

PHYSICS (PHYS)

PHYS 100 Concepts and Questions in Physics (4 Credits)

An exploration of significant questions, concepts, theories and discoveries in physics and astronomy for first-year students. Although topics vary, the courses also seek to improve students' communication skills beyond the written word.

College Curriculum: C100

PHYS 101 General Physics-Lecture (0 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. PHYS 101-102 is a two-semester calculus-based sequence designed to develop an understanding of the fundamental concepts of physics for students considering majoring in one of the sciences or mathematics. Emphasis in Physics 101 is placed upon Newtonian mechanics and applications. Co-registration in the laboratory PHYS 101L is not required, but strongly encouraged. Students may receive credit for only one of PHYS 101, 101H, or 107.

Corequisite(s): PHYS 101P

Domain: NQR

PHYS 101H General Physics I - Honors (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. PHYS 101H is an honors section of PHYS 101 that is open to students who have a good preparation for and a strong interest in physics. Physics 101H offers a more in-depth treatment of topics covered in PHYS 101, and includes more sophisticated examples. Prior exposure to calculus will be assumed. Co-registration in the laboratory PHYS 101L is not required, but strongly encouraged. Students may receive credit for only one of PHYS 101, 101H, or 107.

Prerequisite(s): MATH 111

Domain: NQR

PHYS 101L General Physics-Lab (1 Credit)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. Laboratory techniques in general physics.

Prerequisite(s): PHYS 101 (may be taken concurrently) or PHYS 101P (may be taken concurrently) or PHYS 101H (may be taken concurrently)
Additional fees apply

PHYS 101P General Physics I (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. PHYS 101-102 is a two-semester calculus-based sequence designed to develop an understanding of the fundamental concepts of physics for students considering majoring in one of the sciences or mathematics. Emphasis in Physics 101 is placed upon Newtonian mechanics and applications. Co-registration in the laboratory PHYS 101L is not required, but strongly encouraged. Students may receive credit for only one of PHYS 101, 101H, or 107.

Prerequisite(s): MATH 111 (may be taken concurrently) or MATH 131 (may be taken concurrently)

Corequisite(s): PHYS 101

Domain: NQR

PHYS 102 Gen Physics-Lecture (0 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. PHYS 101-102 is a two-semester calculus-based sequence designed to develop an understanding of the fundamental concepts of physics for students considering majoring in one of the sciences or mathematics. Emphasis in Physics 102 is placed upon thermodynamics, electricity and magnetism, waves, optics, and applications. Co-enrollment in the laboratory PHYS 102L is strongly encouraged. Students may receive credit for only one of PHYS 102, 102H, or 108.

Prerequisite(s): (PHYS 101 or PHYS 101H or PHYS 101P) and (MATH 112 (may be taken concurrently) or MATH 132 (may be taken concurrently))

Corequisite(s): PHYS 102P

Domain: NQR

PHYS 102H General Physics II - Honors (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. PHYS 102H is an honors section of PHYS 102 that is open to students who have a good preparation for and a strong interest in physics. Physics 102H offers a more in-depth treatment of topics covered in PHYS 102, and includes more sophisticated examples. Prior exposure to calculus will be assumed. Co-registration in the laboratory PHYS 102L is not required, but strongly encouraged. Students may receive credit for only one of PHYS 102, 102H, or 108.

Prerequisite(s): (PHYS 101 or PHYS 101H or PHYS 101P) and (MATH 112 or MATH 132)

Domain: NQR

PHYS 102L General Physics-Lab (1 Credit)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. Laboratory techniques in general physics.

Prerequisite(s): PHYS 101L and (PHYS 102 (may be taken concurrently) or PHYS 102P (may be taken concurrently) or PHYS 102H (may be taken concurrently))

Additional fees apply

PHYS 102P General Physics II (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. PHYS 101-102 is a two-semester calculus-based sequence designed to develop an understanding of the fundamental concepts of physics for students considering majoring in one of the sciences or mathematics. Emphasis in Physics 102 is placed upon thermodynamics, electricity and magnetism, waves, optics, and applications. Co-enrollment in the laboratory PHYS 102L is strongly encouraged. Students may receive credit for only one of PHYS 102, 102H, or 108.

Prerequisite(s): (PHYS 101P or PHYS 101 or PHYS 101H) and (MATH 112 (may be taken concurrently) or MATH 132 (may be taken concurrently))

Corequisite(s): PHYS 102

Domain: NQR

PHYS 107 Physics for the Life Sciences I (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. PHYS 107-108 is a two-semester algebra-based sequence designed to cover the fundamental concepts of physics for students in the life sciences, including pre-meds. Emphasis is placed on Newtonian mechanics, fluids and waves. High school science as well as algebra and trigonometry are assumed. Co-registration in the laboratory PHYS 107L is not required, but strongly encouraged. Students may receive credit for only one of PHYS 101, 101H, or 107.

Domain: NQR

PHYS 107L Physics for the Life Sciences I Lab (1 Credit)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. Laboratory techniques in physics for the life sciences.

Prerequisite(s): PHYS 107 (may be taken concurrently)

Additional fees apply

PHYS 108 Physics for the Life Sciences II (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. PHYS 107-108 is a two-semester algebra-based sequence designed to cover the fundamental concepts of physics for students in the life sciences, including pre-meds. Emphasis is placed on thermodynamics, electric and magnetic fields, simple circuits, optics and some modern physics. High school science as well as algebra and trigonometry are assumed. Co-registration in the laboratory PHYS 108L is not required, but strongly encouraged. Students may receive credit for only one of PHYS 102, 102H, or 108.

Prerequisite(s): PHYS 107 or PHYS 107P

Domain: NQR

PHYS 108L Physics for the Life Sciences II Lab (1 Credit)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. Laboratory techniques in physics for the life sciences.

Prerequisite(s): PHYS 107L or PHYS 108P (may be taken concurrently) or PHYS 108 (may be taken concurrently)

Additional fees apply

PHYS 109 Practical Physics (3 Credits)

Bicycles, guitars, cameras and other ordinary objects are studied and explained to obtain an appreciation of the underlying laws of nature. Mechanics, wave motion, optics, acoustics, thermodynamics and some electromagnetism and nuclear/particle physics are discussed and demonstrated by understanding the functioning of objects of everyday experience. The required mathematics is limited to algebra. The associated laboratory is strongly encouraged but not required. Students may not receive credit for Physics 109 if taken after passing PHYS 101 or PHYS 107.

PHYS 110 Practical Physics Lab (1 Credit)

A series of experiments employing common objects of general, everyday experience is undertaken with the goal of understanding both the scientific method of measurement and the laws of nature. Student-generated projects will be encouraged.

Prerequisite(s): PHYS 109 (may be taken concurrently)

Additional fees apply

PHYS 121 Physics of Music (3 Credits)

Basic concepts of physics, particularly acoustics, needed for an understanding of the properties of sound and music. The course will be in the form of a workshop and students will participate in the performance of experiments which illustrate the ideas.

College Curriculum: C200

Domain: NQR

PHYS 150 First-Year Seminar (4 Credits)

An exploration of a specific topic in physics and astronomy. A grade of C- or better fulfills the COLL 150 requirement. Although topics vary, the courses emphasize academic writing skills, reading and analysis of texts, and discussion.

College Curriculum: C150

PHYS 155 Freshman Research (1-3 Credits)

Research opportunity for Freshmen having an unusually strong background in Physics. Students will work with an individual faculty member on a research project.

PHYS 171 Planetary and Stellar Astronomy (3 Credits)

This course is intended for anyone interested in learning about planetary and stellar astronomy. (Galactic astronomy and cosmology are covered in PHYS 172: Stellar and Galactic Astronomy and Cosmology.) In addition to our coverage of the scientific ground of the subject, we will also discuss the technological advances that have made major discoveries possible. Along the way, we will include two interludes of a week's duration each that will allow us to explore the wider historical context of the material, via exploration of historical periods that have important Astronomy events in them and also connections to Theater through analysis of the play "Galileo" by Bertolt Brecht and Copenhagen by Michael Frayn.

College Curriculum: C200

Domain: NQR

PHYS 172 Stellar and Galactic Astronomy and Cosmology (3 Credits)

Star classifications, stellar evolution and stellar remnants, distance scales in the universe, galactic structure and evolution, galactic superclusters. The past history of the universe and the experimental evidence for the big bang. The beginning and the end of the universe. Included will be discussions of the historical ramifications of the discoveries of the early 20th century and the philosophical implications of study of the beginning of the universe (or universes).

College Curriculum: C200

Domain: NQR

PHYS 175 Cosmology & History of Wonder (4 Credits)

The evolution of ideas about the structure and nature of the universe from the ancient world to the present. The rise of science, and its eventual separation from religion and philosophy, is explored through case studies of important astronomical discoveries.

Corequisite(s): PHYS 175D

PHYS 175D Cosmology & Hist of Wonder-Dis (0 Credits)

Cosmology and the History of Wonder Discussion

Corequisite(s): PHYS 175

PHYS 177 Astronomy Laboratory (1 Credit)

A series of experiments is undertaken with the goal of understanding both the scientific method of measurement and the laws of nature as they apply to astronomy.

Prerequisite(s): PHYS 171 (may be taken concurrently) or PHYS 172 (may be taken concurrently) or PHYS 176

Additional fees apply

Domain: NQR

PHYS 201 Modern Physics (4 Credits)

20th-century developments in physics. Relativity theory; the nature of space and time, the paradox of the twins, the equivalence of mass and energy. Introductory quantum theory; the particle nature of light, the wave nature of electrons, atomic and molecular structure, the structure of the nucleus and the discovery of new particles. This course is appropriate for all those majoring in science or mathematics.

Prerequisite(s): (PHYS 101 or PHYS 101H or PHYS 101P or PHYS 107) and (PHYS 102 or PHYS 102H or PHYS 102P or PHYS 108 or PHYS 108P)

College Curriculum: C200

Domain: NQR

PHYS 208 Classical Mechanics of Particles and Waves I (4 Credits)

The simple harmonic oscillator, coupled oscillations and normal modes, variational methods, Lagrangian and Hamiltonian mechanics, central forces. Overview of relevant mathematical methods. PRE-REQ: PHYS 201 with a grade of C- or better, and PRE or CO-REQ: MATH 212 or 213.

Prerequisite(s): PHYS 201 and (MATH 212 (may be taken concurrently) or MATH 213 (may be taken concurrently))

PHYS 212 Undergraduate Seminar (1 Credit)

Discussion of contemporary research in physics. Faculty members give survey talks during the first part of the semester. During the second part, students give talks based on their reading and research.

PHYS 213 Introduction to Modern Optics (3 Credits)

This course introduces the basic optics concepts and their applications, such as geometrical optics and optical instrumentation design; wave optics and interaction with matter; quantum optics and lasers. Connections to visual arts are explored and practiced.

Prerequisite(s): MATH 111

College Curriculum: C200

Domain: NQR

PHYS 251 Experimental Atomic Physics (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. Fundamental experiments in atomic physics. Modern scientific methods and instruments are used in such classic experiments as the measurement of the speed of light, the Millikan oil drop experiment, the photo-electric effect and optical spectroscopy.

Prerequisite(s): PHYS 201 (may be taken concurrently)

Domain: NQR

PHYS 252 Electronics (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. Introduction to electronics, with an emphasis on analog circuits. Theory, design, simulation, debugging, and application of circuits using passive and active components.

Prerequisite(s): PHYS 102 or PHYS 102P or PHYS 102H or PHYS 108 or PHYS 108P

Domain: NQR

PHYS 254 Introduction to Mathematical Physics (3 Credits)

Vector analysis, complex variables, matrices, series solutions of differential equations, orthogonal functions and partial differential equations.

Prerequisite(s): MATH 212 or MATH 213

PHYS 255 Sophomore Research (1-3 Credits)

Research opportunity for Sophomores having an unusually strong background in Physics. Students will work with an individual faculty member on a research project.

PHYS 256 Practical Computing for Scientists and Engineers (3 Credits)

This course will focus on breaking scientific problems into algorithmic pieces that can be solved using computational methods. Topics will include root finding, linear and non-linear equations, numerical modeling, optimization, random processes, graphical data presentation and fitting.

Prerequisite(s): CSCI 141 and (MATH 112 or MATH 132) and (PHYS 101 or PHYS 101H)

Domain: NQR

PHYS 301 Intro Mathematical Physics (3 Credits)

Vector analysis, complex variables, matrices, series solutions of differential equations, orthogonal functions and partial differential equations.

Prerequisite(s): MATH 212 or MATH 213

PHYS 302 Fluid Mechanics (3 Credits)

This course will provide a first introduction to the topic of fluid mechanics and dynamics. Topics that will be covered are properties of fluids, dimensional analysis, fluid statics, elementary fluid dynamics, conservation of mass and momentum, flows in different settings, geofluid concepts and aerodynamics. The impact of fluids on society will also be addressed.

Prerequisite(s): (PHYS 102 or PHYS 102P or PHYS 102H or PHYS 108) and (MATH 212 or MATH 213)

PHYS 303 Classical Mechanics of Particles and Waves II (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. Scattering, rigid body rotation, inertia tensor, noninertial frames, continuum mechanics and wave motion, special relativity, nonlinear dynamics and chaos.

Prerequisite(s): PHYS 208

PHYS 309 Undergraduate Seminar (1 Credit)

Discussion of contemporary research in physics. Faculty members give survey talks during the first part of the semester. During the second part, students give talks based on their reading and research.

PHYS 313 Quantum Mechanics I (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. Fundamentals of non-relativistic quantum mechanics, solutions of the Schrodinger equation in one and three dimensions, symmetry, identical particles.

Prerequisite(s): PHYS 201 and PHYS 208

PHYS 314 Quantum Mechanics II (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. Perturbation theory and other approximate methods, applications of quantum mechanics for atomic, solid state and nuclear physics.

Prerequisite(s): PHYS 313

PHYS 351 Scientific Instrumentation Laboratory (3 Credits)

Advanced scientific instrumentation is the second course on electronics. Students will learn to design and construction of digital circuits with computer-based control of digital devices used in electrical engineering design & development and experimental research. Python is the primary programming language. C++ maybe explored during the weekly labs and the final project stage.

Prerequisite(s): PHYS 252 and (PHYS 256 (may be taken concurrently) or CSCI 241 (may be taken concurrently))

PHYS 352 Experimental Modern Physics (2 Credits)

Experiments in atomic, nuclear, solid state and elementary particle physics.

Prerequisite(s): PHYS 251

PHYS 355 Junior Research (1-3 Credits)

Research opportunity for Juniors having an unusually strong background in Physics. Students will work with an individual faculty member on a research project.

PHYS 357 Careers in Physics (1 Credit)

Presentations and discussion of a wide spectrum of career options for physics graduates. Invited speakers from private enterprises, the public sector, and nonprofit organizations will describe opportunities and experiences in their professions.

PHYS 401 Electricity & Magnetism I (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. Development of the theory of electricity and magnetism including electrostatics, magnetostatics and Maxwell's equations.

Prerequisite(s): PHYS 208

PHYS 402 Electricity & Magnetism II (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. Continued development of the theory of electromagnetism, Maxwell's equations, electromagnetic waves and radiation, and special relativity.

Prerequisite(s): PHYS 401

PHYS 403 Statistical Mechanics and Thermodynamics (3 Credits)

A \$250 per credit fee will apply for students for whom initial enrollment at W&M begins in Fall 2025 or later. Introduction to quantum statistical mechanics and thermal physics. Definitions of accessible quantum states, entropy, free energy, temperature and partition function for noninteracting systems. Derivation and interpretation of the physical and thermodynamic properties of classical and quantum gases, solids, thermal radiation and diffusive equilibrium.

Prerequisite(s): PHYS 201

PHYS 404 Quantum Physics: Research Applications (3 Credits)

Applications of quantum physics to modern research topics. The course will focus on areas (to be determined by the instructor) such as : electronic and magnetic properties of solids, atomic and optical physics, or nuclear and particle physics.

Prerequisite(s): PHYS 313 and PHYS 314

Domain: NQR

PHYS 430 Quantum Optics and Atomics (3 Credits)

This course covers the core concepts and processes in quantum optics and atomic physics, including 2-level atoms, atom-light interactions, quantum coherence, and the quantized electromagnetic field. The course will also include topics in current research, such as laser cooling and trapping, quantum gases, electromagnetically induced transparency, quantum information science, quantum sensing, entanglement, and squeezing.

Prerequisite(s): (PHYS 313 and PHYS 314)

PHYS 432 Quantum Materials and Quantum Devices (3 Credits)

The course introduces the basic concepts and methods for the theoretical description of quantum materials and quantum devices. The first part of the course focuses on the electronic properties of quantum materials. In the second part, the concepts of qubit, quantum gate, and quantum sensor are introduced, along with examples of their implementation based on quantum materials.

Prerequisite(s): PHYS 313

PHYS 434 Plasma Physics (3 Credits)

This course provides an introduction to plasma physics, including where plasmas are found, avenues of current research, and computational methods in the field. The concepts of single particle motion, fluid equations, magnetohydrodynamics, and waves and instabilities are covered.

Prerequisite(s): (PHYS 302 and PHYS 401 (may be taken concurrently))

PHYS 436 Modern Astrophysics (3 Credits)

An introduction to modern astrophysics. Topics may include stellar characteristics and evolution, galactic structure, cosmology, general relativity and the tools and techniques of astronomy and astrophysics.

Prerequisite(s): (PHYS 313 and PHYS 401 (may be taken concurrently))

PHYS 438 Nuclear and Particle Physics (3 Credits)

This course provides an introduction to particle and nuclear physics. Topics include: global properties of nuclei, nuclear stability, nucleon structure, elastic and deep inelastic scattering from nuclei, QCD (quarks and gluons), quarkonia and other mesons, collider physics, weak interaction phenomenology, neutrino oscillations, weak bosons, and the Standard Model.

Prerequisite(s): PHYS 313 and PHYS 314

PHYS 439 General Relativity & Cosmology (3 Credits)

Introduction to general relativity, tensor analysis, gravitational field equations, gravitational waves, Schwarzschild and Kerr solutions, cosmological models, gravitational collapse. PHYS 402 recommended.

Prerequisite(s): PHYS 208 and PHYS 401

PHYS 451 Physics Research (1-3 Credits)

Independent study including bibliographic and experimental or theoretical research and a research paper. The student will be required to submit a preliminary draft of the research paper during the first semester and will be expected to work closely with an advisor both in the actual research and in preparation of an acceptable report. If satisfactorily completed, this course will meet the departmental writing requirement.

PHYS 452 Physics Research (1-3 Credits)

Independent study including bibliographic and experimental or theoretical research and a research paper. The student will be required to submit a preliminary draft of the research paper during the first semester and will be expected to work closely with an advisor both in the actual research and in preparation of an acceptable report. If satisfactorily completed, this course will meet the departmental writing requirement.

College Curriculum: C400

PHYS 455 Sup Senior Research (1-3 Credits)

This course is intended for senior research unrelated to the regular capstone courses. Research is supervised by a faculty member. This course does not satisfy the COLL 400 requirement.

PHYS 471 Capstone Engineering Design Senior Project (3 Credits)

A full-year sequence focused on engineering design processes, professional practices and expectations (e.g. communication, teamwork, and ethics), project management, introduction technical business and entrepreneurial practices, design communication, and an overview of careers opportunities in applied physics and engineering. The centerpiece of the project is a year-long team-based faculty-mentored applied design project. The course includes a 75 minute weekly classroom meeting, weekly team meetings with mentors, and the expectation substantial out-of-class involvement.

Prerequisite(s): APSC 251 (may be taken concurrently)

PHYS 472 Capstone Engineering Design Senior Project (3 Credits)

A full-year sequence focused on engineering design processes, professional practices and expectations (e.g. communication, teamwork, and ethics), project management, introduction technical business and entrepreneurial practices, design communication, and an overview of careers opportunities in applied physics and engineering. The centerpiece of the project is a year-long team-based faculty-mentored applied design project. The course includes a 75 minute weekly classroom meeting, weekly team meetings with mentors, and the expectation substantial out-of-class involvement.

College Curriculum: C400

PHYS 481 Topics in Physics (1-3 Credits)**PHYS 482 Topics in Physics (1-3 Credits)**

PHYS 495 Honors (3 Credits)

Students admitted to Honors study in physics will be enrolled in this course during both semesters of their senior year. Each candidate will be responsible for (a) reading and discussion of a selected list of books in some specific area of the literature of physics; (b) the preparation and presentation by April 15 of an Honors essay based on the student's own research, or part of a major research project; (c) satisfactory completion of a comprehensive oral examination on essay and related topics. If successfully completed this course will satisfy the College writing requirement. For students graduating before Spring 2015: In addition to the major course requirements, the department requirements for Honors specify PHYS 303 and PHYS 351, as well as either PHYS 314 or PHYS 402. For students graduating Spring 2015 or later: In addition to the major course requirements, the department requirements for Honors specify PHYS 314 and PHYS 403, as well as either PHYS 303 or PHYS 402, and either PHYS 351 or PHYS 352. Students graduating in Spring 2015 may choose to use the earlier set of course requirements instead. In applying for Honors, students must submit a proposal to the undergraduate committee during the semester preceding enrollment.

PHYS 496 Honors (3 Credits)

Students admitted to Honors study in physics will be enrolled in this course during both semesters of their senior year. Each candidate will be responsible for (a) reading and discussion of a selected list of books in some specific area of the literature of physics; (b) the preparation and presentation by April 15 of an Honors essay based on the student's own research, or part of a major research project; (c) satisfactory completion of a comprehensive oral examination on essay and related topics. If successfully completed this course will satisfy the College writing requirement. For students graduating before Spring 2015: In addition to the major course requirements, the department requirements for Honors specify PHYS 303 and 351 PHYS 351, as well as either PHYS 314 or PHYS 402. For students graduating Spring 2015 or later: In addition to the major course requirements, the department requirements for Honors specify PHYS 314 and PHYS 403, as well as either PHYS 303 or PHYS 402, and either PHYS 351 or PHYS 352. Students graduating in Spring 2015 may choose to use the earlier set of course requirements instead. In applying for Honors, students must submit a proposal to the undergraduate committee during the semester preceding enrollment.

College Curriculum: C400

Domain: NQR