Physics
NATURAL SCIENCES DIVISION

Faculty

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Physics is the study of the most basic principles of nature that describe the world around us, from the subatomic particles to the motion of everyday particles to the galaxies and beyond. Courses in physics allow students to develop a sound knowledge of these principles, as well as the analytical and experimental techniques necessary to apply them to a broad range of theoretical and experimental problems.

The Physics Curriculum

The Department of Physics offers three options for students wishing to begin their exploration of physics. Look for the ◆ symbol, which designates those courses particularly appropriate for first-year students or upperclass students new to the physics department curriculum.

Students who want a less mathematical approach to interesting subfields of physics should consider PHYS 101 (Natural Philosophy), PHYS 103 (Fundamentals of Modern Electronics), PHYS 105 (Unifying Ideas in Physics), PHYS 106 (Astronomy: Planets and Moons), or PHYS 107 (Astronomy: Stars and Galaxies). These courses are suitable for diversification in the sciences and are accessible to any Kenyon student. All contain some laboratory sessions in which students become familiar with the phenomena discussed in lectures.

The second option is PHYS 130 (111) and 135 (112) (General Physics I and II). PHYS 130 and 135 constitute a general survey of physics designed primarily for students who will take only one year of physics. There is a weekly laboratory that makes extensive use of computers for data acquisition and analysis.

The third option is PHYS 140 (115) (Classical Physics) and PHYS 145 (116) (Modern Physics), which, together with PHYS 240 (223) (Fields and Spacetime), form a calculus-based introduction to the fundamentals of physics. These courses are more analytical than PHYS 130 and 135 and treat topics in greater depth. PHYS 140 and PHYS 145 are particularly suitable for students who plan to take more physics or upper-level chemistry or mathematics courses. PHYS 140 and 145 are required for all physics courses with higher numbers. They require current enrollment in or credit for calculus. There is a weekly laboratory that makes extensive use of computers for data acquisition and analysis.

Students who have an unusually strong background in high-school physics, or who receive high scores on the Advanced Placement C-level Physics Examination, should consider beginning their study of physics with PHYS 240 (Fields and Spacetime). Placement in this course is done in consultation with the instructor and chair of the department.

Requirements for the Major

The program for a major in physics consists of the following:

- PHYS 140 (115); 141; 145 (116); 146; 240 (223); 241; 245 (224); 246; 280 (231); 281; 480; 481 (445). PHYS 130 (111) and 135 (112) may be substituted for PHYS 140 and 145 with permission of the department chair.

- One additional unit selected from physics courses numbered above 320 and including PHYS 340 (335); PHYS 350 (332); or 360 (441).

- MATH 111; 112; 221; either 224 or 333.

Additional physics courses may be elected. A student preparing for graduate study in physics should enroll in several advanced physics courses in addition to the minimum requirements and may wish to take further work in mathematics and chemistry. Honors work in physics involves directed research on a specific topic in experimental physics, theoretical physics, or the history of physics, culminating in a written thesis, an oral presentation to a departmental colloquium, and an examination by an outside specialist. The Senior Exercise includes a talk on a topic in physics given at a department colloquium.

Requirements for the Minor

The department offers two minors, physics and astronomy. Students considering one of these minors should work with a faculty member in
the physics department as the minor is being planned, since some courses are not offered every year.

Requirements for the Physics Minor
The program for a minor in physics consists of the following:

- PHYS 140; 141; 145; 146; 240; 241. PHYS 130 and 135 may be substituted for 140 and 145 with permission of the department chair.
- One additional unit selected from physics courses numbered above 241.

This minor is open to students with all majors, but may be especially attractive to students in disciplines that have strong ties to physics, such as chemistry, mathematics, and biology. Other combinations of introductory courses may also be acceptable. Note: All courses in physics numbered above 241 have as prerequisites PHYS 140 (115), 141, 145 (116), 146, and MATH 111 (11) and 112 (12), unless otherwise noted.

Requirements for the Astronomy Minor
The program for a minor in astronomy consists of the following:

- PHYS 130 and 135 or 140 and 145; 141; 146; 106; 107.
- An additional 1/2 unit selected from all physics courses (see suggestions below).

There are several options for the choice of the fifth course. PHYS 240, 241 (Fields and Spacetime) and PHYS 245, 246 (Oscillations and Waves) provide further experience with the foundations of physics (note that these two courses have prerequisites in mathematics). Students with interests in instrumentation can choose PHYS 280, 281 (Electronics). Other options may include Independent Study and Special Topics courses related to astronomy.

Year Course
Senior Honors
PHYS 497-498 (1 unit)
Staff
This course offers guided experimental or theoretical research for senior honors candidates. Prerequisite: permission of department chair.

First-Semester Courses

Natural Philosophy
- QR PHYS 101 (1/2 unit)
Greenslade
This is a lecture course with evening laboratories. The course is designed for nonscience majors who wish to study topics in acoustics and optics. It starts with general discussions of oscillations and waves, and then applies these ideas to a number of examples, including human vision and hearing, cameras, theater lighting instruments, optical illusions, and architectural and musical acoustics. These are placed in historical contexts when appropriate.

The text for the course is College Physics, by Franklin Miller Jr. Required work includes two examinations, regular problem assignments, and a paper relating course material to an area of interest to the student. No prerequisite.

Classical Physics
- QR PHYS 140 (1/2 unit)
Sullivan
This lecture course is the first in a three-semester, calculus-based introduction to physics. Topics include the kinematics and dynamics of particles and solid objects, work and energy, linear and angular momentum, gravitational, electrostatic, and magnetic forces, and usually the theory of single, direct-current circuits as well. PHYS 140, 145, and 240 are recommended for students who may wish to major in physics, and are also appropriate for students majoring in other sciences and mathematics.

The course will include weekly homework assignments and three exams. Prerequisite: trigonometry. Co-requisite: PHYS 141 and MATH 111 or 112 taken concurrently, or equivalent. (While calculus is a co-requisite, we will develop the necessary mathematical tools in our lectures as well.) PHYS 140 is open only to first- and second-year students, or by permission of the instructor.

Introduction to Experimental Physics I
- QR PHYS 141 (1/4 unit)
Staff
This lecture and laboratory course is required for all students enrolled in PHYS 130 or 140, and is a prerequisite for all physics courses numbered above 141. The course meets one afternoon each week and is organized around weekly experiments which demonstrate the phenomena of classical mechanics, including projectile motion, rotation, electrical circuits and fields, and conservation of energy and momentum. Lectures cover the theory and instrumentation required to understand each experiment. Experimental techniques emphasize computerized acquisition and analysis of video images to study motion. Students are introduced to computer-assisted graphical and statistical analysis of data as well as the analysis of experimental uncertainty. Enrollment is limited to sixteen students in each of four sections. Co-requisite: Phys 130 or 140.

Fields and Spacetime
QR PHYS 240 (1/2 unit)
Schumacher
This lecture course is the third semester of the calculus-based introductory sequence in physics, which begins with PHYS 140 (115) and PHYS 145 (116). Topics covered include electric charge, electric and magnetic fields, electrostatic potentials, Ampere’s law, electromagnetic induction, Maxwell’s equations in integral form, electromagnetic waves, the postulates of the special theory of relativity, relativistic kinematics and dynamics, and the connections between special relativity and electromagnetism.
This course may be an appropriate first course for students with advanced placement in physics or two years of high-school physics; such students should contact the chair of the physics department. Prerequisites: PHYS 140 (115) and 141 or equivalent and MATH 111 (11). Co-requisite: PHYS 241.

Fields and Spacetime Laboratory

QR PHYS 241 (1/4 unit)
Schumacher

This lecture and laboratory course is required for all students enrolled in Physics 240, and is a prerequisite for all physics courses numbered above 241. The course meets one or two afternoons each week and is organized around weekly experiments demonstrating various phenomena associated with electric and magnetic fields. Lectures cover the theory and instrumentation required to understand each experiment. Laboratory work emphasizes computerized acquisition and analysis of data, the use of a wide variety of modern instrumentation, and the analysis of experimental uncertainty. Prerequisite: PHYS 140 and 141 or equivalent. Co-requisite: PHYS 240.

Classical Mechanics

QR PHYS 340 (1/2 unit)
Peris

This is an analytic course in physical mechanics. Topics include the general theory of Newtonian mechanics, fluid statics and dynamics, rigid body motion, Lagrangian mechanics, and Hamiltonian mechanics. Prerequisites: PHYS 245 (224) and MATH 221 (21).

Electricity and Magnetism

QR PHYS 350 (1/2 unit)
Sullivan

This course covers the classical theory of the electromagnetic field. Topics include vector analysis, calculation of static fields from source distributions, time-dependent fields, electromagnetic radiation, and the electric and magnetic properties of matter. Prerequisites: PHYS 245 (224) and MATH 221 (21) (may be taken concurrently).

Research Methods for Experimental Physics

QR PHYS 480 (1/4 unit)
Turner

This lecture course is a prerequisite for the physics major. It presents the theory, instrumentation, and statistical analysis of data needed to prepare students for the experiments performed in Experimental Physics (PHYS 481). Topics are selected from many fields of physics and are currently drawn from nuclear physics, solid state physics, x-ray physics, optics, thermodynamics, and nuclear magnetic resonance. Understanding the physics behind the operation of detectors, lock-in amplifiers, analog-to-digital converters, and other modern instrumentation is stressed. Co-requisite: PHYS 481 and senior standing.

Experimental Physics

QR PHYS 481 (1/2 unit)
Turner

This advanced course in experimental physics includes extensive laboratory work and methods of data analysis. Students will gain experience with nuclear detection equipment, x-ray diffraction and fluorescence techniques, noise reduction using phase-sensitive detection, computer data acquisition and analysis, and Fourier techniques in optics. Prerequisites: PHYS 245 (224), 280 (231), and senior standing. Co-requisite: PHYS 480.

Individual Study

PHYS 493 (1/2 unit)
Staff

The student may conduct special experimental or theoretical work on advanced topics in physics. Prerequisites: permission of instructor and department chair.

Second-Semester Courses

Geology

• PHYS 108 (1/2 unit)
Holdener

The course will survey physical geology topics, placing emphasis on how these support the modern theory of plate tectonics. Topics will include matter, minerals, and rocks; surveys of environments, their major processes and features, and how these influence the physical world and can be recognized in the rock record; the history of the development of plate tectonic theory; and the major supporting evidence for plate tectonics, including seismicity and earthquakes, volcanism and plutonic activity, orogenesis and structural geology, and geomagnetism and paleogeographic reconstruction. We will build these ideas in a global context and apply them to the geologic history of the North American continent. The course will consist of lecture and laboratory exercises plus required field trips. Some evening lab sessions will be required. No prerequisites.

General Physics II

• QR PHYS 135 (1/2 unit)
Turner

This course focuses on a wide variety of physics topics relevant to students in the life sciences. Topics will include electric and optical devices, fluids, waves, atomic physics, X-rays, radioactivity, and nuclear physics. When possible, examples will relate to life-science contexts. The course will be taught using a combination of lectures, in-class exercises, homework assignments, and three examinations. Prerequisites: PHYS 130 (11) or 140 (115). Co-requisite: PHYS 146.

Modern Physics

• QR PHYS 145 (1/2 unit)
Schumacher

This lecture course is a calculus-based introduction to the physics of the twentieth century. Topics include geometrical and wave optics, special relativity, photons, photon-electron interactions, elementary quantum theory (including wave-particle duality, the Heisenberg uncertainty principle, and the time-independent Schrödinger equation), atomic physics, solid-state physics, nuclear physics, and elementary particles. PHYS 145 (116) is recommended for students who may wish to major
in physics, and is also appropriate for students majoring in other sciences or mathematics. There will be two or three midterm exams and weekly problem assignments. Prerequisite: PHYS 140 (115) and MATH 111 (11) and or permission of the instructor. Co-requisite: PHYS 146 and MATH 112 (12) taken concurrently or equivalent.

Introduction to Experimental Physics II

QR PHYS 146 (1/4 unit)
Staff

This lecture and laboratory course is required for all students enrolled in Physics 135 or 145, and is a prerequisite for all physics courses numbered above 146. The course meets one afternoon each week and is organized around weekly experiments demonstrating the phenomena of waves, optics, x-rays, and atomic and nuclear physics. Lectures cover the theory and instrumentation required to understand each experiment. Experimental techniques include the use of lasers, x-ray diffraction and fluorescence, optical spectroscopy, and nuclear counting and spectroscopy. Students are introduced to computer-assisted graphical and statistical analysis of data, and the analysis of experimental uncertainty. Enrollment is limited to sixteen students in each of four sections. Co-requisite: PHYS 135 or 145.

Oscillations and Waves

QR PHYS 245 (1/2 unit)
Peiris

The topics of oscillations and waves serve to unify many subfields of physics. This course begins with a discussion of damped and undamped, and free and driven, mechanical and electrical oscillations. Oscillations of coupled bodies and normal modes of oscillations are studied along with the techniques of Fourier analysis and synthesis. We then consider waves and wave equations in continuous and discontinuous media, both bounded and unbounded. The course may also treat properties of the special mathematical functions that are the solutions to wave equations in various coordinate systems. Prerequisite: PHYS 240 (116) or equivalent or permission of instructor. Co-requisite: PHYS 246 and MATH 221 (21)

Optics

QR PHYS 355 (1/2 unit)
Peiris

The course begins with a discussion of the wave nature of light. The remainder of the course is concerned with the study of electromagnetic waves and their interactions with lenses, apertures of various configurations, and matter. Subjects include the properties of waves, reflection, refraction, interference, and Fraunhofer and Fresnel diffraction, along with Fourier optics and coherence theory. Prerequisite: PHYS 350 (332) or consent of the instructor.

Mechanics

QR PHYS 370 (1/2 unit)
Sullivan

This introduction to classical thermodynamics and statistical mechanics focuses on how microscopic physical processes give rise to macroscopic phenomena—for example, how the dynamics of atoms and molecules can explain the large-scale behavior of gases. Prerequisites: PHYS 245.

Individual Study

PHYS 494 (1/2 unit)
Staff

The student may conduct special experimental or theoretical work on advanced topics in physics. Prerequisites: permission of instructor and department chair.
The following courses will be offered in 2002–2003:

PHYS 107  Astronomy: Stars and Galaxies
PHYS 218  Dynamical Systems and Scientific Computing
PHYS 360  Quantum Mechanics
PHYS 365  Atomic and Nuclear Physics
PHYS 492  Special Topics in Physics
PHYS 493, 494  Individual Study
PHYS 497-498  Senior Honors