

Physics and Astronomy

Undergraduate Study

Physics and astronomy are basic natural sciences which attempt to describe and provide an understanding of both our world and our universe. Physics serves as the underpinning of many different disciplines including the other natural sciences and technological areas. Graduates are proficient in the methods of rigorous scientific analysis, relevant mathematical techniques, and modern computational and laboratory methods. They have a broad knowledge of physics, including mechanics, electricity and magnetism, thermodynamics, and modern physics. They are able to communicate clearly and effectively at general and technical levels. They are prepared to pursue a wide range of careers as a professional physicist, astronomer, or science educator. They are also prepared to pursue advanced studies and careers in areas as diverse as engineering, medicine, law, and business administration. Many opportunities exist for students who terminate their studies with a bachelor's degree, especially when combined with technology studies in other areas. Students who meet the necessary scholastic standards often continue their studies in a graduate college, exploring and contributing to new developments in the field.

The department normally expects each student majoring in physics to complete at least the following courses:

PHYS 241	Principles and Symmetries in Classical Physics I	5
PHYS 242	Principles and Symmetries in Classical Physics II	5
PHYS 321	Introduction to Modern Physics I	3
PHYS 321L	Introductory Laboratory in Modern Physics I	1
PHYS 322	Introduction to Modern Physics II	3
PHYS 322L	Introductory Laboratory in Modern Physics II	1
PHYS 304	Thermal Physics	3
PHYS 306	Physics of Wave Motion	3
PHYS 361	Classical Mechanics	3
PHYS 362	Intermediate Mechanics	3
PHYS 364	Electricity and Magnetism I	3
PHYS 365	Electricity and Magnetism II	3
PHYS 480	Quantum Mechanics I	3
MATH 207	Matrices and Linear Algebra (or)	3

or

MATH 317	Theory of Linear Algebra	4
and 3 credits of laboratory work chosen from		3

PHYS 310	Electronic Instrumentation for Experimental Physics	
PHYS 311	Intermediate Laboratory	
PHYS 311T	Intermediate Laboratory for Secondary Physics Teachers	

PHYS 470L	Applied Physics Laboratory	
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or

ASTRO 344L	Astronomy Laboratory	
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*PHYS 221 and PHYS 222 may be substituted for PHYS 241 and PHYS 242.

All students are required to earn at least 5 credits in laboratory work in physics in addition to the laboratory components of PHYS 241 and PHYS 242. These 5 credits must be in courses numbered 304 or higher or in approved substitutions. All students must earn at least 32 credits in physics and astronomy courses numbered 304 or higher. The basic list of expected courses is not a rigid requirement and changes in this basic list will be approved by the department curriculum committee on recommendation of the student's adviser when such changes will better serve the student's needs. In particular, students planning a physics major and also seeking certification for high school teaching may, with the approval of their adviser, follow a significantly different program designed to meet their particular needs; these students should consult the department for further information. Further information concerning programs of study, including sample degree programs, is available from the department.

Students majoring in physics who wish an emphasis in astronomy/astrophysics should consider a minor in astronomy. Those planning graduate work in physics or astronomy/astrophysics should add to the basic list the course PHYS 481. Other useful courses include:

MATH 365	Complex Variables with Applications	3
PHYS 496	Modern Optics	3
STAT 447	Statistical Theory for Research Workers	4

One or more of the following may also be added according to interest

ASTRO 405	Astrophysical Cosmology	3
PHYS 421	Ultrafast Laser Science and Spectroscopy	3
PHYS 432	Molecular and Cell Biophysics	3
PHYS 461	Physics of Biomolecules	3
PHYS 511	Condensed Matter Physics I	3
PHYS 526	Particle and Nuclear Physics	4
PHYS 528	Mathematical Methods for the Physical Sciences	3
PHYS 541	General Relativity	3

The expected outcomes for students in these programs are:

1. a broad knowledge of physics, including mechanics, electricity and magnetism, thermodynamics, wave motion and modern physics
2. proficiency in laboratory methods
3. proficiency in modern scientific computational methods
4. a sound foundation in the liberal arts including proficiency in communication skills.

In addition to the performance on exams and course grades, information on evaluating the success in meeting these goals is obtained by:

1. an annual written survey of all students majoring in the program
2. an annual written survey of all graduating seniors
3. a periodic written survey of program alumni
4. student evaluations of all courses
5. adviser evaluations
6. a bimonthly meeting of program majors with the department chair

The department offers a minor in physics which may be earned by completing 20 credits in physics courses chosen as follows:

PHYS 241	Principles and Symmetries in Classical Physics I	5
PHYS 242	Principles and Symmetries in Classical Physics II	5
PHYS 321	Introduction to Modern Physics I	3

One of the following

PHYS 321L	Introductory Laboratory in Modern Physics I	
PHYS 322L	Introductory Laboratory in Modern Physics II	
PHYS 310	Electronic Instrumentation for Experimental Physics	
PHYS 311	Intermediate Laboratory	
PHYS 311T	Intermediate Laboratory for Secondary Physics Teachers	

Other acceptable courses

PHYS 304	Thermal Physics	
PHYS 306	Physics of Wave Motion	
PHYS 322	Introduction to Modern Physics II	
PHYS 361	Classical Mechanics	
PHYS 362	Intermediate Mechanics	
PHYS 364	Electricity and Magnetism I	
PHYS 365	Electricity and Magnetism II	
PHYS 421	Ultrafast Laser Science and Spectroscopy	
PHYS 432	Molecular and Cell Biophysics	
PHYS 461	Physics of Biomolecules	
PHYS 480	Quantum Mechanics I	
PHYS 481	Quantum Mechanics II	
PHYS 496	Modern Optics	

*PHYS 221 and PHYS 222 may be substituted for PHYS 241 and PHYS 242

The department offers a minor in astronomy which may be earned by completing 15 credits chosen as follows:

ASTRO courses *		12-15
3 credits from the following (if only 12 Astro credits)		3
PHYS 304	Thermal Physics	
PHYS 321	Introduction to Modern Physics I	
PHYS 361	Classical Mechanics	
PHYS 362	Intermediate Mechanics	
PHYS 364	Electricity and Magnetism I	
PHYS 365	Electricity and Magnetism II	
PHYS 480	Quantum Mechanics I	
PHYS 481	Quantum Mechanics II	

PHYS 496	Modern Optics
AER E 351	Astrodynamics I

* must include ASTRO 344L Astronomy Laboratory and may include one of the courses ASTRO 120 The Sky and the Solar System, ASTRO 150 Stars, Galaxies, and Cosmology or ASTRO 250 Astronomy Bizarre

12 or more credits must be at the 300 level or higher. Note that only ASTRO 344L may be used to satisfy both the requirements of a physics major and an astronomy minor.

Communication Proficiency requirement: The department requires a grade of C or better in each of ENGL 150 and ENGL 250 (or ENGL 250H), and a C– or better in ENGL 302, ENGL 305, ENGL 309 or ENGL 314. Students are also encouraged to study at least one foreign language.

Graduate Study

The department offers studies for the degrees master of science and doctor of philosophy with majors at both levels in applied physics, astrophysics, condensed matter physics, high energy physics, nuclear physics, and physics; and minor credit courses for students majoring in other departments.

Facilities of various research groups of the department, the Ames Laboratory, and the Applied Science Center, including the Microelectronics Research Center, are available for research.

Students with bachelor's degrees in physics or astronomy from other institutions ordinarily will qualify for graduate study at Iowa State provided they have satisfactorily completed course work similar to that suggested for undergraduate majors here intending to go on to graduate school. In some cases additional instruction at the intermediate level may be required.

Graduates have a broad understanding of physical science, as well as mastery of state-of-the-art methods in their area of specialization. They are able to communicate effectively to a wide range of audiences, from the general public to research colleagues. Their skills in rigorous scientific thinking prepare them for leadership in the broader community. They are skilled in carrying out research, communicating research results, and soliciting research support. They have considerable teaching experience. They have developed problem solving skills that prepare them for careers in either industry or academia.

All candidates for an advanced degree in physics are expected to complete:

PHYS 531	Statistical Mechanics	3
PHYS 564	Advanced Classical Mechanics	3
PHYS 571	Electricity and Magnetism I	3
PHYS 572	Electricity and Magnetism II	3
PHYS 591	Quantum Physics I	4
PHYS 592	Quantum Physics II	4

Candidates for an advanced degree in applied physics are expected to complete:

PHYS 571	Electricity and Magnetism I	3
PHYS 591	Quantum Physics I	4
PHYS 470L	Applied Physics Laboratory	2-5
PHYS 699	Research	arr
		†
PHYS 572	Electricity and Magnetism II	3
or PHYS 531	Statistical Mechanics	

† Arranged with instructor.

Candidates for an advanced degree in astrophysics should complete:

PHYS 531	Statistical Mechanics	3
PHYS 564	Advanced Classical Mechanics	3
PHYS 571	Electricity and Magnetism I	3
PHYS 591	Quantum Physics I	4
ASTRO 505	Astrophysical Cosmology	3
ASTRO 510	Observational Astrophysics	3

Astrophysics Ph.D. candidates must take at least three of the 580 level Astro courses, while candidates for the Research Masters must take at least two 580 level Astro courses.

Except for the applied physics major where a thesis is always required, the degree master of science is offered both with and without thesis. For all areas of study except applied physics the basic requirements for the M.S. are the same: at least 30 credits of acceptable graduate work must be completed, not less than 21 of which must be in physics or astronomy. Students must complete not less than 6 credits from outside their major area, with 3 credits being required from outside

the department, and 3 credits from a 500 or 600 level course in another area of specialization. Students choosing a M.S. degree with thesis may apply up to 8 credits of 699 but no credits of 599 toward the minimum 30 credits. Students choosing a degree without thesis should apply 2 credits of 599, but may not apply any credits of 699 toward the minimum 30 credits.

Students whose major area is applied physics must complete at least 30 credits of acceptable graduate work for the M.S. degree and not less than 19 credits of these must be in the required courses listed above; the remaining 11 credits of the 30 credit minimum may be chosen freely either from within the student's major area or from without and either from the department or outside, but it should be noted that not more than 3 credits of PHYS 699 Research may be applied toward the 30 credit minimum.

In addition to course work in the major area of study, all candidates for the Ph.D. degree must complete 12 credits from outside this area. Of these 6 must be taken from other departments and 6 must be taken from the department with the additional constraint that this latter 6 must include at least one 500 or 600 level introductory course in another area of specialization. Each candidate for the Ph.D. degree is required to teach one year of elementary physics or astronomy.

Graduate students interested in a physics minor should contact the department for requirements.