3460 Physics

Programs Offered:

1. Bachelor of Science in Physics
2. Standard Program in Physics
   - Concentration in Applied Physics
   - Concentration in Astronomy
   - Concentration in Pre-Medicine
   - Concentration in Biophysics
   - Concentration in Geology
   - Concentration in Computer Science
   - Concentration in Education
3. Dual Degree Programs: B.S. Physics with the M.A.T. Science Education
4. Minor in Physics

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Chair to be named
Brian Thoms, Undergraduate Director

All degree programs described below are built on a core of 21 semester hours of physics numbered 3300 or above and 3 semester hours of mathematics at the 3000 level. The standard program is designed to prepare the student for graduate school or immediate employment upon graduation. Students selecting the standard program must complete 21 semester hours of physics, astronomy and mathematics beyond the core set of physics and mathematics courses listed below. As an alternative to the standard program, courses in one of several specific areas of concentration may be chosen as described below. The available areas of concentration are applied physics, astronomy, pre-medicine, biophysics, geology, computer science, and education.

A central objective of Georgia State University is that all graduates from its programs will be proficient in writing, critical and analytical thinking, and use of information resources. In support of this objective, the Department of Physics and Astronomy explicitly incorporates activities to develop these skills as appropriate in each course.

To schedule an effective program of study, it is very important that all students intending to major in physics consult with the physics faculty adviser as soon as possible. Physics majors should pay special attention to the early completion of the mathematical requirements if they are to complete their physics requirements during the usual four-year span. The first calculus course should be taken during the freshman year, and the second and third calculus courses should be completed during the sophomore year. The department recommends that General Chemistry I and II be taken during the freshman year. The beginning physics sequence (Physics
2211K-2212K) should be completed before the end of the sophomore year. Students who enter the physics major after completing a non-calculus level elementary physics sequence should consult with their departmental adviser on the best method of preparing for more advanced courses in physics.

Program Degree Requirements
In addition to the Program Degree Requirements, students must fulfill the College of Arts and Sciences Degree Requirements (see section 3030) and the University Degree Requirements (see section 1400).

Program Financial Information
Effective summer 2009, lab fees will be assessed automatically for students who register for certain courses. As a result, students will no longer be required to purchase lab fee cards. For more information, please feel free to contact the department. For a complete list of courses and their respective fees, go to General Registration Information at www.gsu.edu/es/20272.html.

B.S. in Physics
Areas A-E: Core Curriculum Recommendations

1. Required course:
   o Math 1113 Precalculus (3) (or a higher-level mathematics course)

2. Required course:
   o Math 2211 Calculus of One Variable I (4) (or a higher-level mathematics course)

3. Recommended courses:
   o Chem 1211K Principles of Chemistry I (4)
   o Chem 1212K Principles of Chemistry II (4)

Area F: Courses Appropriate to the Major (18)*

1. Required Course
   o Phys 1000 Gateway to Physics (2)

2. Required Courses (Unless used to satisfy Area D requirements)
   o Phys 2211K Principles of Physics I (4)
   o Phys 2212K Principles of Physics II (4)
   o Chem 1211K Principles of Chemistry I (4)
   o Chem 1212K Principles of Chemistry II (4)
   o Math 2212 Calculus of One Variable II (4)
   o Math 2215 Multivariate Calculus (4)*

3. To complete 18 semester hours in Area F, select additional courses from the following list that were not used to satisfy the Area A or D requirements.*
   o Biol 1103K Introductory Biology I (4)
   o Biol 1104K Introductory Biology II (4)
   o Biol 2107K Principles of Biology I (4)
*Required Lower Division Courses

All students majoring in physics must complete the following set of courses: Phys 2211K, 2212K, Chem 1211K, 1212K, Math 2212, and 2215. Any semester hours exceeding 18 earned to complete the lower division and Area F requirements will count toward elective hours.

**Area G: Major Courses**

A grade of C or higher is required in all major courses. The Department of Physics and Astronomy offers several concentrations within the B.S. degree program for the physics major. The standard program is recommended for those who plan to pursue graduate study in physics, or who plan to seek immediate employment upon graduation. Other options include concentrations in applied physics, astronomy, pre-medicine, biophysics, geology, and computer science. Course requirements listed below for each of the options are in addition to the courses listed under Area F and the required lower division courses listed above. The standard program and all concentrations are centered on the 21-hour core of physics courses and the three-hour core of mathematics courses listed below.

**Physics and Mathematics Core (24)**

1. **Required Courses to Fulfill CTW Requirement (6)**
   - Phys 3300 Advanced Physics Laboratory-CTW (3)
   - Phys 4900 Research Project-CTW (3)
2. **Additional Physics Requirements (15)**
   - Phys 3401 Modern Physics I (4)
   - Phys 3850 Statistical and Thermal Physics (3)
   - Phys 4600 Classical Mechanics (4)
   - Phys 4700 Electricity and Magnetism (4)
3. **Mathematics Requirements (3)**
   - Math 3260 Differential Equations (3)

**Standard Program in Physics (21)**

To meet the requirements for the degree with the standard program, the core set of physics and mathematics courses must be completed along with additional physics and mathematics courses as described below:
1. Required course (9)
   - Phys 3402 Modern Physics II (3)
   - Math 4258 Vector Calculus (3)
   - Math 4265 Partial Differential Equations (3)

2. Physics and Astronomy Courses. Select nine hours from the following (9):
   - Phys 3500 Electronics (3)
   - Phys 3800 Optics (3)
   - Phys 4110 Introduction to Embedded Systems Laboratory (4)
   - Phys 4340 Neurophysics (3)
   - Phys 4410 Nuclear and Particle Physics (3)
   - Phys 4710 Functional Neuroimaging (3)
   - Phys 4810 Quantum Mechanics (3)
   - Phys 4910 Solid State Physics (3)
   - Phys 4950 Senior Research (1-3)
   - Astr 3500 Quantitative Astronomy (4)
   - Astr 4000 Fundamentals of Astrophysics (3)
   - Astr 4100 Astronomical Techniques and Instrumentation (3)

3. Mathematics and Computer Science Courses: Select one course. (3)
   - CSc 4610 Numerical Analysis I (3)
   - Math 3435 Introductory Linear Algebra (3)
   - Math 4250 Complex Analysis (3)
   - Math 4391 Introduction to Differential Geometry and Its Applications (3)

Applied Physics Concentration (21)

In addition to the core courses in physics and mathematics, the applied physics concentration allows courses from other sciences and engineering to complete the program in physics-related areas. Engineering courses are available through cross registration at the Georgia Institute of Technology. At least 18 semester hours must be completed at the 3000 level or above, and at least nine semester hours must be selected from science and/or engineering courses offered by other departments. **The overall program must be developed in consultation with a faculty adviser within the Department of Physics and Astronomy.**

Astronomy Concentration (21)

In addition to the core set of physics and mathematics courses, the astronomy concentration consists of 10 semester hours in astronomy courses (Astr 3500, 4000, and 4100), and others from the list below, to complete the requirements for the degree. (Although not a requirement, the department recommends that students take Astr 1010 and/or Astr 1020 before the junior year.)

1. Required courses (10)
   - Astr 3500 Quantitative Astronomy (4)
   - Astr 4000 Fundamentals of Astrophysics (3)
   - Astr 4100 Astronomical Techniques and Instrumentation (3)
2. Physics, Mathematics, and Computer Science Courses. Select eleven hours from the following: (11)
   - Phys 3402 Modern Physics II (3)
   - Phys 3500 Electronics (3)
   - Phys 3800 Optics (3)
   - Phys 4110 Introduction to Embedded Systems Laboratory (4)
   - Phys 4340 Neurophysics (3)
   - Phys 4410 Nuclear and Particle Physics (3)
   - Phys 4710 Functional Neuroimaging (3)
   - Phys 4810 Quantum Mechanics (3)
   - Phys 4910 Solid State Physics (3)
   - Phys 4950 Senior Research (1-3)
   - CSc 4610 Numerical Analysis I (3)
   - Math 3435 Introductory Linear Algebra (3)
   - Math 4250 Complex Analysis (3)
   - Math 4258 Vector Calculus (3)
   - Math 4265 Partial Differential Equations (3)
   - Math 4391 Introduction to Differential Geometry and Its Applications (3)

Pre-Medicine Concentration (21)

In addition to the core set of physics and mathematics courses, the pre-medicine concentration allows courses from biology and chemistry to complete the requirements for the degree. The concentration also provides the set of physics, chemistry, and biology courses required for admission to most medical schools. Note that Biol 2107K and 2108K are prerequisites for Biol 3800 and other upper-division biology courses.

1. Required Chemistry courses (12)
   - Chem 2400 Organic Chemistry I (4)
   - Chem 3410 Organic Chemistry II (4)
   - Chem 3100 Organic Chemistry Laboratory I (2)
   - Chem 3110 Organic Chemistry Laboratory II (2)

2. Required Biology courses. Select one of the following (3):
   - Biol 3240 Human Physiology (3)
   - Biol 3800 Molecular Cell Biology (3)

3. Electives. Select six hours from the following (6):
   - Biol 3240 Human Physiology (3) (unless used above)
   - Biol 3250 Human Physiology Laboratory (1)
   - Biol 3800 Molecular Cell Biology (3) (unless used above)
   - Biol 3810 Molecular Cell Biology Laboratory-CTW (3)
   - Biol 3880 Microbiology (3)
   - Biol 3890 Microbiology Laboratory (1)
   - Biol 3900 Genetics (3)
   - Biol 3910 Genetics Laboratory (1)
   - Chem 4600 Biochemistry I (5)
Biophysics Concentration (21)

In addition to the core set of physics and mathematics courses, the biophysics concentration allows biology and chemistry courses to complete the requirements for the degree. The courses should be chosen from the list below and provide background in several areas including biochemical, biomolecular, and neural sciences. This concentration provides excellent preparation for advanced study in biological physics and for admission to M.D./Ph.D. programs. Note that Biol 2107K and 2108K are prerequisites for Biol 3800 and other upper-division biology courses.

1. Required courses (7)
   - Biol 3800 Molecular Cell Biology (3)
   - Chem 2400 Organic Chemistry I (4)

2. Select 14 hours from the following: (Chem 3410, Organic Chemistry II, is a prerequisite for many other courses listed.) (14)
   - Chem 3100 Organic Chemistry Laboratory I (2)
   - Chem 3110 Organic Chemistry Laboratory II (2)
   - Chem 3410 Organic Chemistry II (4)
   - Chem 4000 Fundamentals of Chemical Analysis-CTW (3)
   - Chem 4110 Physical Chemistry I (3)
   - Chem 4600 Biochemistry I (5)
   - Biol 3810 Molecular Cell Biology Laboratory-CTW (3)
   - Biol 3840 Animal Biology (3)
   - Biol 3850 Animal Biology Laboratory (1)
   - Biol 3880 Microbiology (3)
   - Biol 3890 Microbiology Laboratory (1)
   - Biol 3900 Genetics (3)
   - Biol 3910 Genetics Laboratory (1)
   - Biol 4102 Neurobiology (4)
   - Neur 3000 Principles of Neuroscience (4)
   - Neur 3010 Neuroscience Laboratory (4)
   - Phys 3402 Modern Physics II (3)
   - Phys 3500 Electronics (3)
   - Phys 4340 Neurophysics (3)
   - Phys 4710 Functional Neuroimaging (3)
   - Math 4258 Vector Calculus (3)
   - Math 4265 Partial Differential Equations (3)

Geology Concentration (21)

In addition to the core set of physics and mathematics courses, this concentration allows geology courses to complete the requirements for the degree. The courses should be chosen
from the list below. Note that Geol 1121K and 1122K are prerequisites for upper-division geology courses.

1. Required courses (4)
   - Geol 3002 Introduction to Earth Minerals (4)

2. Electives: Select 12 hours from the following (or other approved 3000-4000 geology courses) (12)
   - Geol 4007 Hydrogeology (4)
   - Geol 4013 Structural Geology (4)
   - Geol 4015 Crystallography and Optical Mineralogy (4)
   - Geol 4017 Environmental Geology (4)

3. Electives: Select six hours from the following (5):
   - Phys 3402 Modern Physics II (3)
   - Phys 3500 Electronics (3)
   - Phys 3800 Optics (3)
   - Phys 4110 Introduction to Embedded Systems Laboratory (4)
   - Phys 4410 Nuclear and Particle Physics (3)
   - Phys 4810 Quantum Mechanics (3)
   - Phys 4910 Solid State Physics (3)
   - Phys 4950 Senior Research (1-3)
   - CSc 4610 Numerical Analysis I (3)
   - Math 3435 Introductory Linear Algebra (3)
   - Math 4250 Complex Analysis (3)
   - Math 4258 Vector Calculus (3)
   - Math 4391 Introduction to Differential Geometry and Its Applications (3)

**Computer Science Concentration (21)**

In addition to the core set of physics and mathematics courses, this option allows courses in computer science and related areas to complete the requirements for the degree. The courses should be chosen from the list below. Note that CSc 2010, 2310 and 2510 are prerequisites for upper-division computer science courses.

1. Required Physics course (3)
   - Phys 3500 Electronics (3)

2. Electives: Select 12 hours of courses from the following (or other approved computer science courses) (12)
   - CSc 3210 Computer Organization and Programming (3)
   - CSc 3320 System Level Programming (3)
   - CSc 3330 C++ Programming (3)
   - CSc 3410 Data Structures-CTW (3)
   - CSc 3610 MATLAB Programming (3)
   - CSc 4210 Computer Architecture (4)
   - CSc 4220 Computer Networks (3)
3. Electives. Select six hours from the following (6):
   - Phys 3402 Modern Physics II (3)
   - Phys 3800 Optics (3)
   - Phys 4110 Introduction to Embedded Systems Laboratory (4)
   - Phys 4410 Nuclear and Particle Physics (3)
   - Phys 4340 Neurophysics (3)
   - Phys 4810 Quantum Mechanics (3)
   - Phys 4910 Solid State Physics (3)
   - Phys 4950 Senior Research (1-3)
   - Math 3030 Mathematical Models for Computer Science (3)
   - Math 3435 Introductory Linear Algebra (3)
   - Math 4250 Complex Analysis (3)
   - Math 4258 Vector Calculus (3)
   - Math 4265 Partial Differential Equations (3)
   - Math 4391 Introduction to Differential Geometry and Its Applications (3)

**Education Concentration (21)**

In addition to the core set of physics and mathematics courses, this option leads to certification to teach physics in grades 6-12. Prior to beginning this concentration, students must be accepted into Teacher Education in the College of Education. Entrance requirements include a passing score on the GACE Assessment of Basic Skills (or official scores to demonstrate exemption (see [www.gace.nesinc.com](http://www.gace.nesinc.com)), and a cumulative GPA of 2.50 or higher on all coursework previously completed. In addition, students must have completed Areas A-F of the program of study. Note that EDUC 2110(3), EDUC 2120(3), and EDUC 2130(3) are prerequisites for the field placement courses (EDCI 4600 and EDCI 4750).

1. Required courses (21)
   - EXC4020 Characteristics and Instructional Strategies for Students with Disabilities (3)
   - EDSC4655 Principles of Science Instruction (3)
   - EDSC4755 Theory & Pedagogy of Science Instruction (3)
   - EDCI3250 Introduction to Teaching in Secondary Schools (3)
   - EDCI4600 Practicum (3)
   - EDCI4750 Student Teaching in Secondary Schools (6)

2. Additional requirements for teacher certification:
Students must maintain a 3.00 GPA for courses in the education concentration.

Only hours of EDCI4600 and EDCI4750 completed with a grade of B or better will count toward certification.

Students must pass appropriate GACE II examination to be recommended for certification.

Each student will be required to maintain an electronic program portfolio and to demonstrate proficiency in the pedagogy standards from the Interstate New Teacher Assessment and Support Consortium (INTASC) and the content standards from the National Science Education Standards (NSES). Requirements for the INTASC standards and the National Educational Technology Standards (NETS) will be embedded in the coursework listed above.

Area H: Minor and/or Additional Courses

1. Students earning a B.S. through the Department of Physics and Astronomy are not required to take a minor.

2. Additional courses must be taken as electives to complete a minimum of 120 semester hours, exclusive of KH 1010. Although not a requirement, the department recommends that physics majors take these elective courses at the 2000 level or above in mathematics, computer science, chemistry, biology, geology, physics, or astronomy. (Consult with the departmental academic adviser.)

B.S. Physics / M.A.T. Science Education Dual Degree Program

This dual degree program, allowing completion of both degrees and teacher certification requirements in approximately 5 years, is available to undergraduates majoring in physics who have completed at least 30 hours of academic credit (including Math 2211 and Phys 2211K) and who have earned a minimum cumulative GPA of 3.3. Students may apply to the option at any time after completing 30 hours but prior to completing 90 hours of undergraduate coursework. Applicants are applying for early acceptance into the College of Education’s MAT program and therefore must submit the following documentation in addition to meeting the GPA requirement:

- Complete the BS/MAT pre-application form. This will be kept on file in the Department of Physics & Astronomy and in the Office of Academic Assistance in the College of Arts & Sciences.
- 2-3 letters of recommendation: (a) one academic or professional letter; (b) one letter from someone who can evaluate the applicant’s personal qualifications, experience, and background in light of potential to work successfully with adolescents; (c) one letter from a current work supervisor, if applicable
- Documentation of previous work experience (résumé or curriculum vitae)
- Personal statement of goals and/or reasons for teaching
Successful interview with appropriate program faculty in the Department of Physics and Astronomy and in the College of Education

Final acceptance into the M.A.T. portion of the program will be contingent upon the following:

- Maintaining a cumulative GPA of 3.0 or higher;
- Completion of 90 hours towards the B.S. degree in Physics (including Phys 7460 and Phys 7850);
- Submission of acceptable GRE scores;
- Filing an application to the M.A.T. program by the appropriate deadline.

Acceptance into the Teacher Education track is contingent upon acceptance into the M.A.T. portion, completion of 24 hours in physics, and passing or exempting the GACE Basic Skills test.

Students in this program will select one of the B.S. concentrations listed above. The curriculum allows students to satisfy the content requirement of the M.A.T. program by enrolling in the 7000-level counterparts of the core physics courses (Phys 7850 for 3850, Phys 7460 for 3401, Phys 7600 for 4600, and Phys 7700 for 4700). In addition, to meet the M.A.T. and teacher certification requirements, students will enroll in EXC 4020 and 6 hours of graduate-level courses required for the M.A.T. in satisfying 9 hours of elective credits towards the B.S. in Physics.

Normally, students in their 4th year are enrolled in both the B.S. and the M.A.T. programs and will receive the B.S after the 4th year. In the 5th year, students will take professional education courses (24 hours) and will focus on the student teaching requirements.

For more information on this program’s curriculum, please contact the Department of Physics and Astronomy. The M.A.T. requirements for Science Education are described more fully in the College of Education section of the Graduate Catalog.

**Minor in Physics**

Students who wish to minor in physics must take at least 15 semester hours in physics and/or astronomy courses, including at least nine semester hours at the 3000 level or above. Students taking more than 15 semester hours in these courses may count the additional hours toward their electives or may consider completing a double major. A grade of C or higher is required in all courses counting toward the minor.