PHYSICS, B.S.

The Department of Physics has a long history of providing students with a great educational experience. The department awarded its first Ph.D. in 1899. Since then, physics students have earned degrees in virtually every area of physics, and the department’s faculty has played key roles in a myriad of important research efforts.

Physics is the science of the properties of matter, radiation, and energy in all forms. As such, it is the most fundamental of the sciences. It provides the underlying framework for the other physical sciences and engineering and for understanding physical processes in biological and environmental sciences.

CHOOSE TO BE A PHYSICS MAJOR

WHY STUDY PHYSICS?

- **Intellectual Satisfaction.** First, and foremost, physics satisfies our deep desire to understand how the universe works. Physics is interesting.
- **Intellectual Challenge.** By striving for fundamental understanding, the physicist accepts the challenge to move past a merely descriptive approach of our world and probes deeply into how and why it works.
- **Physics Produces New Technology.** Today’s esoteric physics research will become tomorrow’s technological advances.
- **Technical Expertise.** Physicists exploit forefront technologies in their pursuits.
- **Flexibility.** In a fast-paced and changing world, it is much more important to have a broad substantive education than to be trained in a specific skill. We teach people how to think, and how to apply and extend what they know to new types of problems.
- **Physics is Analytical and Quantitative.** People who can reason analytically and quantitatively are essential for the success of almost any pursuit.

YOUR FUTURE IS SO BRIGHT . . .

A degree in physics helps prepare students for employment in industry, research, government, and academia. A bachelor’s degree from the undergraduate physics program will provide an overall view of both classical and modern physics along with problem-solving ability and the flexibility to continue learning.

Your education can:

- Prepare you for employment in industrial or governmental laboratories.
- Prepare you for graduate studies for master’s or doctoral degrees in experimental or theoretical physics.
- Provide a broad background for further work in other sciences, such as materials sciences, aerospace, astronomy, computer science, geophysics, meteorology, radiology, medicine, biophysics, engineering, and environmental studies.
- Provide a science-oriented liberal education. This training can be useful in some areas of business administration, law, or other fields where a basic knowledge of science is useful.
- Provide part of the preparation you need to teach physics. To teach physics in high school, you will also take education courses to become certified. You will need a doctoral degree to become a college or university professor.

PHYSICS MENTOR PROGRAM

Any student contemplating becoming a physics major is encouraged to obtain a faculty mentor. A mentor is a faculty member with whom students can discuss physics, courses, careers, graduate schools, aspirations, etc. Mentors are not primarily academic advisors. Information is available at the department office.

OTHER PROGRAMS

AMEP
A program in applied mathematics, engineering and physics (AMEP) is described in its own section of The Guide.

Astronomy-Physics
Students interested in an astronomy–physics major should contact the astronomy department (http://guide.wisc.edu/undergraduate/letters-science/astronomy).

Education-Physics
A student working toward the Bachelor of Science–Education degree may major or minor in physics. Interested students should contact the School of Education (http://guide.wisc.edu/undergraduate/education). Upon request, the physics department will assign an advisor.

Medical-Physics
A suggested curriculum for students interested in graduate study in medical physics is available in the medical physics (https://www.medphysics.wisc.edu) department office.

HOW TO GET IN

TO DECLARE A PHYSICS MAJOR

Students must declare the physics major by filing out a major declaration form, signed by a physics undergraduate advisor. They should talk with one of the undergraduate advisors as soon as they know they might have an interest in the physics major. Students can declare their physics major at any time after completing their first physics course on the UW–Madison campus, and we encourage them to do this as early as possible. They must have a 2.5 GPA in physics and math courses taken at UW–Madison at the time they declare. In all cases, the major must be declared before the semester of graduation. The form can be obtained at the department office in 2320 Chamberlin Hall. Note: Students should bring a copy of their current course history when they talk with the undergraduate advisor.

ENGINEERING AND OTHER NON-L&S MAJORS SEEKING AN ADDITIONAL MAJOR IN PHYSICS

An undergraduate in any college other than Letters & Science (L&S) needs to complete the physics requirements for the physics major, and the L&S residence and quality of work in the major requirements. None of the other requirements of L&S need to be satisfied. Students majoring in any other program that is not in L&S require formal approval from the other college to declare the additional major in physics. This process may delay declaring the major in physics.
REQUIREMENTS

UNIVERSITY GENERAL EDUCATION REQUIREMENTS

All undergraduate students at the University of Wisconsin–Madison are required to fulfill a minimum set of common university general education requirements to ensure that every graduate acquires the essential core of an undergraduate education. This core establishes a foundation for living a productive life, being a citizen of the world, appreciating aesthetic values, and engaging in lifelong learning in a continually changing world. Various schools and colleges will have requirements in addition to the requirements listed below. Consult your advisor for assistance, as needed. For additional information, see the university Undergraduate General Education Requirements (http://guide.wisc.edu/undergraduate/#requirementsforundergraduatetestudytext) section of the Guide.

Requirements Detail

General Education

- Breadth—Humanities/Literature/Arts: 6 credits
- Breadth—Natural Science: 4 to 6 credits, consisting of one 4- or 5-credit course with a laboratory component; or two courses providing a total of 6 credits
- Breadth—Social Studies: 3 credits
- Communication Part A & Part B *
- Ethnic Studies *
- Quantitative Reasoning Part A & Part B *

* The mortarboard symbol appears before the title of any course that fulfills one of the Communication Part A or Part B, Ethnic Studies, or Quantitative Reasoning Part A or Part B requirements.

COLLEGE OF LETTERS & SCIENCE BREADTH AND DEGREE REQUIREMENTS: BACHELOR OF SCIENCE (B.S.)

Students pursuing a bachelor of science degree in the College of Letters & Science must complete all of the requirements below. The College of Letters & Science allows this major to be paired with either a bachelor of arts or a bachelor of science curriculum. View a comparison of the degree requirements here. (https://pubs.wisc.edu/home/archives/ug15/images/babs2009.pdf)

BACHELOR OF SCIENCE DEGREE REQUIREMENTS

Requirements Detail

Mathematics

- Two (2) 3+ credits of intermediate/advanced level MATH, COMP SCI, STAT
  - Limit one each: COMP SCI, STAT

Foreign Language

- Complete the third unit of a foreign language
  - Note: A unit is one year of high school work or one semester/term of college work.

L&S Breadth

- Humanities, 12 credits: 6 of the 12 credits must be in literature
- Social Sciences, 12 credits
- Natural Sciences, 12 credits: must include 6 credits in biological science; and must include 6 credits in physical science

NON–L&S STUDENTS PURSuing AN L&S MAJOR

Non–L&S students who have permission from their school/college to pursue an additional major within L&S only need to fulfill the major requirements and do not need to complete the L&S breadth and degree requirements above.

REQUIREMENTS FOR THE MAJOR

The physics major requires 35 credits from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 247</td>
<td>A Modern Introduction to Physics (recommended) 1</td>
<td>5</td>
</tr>
<tr>
<td>PHYSICS 207</td>
<td>General Physics</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 201</td>
<td>General Physics</td>
<td></td>
</tr>
<tr>
<td>EMA 201</td>
<td>Statics and Dynamics 2</td>
<td>2</td>
</tr>
<tr>
<td>&amp; EMA 202</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMA 201</td>
<td>Statics and Dynamics 2</td>
<td>2</td>
</tr>
<tr>
<td>&amp; MEE 240</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHYSICS 248</td>
<td>A Modern Introduction to Physics (recommended)</td>
<td>5</td>
</tr>
<tr>
<td>PHYSICS 208</td>
<td>General Physics</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 202</td>
<td>General Physics</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 249</td>
<td>A Modern Introduction to Physics (recommended)</td>
<td>3-4</td>
</tr>
<tr>
<td>PHYSICS 205</td>
<td>Modern Physics for Engineers</td>
<td></td>
</tr>
<tr>
<td>PHYSICS/ ECE 235</td>
<td>Introduction to Solid State</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 241</td>
<td>Introduction to Modern Physics</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 244</td>
<td>Modern Physics (Primarily for ECE Majors)</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 311</td>
<td>Mechanics</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 322</td>
<td>Electromagnetic Fields</td>
<td></td>
</tr>
</tbody>
</table>

Option 1:

Option 2:
ECE 220  Electrodynamics I
ECE 320  Electrodynamics II
ECE 420  Electromagnetic Wave Transmission

Select one of the following: 3

PHYSICS 415  Thermal Physics
CHEM 561  Physical Chemistry
& CHEM 562  and Physical Chemistry 4
M E 361  Thermodynamics

Select one of the following: 3-6

PHYSICS 448  Atomic and Quantum Physics
& PHYSICS 449  and Atomic and Quantum Physics (recommended)
PHYSICS 531  Introduction to Quantum Mechanics
Laboratory 5

Select 6 credits from the following: 6

Full registered credit per course:

PHYSICS 307  Intermediate Laboratory-Mechanics and Modern Physics
PHYSICS 308  Intermediate Laboratory-Electromagnetic Fields and Optics
PHYSICS 407  Advanced Laboratory

Two credits applies for each of these courses:

PHYSICS 321  Electric Circuits and Electronics
PHYSICS 623  Electronic Aids to Measurement
PHYSICS 625  Applied Optics
NUC 427  Nuclear Instrumentation Laboratory
NUC 428  Nuclear Reactor Laboratory

One credit applies for each of these courses:

ECE 305  Semiconductor Properties Laboratory
ECE 313  Optoelectronics Lab

Select additional electives to reach 35-credit minimum for the major:

Advanced Physics Electives 5

PHYSICS 301  Physics Today 6
PHYSICS 325  Wave Motion and Optics
PHYSICS 406  Special Topics in Physics
PHYSICS/ENVIR ST 472  Environmental Problems
PHYSICS/B M E/H ONCOL/MED PHYS 501  Radiological Physics and Dosimetry
PHYSICS 507  Graduate Laboratory
PHYSICS/ECE/N E 525  Introduction to Plasmas
PHYSICS/ECE/N E 527  Plasma Confinement and Heating
PHYSICS 535  Introduction to Particle Physics
PHYSICS 545  Introduction to Atomic Structure
PHYSICS/ECE 546  Lasers
PHYSICS 551  Solid State Physics
PHYSICS/ANATOMY  

B M E/CHEM/MED PHYS/PHMCOL-M/RADIOL 619

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1. It is recommended that students follow one of the sequences PHYSICS 247–PHYSICS 248, PHYSICS 207–PHYSICS 208, or PHYSICS 201–PHYSICS 202 for the first two courses, and PHYSICS 249 or PHYSICS 241 is strongly recommended for the third course. But any combination can be used to satisfy the requirements, except that students may not transfer into the PHYSICS 247–PHYSICS 248–PHYSICS 249 sequence from another introductory sequence.

2. A maximum of 5 credits from EMA 201, EMA 202, and M E 240 count toward the 35 required.

3. A maximum of 3 credits from ECE 220 and ECE 320 and ECE 420 apply toward the 35 required.

4. A maximum of 3 credits from CHEM 561 and CHEM 562 apply toward the 35 required.

5. For non-physics courses, students will receive only the credit applied as lab toward the 35 credits requirement.

6. It is recommended that the student's program include the seminar PHYSICS 301 Physics Today.

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RESIDENCE AND QUALITY OF WORK IN THE MAJOR

- 2.000 GPA in all PHYSICS and major courses
- 2.000 on at least 15 credits in upper-level work taken in residence: courses in Core, Laboratory, and Advanced Physics Electives
- 15 credits in PHYSICS, taken on campus

DISTINCTION IN THE MAJOR

Distinction in the Major requires no declaration, and is awarded at the time of graduation. Students may not receive Distinction and Honors in the same major. To receive Distinction in the Major, students must have met the following requirements:

- 3.300 university GPA
- 3.300 GPA in all major and major subject (physics) courses
- 6 additional credits in advanced-level physics beyond the minimum required for the major.

THESIS OF DISTINCTION

An exceptional original thesis will be designated as a Thesis of Distinction upon recommendation by the department.

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MATHEMATICS

MATH 221–MATH 222–MATH 234 or equivalents are necessary since they are prerequisites for other courses.

CHEMISTRY

A college course in chemistry is advised for all physics students.

COMPUTING

Students should become familiar with scientific programming using a language such as C or FORTRAN. The computer sciences department offers introductory courses (such as 302). The Division of Information Technology (DoIT) also offers short courses to introduce programming.
HONORS IN THE MAJOR

Students may declare Honors in this Major in Physics in consultation with their major advisor.

HONORS IN THE PHYSICS MAJOR REQUIREMENTS

To earn a B.A. or B.S. with Honors in the Major in Physics students must satisfy both the requirements for the major (above) and the following additional requirements:

- Earn a 3.300 university GPA
- Earn a 3.300 GPA in all PHYSICS courses, and all courses accepted in the major
- Complete 12 credits for Honors in courses counting in the major, to include:
  - 9 credits at the advanced level
  - A two-semester Senior Honors Thesis in PHYSICS 681 Senior Honors Thesis and PHYSICS 682 Senior Honors Thesis for a total of 6 credits

UNIVERSITY DEGREE REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirements Detail</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Degree</td>
<td>To receive a bachelor’s degree from UW–Madison, students must earn a minimum of 120 degree credits. The requirements for some programs may exceed 120 degree credits. Students should consult with their college or department advisor for information on specific credit requirements.</td>
</tr>
<tr>
<td>Residency</td>
<td>Degree candidates are required to earn a minimum of 30 credits in residence at UW–Madison. “In residence” means on the UW–Madison campus with an undergraduate degree classification. “In residence” credit also includes UW–Madison courses offered in distance or online formats and credits earned in UW–Madison Study Abroad/Study Away programs.</td>
</tr>
<tr>
<td>Quality of Work</td>
<td>Undergraduate students must maintain the minimum grade point average specified by the school, college, or academic program to remain in good academic standing. Students whose academic performance drops below these minimum thresholds will be placed on academic probation.</td>
</tr>
</tbody>
</table>

LEARNING OUTCOMES

The physics curriculum is intended to provide a broad and thorough understanding of the fundamental properties and interactions underlying physical phenomena (including mechanical behaviors, electrical and magnetic sources and interactions, light and optics, heat, relativity of space time, quantum mechanics, atomic and nuclear structure, solid state matter, etc.). Many students who major in physics as undergraduates enter graduate schools for work leading to the M.S. or Ph.D. degrees. Others seek employment in a wide range of fields in government, business, and industry. Since current research, both pure and applied, involves interdisciplinary efforts, the broad training of physics with its stress on fundamentals proves to be a valuable experience.
PEOPLE

FACULTY

Yang Bai (https://www.physics.wisc.edu/people/yangbai), Associate Professor
Baha Balantekin (https://www.physics.wisc.edu/people/bahabalantekin), Professor
Vernon Barger (https://www.physics.wisc.edu/people/vernon-dbarger), Professor
Stas Boldyrev (https://www.physics.wisc.edu/people/stanislavboldyrev), Professor
Victor Brar (https://www.physics.wisc.edu/people/victorbrar), Assistant Professor
Duncan Carlsmith (https://www.physics.wisc.edu/people/duncancarlsmith), Professor
Daniel Chung (https://www.physics.wisc.edu/people/daniel-jchung), Professor
Susan Coppersmith (https://www.physics.wisc.edu/people/susan-coppersmith), Professor
Sridhara Dasu (https://www.physics.wisc.edu/people/sridharadasu), Professor
Jan Egedal (https://www.physics.wisc.edu/people/janegedal), Associate Professor
Mark Eriksson (https://www.physics.wisc.edu/people/markeriksson), Professor
Lisa Everett (https://www.physics.wisc.edu/people/lisa-leverett), Professor
Cary Forest (https://www.physics.wisc.edu/people/cary-bforest), Professor
Pupa Gilbert (https://www.physics.wisc.edu/people/pupagilbert), Professor
Francis Halzen (https://www.physics.wisc.edu/people/francis-lhalzen), Professor
Kael Hanson (https://www.physics.wisc.edu/people/kael-dhanson), Professor
Aki Hashimoto (https://www.physics.wisc.edu/people/akihashimoto), Professor
Matthew Herndon (https://www.physics.wisc.edu/people/matthew-therndon), Professor
Lev Ioffe, Professor
Robert Joynt (https://www.physics.wisc.edu/people/robert-joynt), Professor
Albrecht Karle (https://www.physics.wisc.edu/people/albrechtkarle), Department Chairperson and Professor

James Lawler (https://www.physics.wisc.edu/people/james-elawler), Professor
Alex Levchenko (https://www.physics.wisc.edu/people/alexlevchenko), Assistant Professor
Chun Lin (https://www.physics.wisc.edu/people/chun-clin), Professor
Dan McCammon (https://www.physics.wisc.edu/people/dannmcammon), Professor and Undergraduate Advisor
Robert McDermott (https://www.physics.wisc.edu/people/robert-fmcdermott), Professor
Marshall Onellion (https://www.physics.wisc.edu/people/marshallfonellion), Professor
Kimberly Palladino (https://www.physics.wisc.edu/people/kimberlyjpalladino), Assistant Professor
Yibin Pan (https://www.physics.wisc.edu/people/yibinpan), Associate Professor
Mark Rzchowski (https://www.physics.wisc.edu/people/markrzchowski), Associate Chair and Professor
Mark Saffman (https://www.physics.wisc.edu/people/marksaaffman), Professor
John Sarff (https://www.physics.wisc.edu/people/john-ssarff), Professor
Gary Shiu (https://www.physics.wisc.edu/people/garyshiu), Professor
Wesley Smith (https://www.physics.wisc.edu/people/wesley-hsmith), Professor
Paul Terry (https://www.physics.wisc.edu/people/paul-wterry), Professor
Peter Timbie (https://www.physics.wisc.edu/people/peter-ttimbie), Professor
Justin Vandenbroucke (https://www.physics.wisc.edu/people/justinvandenbroucke), Assistant Professor
Maxim Vavilov (https://www.physics.wisc.edu/people/maxim-gvavilov), Professor
Thad Walker (https://www.physics.wisc.edu/people/thad-gwalker), Professor
Stefan Westerhoff (https://www.physics.wisc.edu/people/stefanwesterhoff), Professor and Undergraduate Advisor
Michael Winokur (https://www.physics.wisc.edu/people/michael-jwinokur), Professor and Undergraduate Advisor
Sau Lan Wu (https://www.physics.wisc.edu/people/sau-lanwu), Professor
Deniz Yavuz (https://www.physics.wisc.edu/people/denizyavuz), Professor
Ellen Zweibel (https://www.physics.wisc.edu/people/ellen-gzweibel), Professor
WISCONSIN EXPERIENCE

PHYSICS UNDERGRADUATE COLLOQUIUM
There is a weekly series of talks in the spring semester called "Physics Today," at which a topic of local research is described by one of the physics faculty. These are open and may be attended by anyone. They can also be taken as a course, PHYSICS 301 Physics Today. See the Course Guide for location and time.

THE PHYSICS CLUB
The University Physical Society (UPS)—also known as the Physics Club—is a student organization for people interested in physics and related fields.

WHAT DOES THE PHYSICS CLUB DO?
The Physics Club organizes events such as seminars, tours, trips, and socials for its members. Physics Club volunteers also offer free drop-in tutoring to students in introductory physics and astronomy classes. In addition, we maintain subscriptions to science related magazines such as Scientific American, Astronomy, and Physics Today, which are kept in the club’s room located at 2328 Chamberlin Hall. Every Friday afternoon, we meet with the physics colloquium speaker to learn about the process of becoming a scientist. In addition, UPS sponsors a variety of other events. For example, in the past, we have taken a field trip to Fermilab, sponsored a racquetball tournament, and have frequently gathered for social events such as ice skating, movie night, and bowling.

WHY SHOULD YOU JOIN THE PHYSICS CLUB?
By joining the Physics Club you’ll be meeting many physics majors, who are, in general, really cool people to hang out with. If you are thinking about declaring a physics major, this is the place to come for helpful advice about taking classes and finding undergraduate job in the physics department. If you join, you can get access to the Physics Club room, 2328 Chamberlin Hall. Joining also adds you to the club email list, so you can be notified about club sponsored events.

PERKS OF BEING A PHYSICS CLUB MEMBER
When you join the Physics Club, you get access to an excellent room, 2328 Chamberlin Hall. This room contains a refrigerator, reference shelves of textbooks, couch, tables, and chairs, a phone, blackboards, and a microwave. We have a several computers in the room. You can get your own key to the room and visit at your leisure, and stay as long as you like. Plus, you get the added bonus of knowing people who are in your classes.

University Physical Society
2328 Chamberlin Hall
ups.physics.wisc.edu
ups-officers@googlegroups.com
To Join:
Drop by Room 2328 Chamberlin Hall and pick up a membership form. Turn in a completed form with your $5 annual dues to a UPS club officer.

PHYSICS LEARNING CENTER
The Physics Learning Center: Striving to help all students succeed in Physics

RESOURCES AND SCHOLARSHIPS

STUDENT AWARDS

The Fay Ajzenberg-Selove Award is presented to undergraduate women majoring in physics, astronomy, or physics/astronomy for the purpose of encouraging women to continue their careers in science. Dr. Ajzenberg-Selove, who received her Ph.D. in physics in 1952, is currently a professor emerita the University of Pennsylvania.

The Dr. Maritza Irene Stapanian Crabtree Award in physics was established by William Crabtree to honor his wife, Dr. Maritza Crabtree, who graduated with a physics degree in 1971. This annual award benefits undergraduate students in physics based equally on merit and need. The Bernice Durand Undergraduate Research Scholarship was established by Vice Provost/Physics Professor Bernice Durand to promote meaningful undergraduate research opportunities and to support students in their research endeavors.
support and encourage women and ethnic minorities as undergraduate majors in the departments of physics and astronomy.

**The Henry and Eleanor Firminhac Physics Undergraduate Scholarship**
is given to undergraduates in physics with financial need as the primary consideration. Funding provided by Ralph Firminhac in honor of his parents.

**The L. R. Ingersoll Prize** is given for distinguished achievement in introductory physics. This prize is underwritten by a fund established by the family and friends of the late Professor Ingersoll, a distinguished physicist and teacher at the university who served as department chair for many years.

**The Liebenberg Family Research Scholarship** is for physics, AMEP (applied mathematics, engineering, and physics) or astronomy/physics majors. This scholarship opportunity was initiated by the Liebenberg family for the purpose of promoting undergraduate summer research opportunities.

**The Albert Augustus Radtke Scholarship Award** is given to outstanding junior or senior students majoring in physics or AMEP. This award was made possible by a bequest of the late Mrs. Elizabeth S. Radtke in honor of her husband, a 1900 degree recipient from UW–Madison.

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**For more information.** Go to [www.physics.wisc.edu/awards](https://www.physics.wisc.edu/awards) or contact info@physics.wisc.edu.

**Application Process.** The deadline for student application materials is March 15th. No late applications will be accepted.

**To Apply.** Please submit a statement of interest and how this award would help your education. If it is an award that is for financial need (Crabtree and Firminhac) you need to emphasize what the need is. If the award you are applying for also has a merit requirement, the department will run your transcript.