425 and 2415. The workshops PHYS 1429 and 2419 are also usually taken concurrently with Physics 1425 and 2415. PHYS 1425 and PHYS 2415 cover material similar to PHYS 1420 and PHYS 2410, but from a more applied perspective.

Students desiring a third course covering modern physics (special relativity, quantum physics, atomic and nuclear physics) should enroll in PHYS 2620. There is a brochure about physics as a second major for engineering students.

PHYS 2620 - Modern Physics [credits: 4] This course introduces the basic concepts of special relativity and quantum theory, with application to atomic structure, nuclear and elementary particle physics, condensed matter physics, and cosmology. It is usually taken concurrently with differential equations (MATH 3250). Modern Physics is a prerequisite for most of the more advanced courses in physics.

PHYS 2720 - Problem Solving and Special Topics in Classical Physics [credits: 2] This course uses the content of Introductory Physics 1 and 2 as the basis for developing improved problem-solving skills using more advanced mathematical techniques. It also introduces new applications in mechanics, fluids, thermodynamics, electromagnetism, waves, and optics. It is usually taken concurrently with differential equations (MATH 3250).

Courses for Non-Science Majors

There are five courses (PHYS 1010, 1050, 1060, 1090 and 1110) intended particularly for students who are majoring in disciplines other than physical science. All of them stand alone, that is, they don't require other physics or mathematics courses as pre- or corequisites. All of them count toward the College science requirement and all of them use only high-school mathematics.

PHYS 1010 – The Physical Universe [credits: 3] Science is becoming more and more central to our everyday life. In this course we prepare non-scientists to deal with this changing world, both at home and on the job, and to make informed choices about our environment. We hope students will experience the joy of understanding the few great principles upon which the physical sciences are based. PHYS 1010 requires limited math, but has wide applications in areas like electronics, wifi, rockets, satellites, nuclear reactors, lasers, climate change, earthquakes, the tides, eclipses, plate tectonics, fossil fuels, telescopes, solar energy, and the origin of universe. We help students come to appreciate science as a crowning achievement of the human mind that allows us to understand and shape our world.

PHYS 1050, 1060 - The Physics of How Things Work [credits 3,3] A practical introduction to physics and science in everyday life. These two courses consider objects from our daily environment and focus on their principles of operation, history and relationships to one another. In contrast to most physics courses, which are taught from the perspective of the basic laws of physics, these courses begin with the examples and develop the physical principles in the context of the examples. The courses can be taken in either order.

PHYS 1110 - Energy on our world and elsewhere [credits: 3] This course explores the concept of energy from a physicist's perspective. The course begins by examining the different forms that energy can assume, and then moves on to examine the role that energy plays in our society. Topics will include the impact of energy on space travel and the potential colonization of space. Physics 1110 is meant for students at all levels who are interested in science but wish to limit the mathematics.

PHYS 1130 – Physics of Sports [credits: 3] A study of the physics concepts behind the motion of spinning and curving projectiles in worldwide sports such as soccer, tennis, basketball, baseball, football, etc. and rolling and sliding balls/disks along a flat surface. Basic explanations include utilizing kinematics, gravity, friction, air flow, and Newton's Laws. Learn about hang time, topspin, dimples, drag crisis, sideways forces, least energy launch angle, jumping, and crouching.

What are we teaching you?

Goals for our course offerings for physics majors are …

1. … to stimulate curiosity, questions, and careful analytical thinking about the nature of the physical universe.
2. … to convey some knowledge of the enormous range of physical phenomena, familiarity with techniques for quantifying them, and the role of observations, experiments, and measurements as the basis for understanding them.
3. … to have students understand and use the concepts and theories that have been developed to summarize this vast array of experiences and to predict the outcome of future experiments.
4. … to convey a sense of the unity and beauty of physics, and of the historical context of our present understanding.
5. … to show students the research frontiers in physics, and to have them experience some of the enjoyment and excitement of discovering new knowledge through experiments and theory and thus prepare them for graduate studies in the physical sciences.
6. … to have students appreciate the role of science in modern society and the relationship of science and technology.
7. … to provide the requisite critical and analytical thinking backgrounds that prepare students for careers in diverse environments, such as high-tech industries, national research laboratories, government, and financial institutions.

Majoring in Physics

To serve the wide range of interests of physics majors, the department offers both a BA degree and a BS degree in Physics, and jointly with the Astronomy Department a BS degree in Astronomy/Physics.

The first course you should consider taking is PHYS 1930, which describes how the major works, what research opportunities are available, and what careers the major can prepare you for. The major itself begins with a two-semester sequence in introductory physics, PHYS 1420/2410, and the laboratory sequence PHYS 1429/2419. Most students who plan to major in physics begin with PHYS 1420 and PHYS 1429 in their second semester. If you did not take calculus in high school, you should take MATH 1310 in your first semester, and in any case continue with MATH 1320 and MATH 2310.

In place of the PHYS 1420/2410 sequence, it is possible to substitute the engineering physics sequence PHYS 1425/2415. These courses are both offered every semester and over the summer, making this substitution useful if you are starting the major in your second year. Alternatively, if you have placement or transfer credit, you can jump ahead in the schedule. If so, talk to a physics major advisor.

The BA degree is designed for students interested in physics and planning to enter professional schools in business, education, law, and medicine, and for liberal arts students desiring a strong background in physical science but with career objectives in other areas. A centerpiece of the BA program for many students are the electives PHYS 3110 (Widely Applied Physics), PHYS 3120 (Applied Physics: Energy), and PHYS 3140 (Intermediate Lab). These courses develop the principles and practice of physics from the perspective of modern applications.

The BS degree is designed for students planning graduate study in physics or related fields, or preparing to enter careers in a science or technology. The Astronomy/Physics BS degree offers similar preparation with special emphasis on astrophysics. Special concentrations are available in computational physics, experimental physics or optics.

Detailed requirements and typical course sequences for these degrees can be found at www.phys.virginia.edu/Education/Programs/MajorBrochure/. A printed version is available in the Physics department office, room 101, Physics Building. If you are considering a major in physics, you are encouraged to contact a physics major advisor before you start taking courses.

Many of our majors participate in our local Society of Physics Students chapter. SPS organizes weekly meetings with special talks by physics researchers from UVa and other institutions. There are also presentations giving advice and information about graduate and professional schools, and about careers in science. At each meeting there are refreshments and time for students to meet with each other and with the faculty members who are presenting. Membership in SPS is open to any student interested in physics. In addition, you may be nominated to join the honor society Sigma Pi Sigma, which recognizes special academic achievement.

If you have questions about physics courses, programs, advising, or are curious about how a physics major may fit your interests, please contact one of the physics undergraduate advisors listed below to learn about the various possibilities and to design a program to fit your specific needs. We invite you to visit the department. You can declare a physics major at any time during your studies. Even before the major declaration, contacting an advisor or lecturer might be helpful to discuss the majors, the course sequence, or to find opportunities for your own research.