PHI 351 Philosophy in Literature (3). Philosophical issues as expressed in the novel, drama, and poetry. Fall or Spring.

PHI 352 Philosophy of Religion (3). Problems concerning religious language, the nature and existence of God, and the religious life. Fall, Spring, Summer.

PHI 355 Philosophy of Art (3). Aesthetic experience, functions of art, conceptual foundations of art. Fall, alternate years.

PHI 356 Philosophy of History (3). The nature and limits of our knowledge of the past, analysis of historical explanation and the aims of historical inquiry. Fall, alternate years.

PHI 357 Political Philosophy (3). Issues encountered in the analysis and evaluation of political institutions. Fall, alternate years.

PHI 359 Philosophy of Science (3). An analysis of the conceptual conditions required for doing science. Fall or Spring.

PHI 360 Philosophy of Social Science (3). Critical analysis of ideas of philosophers and social scientists on scientific investigation and explanation of human action. Fall, alternate years.

PHI 361 Philosophy of Culture (3). Examination of philosophical problems involved in understanding various cultures. Fall or Spring.

PHI 411 Senior Thesis (3). 3,000 word minimum. Work to begin by first semester of senior year, oral defense before philosophy faculty to be completed before graduation. Fall or Spring.

PHI 414 Seminar in a Major Philosopher (3). Specific philosophers to be announced in the class schedule. Prerequisite: 9 hours of philosophy or permission of instructor. May be repeated as topic varies for maximum of 6 hours credit.

Physical Therapy
602-523-4092

Faculty: C. DeRosa, Chairman; D. Arnall, R. Borden, M. Cornwall, D. Fukumoto, P. Hansen, K. Mueller, T. McPoil, C. Taber.

The physical therapy program has converted the established entry-level baccalaureate degree in physical therapy to an entry-level master's degree program. The last semester that students were accepted into the baccalaureate degree program was fall 1990.

A complete description of the program's objectives and course offerings can be found in NAU's current Graduate Catalog.

Physics and Astronomy
602-523-2661

Objectives
The Department of Physics and Astronomy offers degree programs in physics, astronomy, and physical science as well as teacher preparation programs in physics and physical science.

The programs in physics and astronomy prepare students for careers as professional scientists. The program in physical science is interdisciplinary and normally includes coursework from physics, chemistry, and earth science. Students preparing for teaching careers in community colleges or secondary schools may choose a major in physics with some courses in one of the related fields of chemistry or mathematics. Those students interested in teaching science at the middle or junior high school level find the broad major in physical science especially appropriate. Physical science also provides a broad scientific background in a less mathematical liberal arts degree.

A program in physics or astronomy can be valuable preparation for a wide variety of careers. The principles of physics are basic to other fields of study, and individual courses in the department meet specific requirements for those programs. Those students majoring in one of the programs in physics and astronomy have opportunities to participate in student and faculty research projects and to work closely with individual professors.

Bachelor of Science
Astronomy Major
This program requires AST 180 or 280, 181, 301, 391, 392; PHY 161, 262, 263, 264, 321, 331, 361, 498; 4 hours of upper-division laboratory or research; 11 hours of prerequisite mathematics; completion of the curriculum for the College of Arts and Sciences (see the information under that heading earlier in this chapter) and electives to complete 125 hours.

Physics Major
This program requires PHY 112, 161, 262, 263, 264, 321, 322, 331, 498; 4 hours of upper-division laboratory or research; MAT 361; 9 hours additional physics or astrophysics electives; 14 hours of prerequisite mathematics; completion of the curriculum for the College of Arts and Sciences (see the information under that heading earlier in this chapter) and additional electives to complete 125 hours.

Physics Extended Major
This program requires PHY 112, 161, 262, 263, 264, 321, 322, 331, 332, 361, 441, 471, 498; 4 hours of upper-division laboratory or research; MAT 361; 15 hours of additional physics or astrophysics electives; completion of the curriculum for the College of Arts and Sciences (see the information under that heading earlier in this chapter) and 14 hours of prerequisite mathematics; and electives to complete 125 hours.

Merged Astronomy and Physics Major
All physics courses, all upper-division physics and astronomy laboratory work or research, and AST 391 and 392 may be counted toward a merged major in physics and astronomy.
Merged Major in Physics and Mathematics
All prerequisite mathematics and MAT 361 may be counted toward a merged major in physics and mathematics.

Physical Science Major
This program requires PHY 111, 112; CHM 130, 230, 151L, 152L; AST 180 or ENV 310; GLG 121; GGR 361; and additional courses in the physical sciences including the designated writing-intensive course to total at least 34 hours; 2 hours of prerequisite mathematics courses; a minor approved by the department; completion of the curriculum for the College of Arts and Sciences (see the information under that heading earlier in this chapter) and electives to complete 125 hours.

Physical Science Extended Major, Physics Emphasis*
This program, intended for secondary school physics teacher preparation, requires PHY 161, 262, 262L, 263, 264, 321, 331, 361, and 498; CHM 152, 152L, 230, and 320 or 360; SCI 350, 410, 420, and 430; and MAT 136, 137, 238, and 239 to total 59 hours; and the completion of the University's liberal studies requirement (including CHM 151 and 151L; PHS 300; SC 340; and MAT 135) for a minimum of 125 hours for graduation.

Physical Science Extended Major/Secondary*
This program, intended for secondary school physical science teacher preparation, requires PHY 111, 112, and 264; CHM 151, 151L, 152, 152L, 230, and 320 or 360; ENV 310 or GGR 361; GLG 101 and 103; SCI 350, 410, 420, and 430; BIO 184 and 190; and MAT 136 to total 55 hours; and the completion of the University's liberal studies requirement (including AST 180 and 181; PHS 300; SC 340; and MAT 135) for a minimum of 125 hours for graduation.

Physical Science Extended Major/Middle School**
This program, intended for middle and junior high school science/mathematics teacher preparation, requires PHY 111 and 112; CHM 130 and 230 or 151, 151L, 152, and 152L; BIO 184 and 190; AST 180; SCI 350, 410, 420, and 430; and MAT 135, 136, 270, 226 or 320, 365, and 430 to total 59 hours; and the completion of the University's liberal studies requirement (including AST 181; GLG 101 and 103; PHS 300; SC 340; and MAT 110) for a minimum of 125 hours for graduation.

Bachelor of Science in Education

Physical Science Majors*
The requirements for these degrees are identical to those listed under the Bachelor of Science. See the following notes for certification information.

*Students planning to teach in the secondary schools may be certified by completing, in addition to one of the above physical science majors, the certification requirements as specified for these programs by the Center for Excellence in Education.

**Students planning to teach science/mathematics in middle and junior high schools, in addition to completing the certification requirements, should also include the courses required for middle level endorsement, which include SCI 250 (2 hours), ECI 308 (2 hours), EPS 325 (3 hours, and SCI 450 (3 hours).
Minor Programs

Astronomy
Requirements include AST 180, 181, 301 and 391 or 392; and PHY 161, 262, and 263 for a total of 22 hours.

Physical Science
Requirements include PHY 111, 112; CHM 130, 132, 151L, and 152L; and additional courses in the physical sciences to total at least 19 hours.

Physical Science Secondary Education
Requirements are the same as for the physical science minor.

Physics
Requirements include PHY 161, 262, and 263, and additional courses in physics to total at least 19 hours and including at least one 3-hour upper-division course.

Physics Secondary Education
Requirements are the same as for the physics minor.

Astronomy Courses (AST)
Some courses may not be offered every semester. Check with the department for current information about when specific courses are offered.

AST 180 Introduction to Astronomy (4). Diurnal motion, motion of solar system objects on the background of stars, light rays and spectra, the planets, Kepler's laws, space travel, coordinates and time, the moon and eclipses, meteors, comets and the sun, stars, stellar distances and stellar evolution, galactic structure, galaxies, quasars and the big bang universe. 3 hrs. lecture, 1 hr. discussion.

AST 181 Introduction to Observational Astronomy (1). Laboratory to accompany AST 180. Astronomical observations and experiments. Use of telescope is stressed. 2 hrs. evening lab. Prerequisite or Corequisite: AST 180.

AST 280 Introduction to Astrophysics (4). Solar system mechanics, overview of planets, electromagnetic radiation, telescopes, stellar evolution, galactic structure, interstellar medium, galaxies and cosmology. 3 hrs. lecture, 1 hr. discussion. Prerequisite: PHY 161 and MAT 136.

AST 301 Observational Astronomy (4). Time and coordinates, spherical triangle, astrometry; photographic and electronic imaging; astronomical optics; orbital elements; photometry, spectroscopy. 3 hrs. lecture, 3 hrs. lab. Prerequisite: AST 181, MAT 135.

AST 391 Astrophysics: Stars (3). Stellar atmospheres and interiors; star formation and stellar evolution. 3 hrs. lecture. Prerequisite: PHY 263.

AST 392 Astrophysics: Galaxies and Cosmology (3). Structure of the Milky Way and other galaxies; interstellar medium; quasars; cosmology. 3 hrs. lecture, 2 hrs. lab. Prerequisite: PHY 263.

Physics Courses (PHY)
Some courses may not be offered every semester. Check with the department for current information about when specific courses are offered.

PHY 101 Introduction to Physics (3). An introduction to physical principles, reasoning, and problem solving techniques for students not meeting the prerequisites for general
Physics and Astronomy

physics or university physics. 2 hrs. lecture, 3 hrs. lab. *Prerequisite:* MAT 109 or equivalent. May not count toward major.

**PHY 111:112 General Physics (4-4).** A one-year, algebra-based introductory physics course covering mechanics, heat, sound, electricity, magnetism, optics, atomic and nuclear physics. 3 hrs. lecture, 3 hrs. lab. *Prerequisite:* High school physics or PHY 101; *Corequisite:* MAT 111 or MAT 112.

**PHY 141 Concepts of Physics (4).** The conceptual basis of physical laws with examples of their applications in the modern world. 3 hrs. lecture, 3 hrs. lab.

**PHY 161 University Physics I (4).** First course in the three-semester, calculus-based, introductory physics sequence. A study of classical mechanics, statics, and dynamics. *Prerequisite:* High school physics or PHY 101; *Corequisite:* MAT 136.

**PHY 262 University Physics II (3).** Second course in the three-semester, calculus-based, introductory physics sequence. A study of thermodynamics, electricity and magnetism. 3 hrs. lecture. *Prerequisite:* PHY 161; *Corequisite:* MAT 137.

**PHY 262L University Physics II Lab (1).** Second semester of introductory experimental physics. *Corequisite:* PHY 262.

**PHY 263 University Physics III (3).** Final course in the three-semester, calculus-based, introductory physics sequence. A study of waves, optics, atomic and nuclear structure. 3 hrs. lecture. *Prerequisite:* PHY 262 or PHY 112 and MAT 137.

**PHY 264 Electronics for Science Students (4).** Review of basic electricity including network theorems. Introduction to semiconductor electronics including bipolar and field effect devices and operational amplifiers. 3 hrs. lecture, 2 hrs. lab. *Prerequisites:* PHY 112 or PHY 262.

**PHY 321 Mechanics I (3).** Vector calculus, Newtonian mechanics, systems of particles, central forces. *Prerequisites:* PHY 263, MAT 238.

**PHY 322 Mechanics II (3).** Lagrange's equations, Hamilton's equations, continuous media, small oscillations and special relativity. *Prerequisite:* PHY 321.

**PHY 331 Electricity and Magnetism I (3).** Electrostatics, magnetostatics, Lorentz force, fields in matter, electromagnetic induction. *Prerequisites:* PHY 263, MAT 238.

**PHY 332 Electricity and Magnetism II (3).** Maxwell's equations, scalar and vector potentials, Laplace's equation, boundary value problems, plane waves, and radiation. *Prerequisite:* PHY 331.

**PHY 333:334 Advanced Laboratory I, H (1-2:1-2).** Advanced laboratory problems in physics. The student and instructor select experiments to be performed. 3 hrs. lab for each credit.

**PHY 361 Modern Physics (4).** Special relativity, atomic and nuclear physics, quantum mechanics. *Prerequisites:* PHY 263, CHM 152, CHM 152L, MAT 238.

**PHY 401:402 Methods of Analytical Physics (3-3).** Applications of the mathematical methods of physics. *Prerequisites:* PHY 321, MAT 239, or permission of instructor.

**PHY 410:411 Statics and Dynamics of the Atmosphere (3-3).** First semester: cloud formation, microphysics and precipitation, radiation processes, atmospheric electricity, optics and acoustics. Second semester: dynamics of fluids in rotating coordinates, basic conservation equations, geostrophic flow, vorticity theorems, the planetary boundary layer, atmospheric waves and numerical weather prediction. *Prerequisite:* MAT 137.

**PHY 421:422 Theoretical Physics (3-3).** Advanced topics in theoretical physics. *Prerequisites:* MAT 236; PHY 321.

**PHY 433 Physical Optics (3).** Electromagnetic theory, geometrical optics, waves, polarization, interference and diffraction. *Prerequisite:* MAT 236.
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PHY 441  Thermal and Statistical Physics (3). Thermodynamics, heat transfer, kinetic theory and quantum statistics. Prerequisite: MAT 238, PHY 263.


PHY 463  Physics of Semiconductor Devices (3). Advanced semiconductor materials, physics of interfaces, quantum devices, surface physics, and special devices. Prerequisites: PHY 481 or EGR 461.

PHY 465:466 Advanced Laboratories III and IV (1-2:1-2). 3 hrs. lab for each credit.

PHY 471  Quantum Mechanics (3). Wave mechanics, Schrodinger's equation, barrier problems, harmonic oscillator, hydrogen atom and matrix methods. Prerequisites: PHY 361, 322.

PHY 481  Solid State Physics (3:3). Band theory of solids. Prerequisite: PHY 264, MAT 238.

Graduate Courses in Physics
PHY 501:502  Theoretical Physics (3-3).

PHY 521  Classical Mechanics (3).

PHY 531  Electricity and Magnetism (3).

PHY 533  Physical Optics (3).

PHY 610  Topics in Modern Physics (3).

PHY 640  Secondary School Physics and Physical Science Curricula (3).

PHY 671  Techniques of Observational Astronomy (3).

PHY 685  Graduate Research (1-6).

PHY 697  Independent Study (1-3).

PHY 698  Graduate Seminar (1-3).

Physical Science Courses (PHS)
Some courses may not be offered every semester. Check with the department for current information about when specific courses are offered.

PHS 300  Issues in Science, Technology, and Society (3). Studies of current issues that involve the impact of science/technology on society. Relevant science concepts will be explored. Prerequisite: An introductory course in physics, chemistry, biology, astronomy, or geology.

PHS 440  Instructional Experiences in Physical Science (2). Designing and carrying out laboratory instruction, lecture demonstrations, and other instructional activities under faculty supervision and guidance. Prerequisite: Major or minor in physical science.

Science Courses (SCI)
Some courses may not be offered every semester. Check with the department for current information about when specific courses are offered.

SCI 204-5  Investigative Science for the Elementary School Teacher (4-4). Investigation of scientific concepts and processes for elementary education. Lectures and lab are integrated.

SCI 250  Seminar Middle Level Science Education (1-1). Students gain an understanding of middle level students, the middle school philosophy, and the nature of scientific investigation and understanding.
SCI 350  Seminar Secondary Science Education (1-1-1). Oral reports and presentations connecting college level science content with secondary science teaching. Prerequisite: Admission to Teacher Education.

SCI 410  Laboratory Techniques for Teaching Science (2). Students prepare, set-up, and present science laboratories techniques and gain practice in laboratory safety procedures.

SCI 420  Resource Development for Teaching Science (2). Students evaluate and develop a collection of resource materials for teaching science.

SCI 450  Integrating Science Across the Middle School Curriculum (3). Students relate the teaching of science to the total middle school curriculum.

Graduate Courses in Science
SCI 629  Instructional and Experimental Aspects of Science for the Elementary Teacher (3).

Political Science
602-523-3163


Objectives
The objectives of the political science, public administration, and international affairs programs are threefold:

• to provide a knowledge of the theory, principles, and practice of government and politics at the national and international levels and a knowledge of the analytic tools in each discipline
• to prepare students for occupations in government, political parties, interest groups, policy institutes, teaching, and law
• to promote liberal education by fostering habits of critical study, clarity of thought, and diligence of research

Bachelor of Science Programs
Political Science
Thirty-six hours are required for this major which is divided into four areas of emphasis: american politics, comparative and international politics, political thought and public law, and public administration.

PS 110, 120, 201, 224, and 351 or 352 are required for each emphasis. An additional 15 hours are selected from a list of courses identified for the particular emphasis and the final 6 hours are selected from one of the other emphases.

In addition, a statistics course (for example, MAT 270, SOC 255, PS 303, or PSY 201) is required as a cognate. A minor of 18 hours or more is required unless the student completes an extended major, a merged major with journalism, or a second major. Finally 44 hours of liberal studies and 125 hours total are required to complete the degree.