

PHYSICS, BS

Physics is the study of matter and energy and their interactions in nature and under man-made conditions. Everything is comprised of matter and energy so the principles of physics touch everything in the world around us and beyond the bounds of Earth into the Universe.

UWM students can shape their Physics major in one of two directions. The standard major provides a broad overview of all aspects of physics: mechanics, optics and lasers, thermodynamics, quantum physics, magnetism, electricity, and the math principles that underlie everything in physics. In the astronomy focused version of the major, students still master these basics plus they add in additional coursework in astrophysics and gravitation.

UWM's program provides excellent preparation for graduate programs in physics, engineering, and math or can serve as a springboard to careers in areas of electronics and computers; space travel and space exploration; satellite technology; medical imaging and treatment; telecommunications; nuclear power; semi- and super-conductors; environmental consulting; climatology; green energy; and more.

The opportunity to participate in research as an undergraduate is a distinct advantage to being a Physics student at UWM. At most large, research universities, research opportunities for undergraduates are limited; there are fewer of them and they often are reserved for juniors or seniors. At UWM, you can get involved as early as freshman year. Students work directly with faculty and graduate students on their current research projects, and sometimes find themselves published in a peer-reviewed journal right alongside the faculty member. Participating in undergraduate research is an excellent way to enhance your resume for graduate school or employment.

Requirements

Course of Study – Bachelor of Science Degree

Complete 120 credits including 90 credits in the College of Letters & Science and with 36 of the 90 credits in L&S upper-level (numbered above 300) courses and 30 of those 36 credits in designated upper-level Natural Science. The College requires that students must complete in residence at UWM at least 15 credits in upper-division (numbered 300 or above) courses in their major. Students are also required to complete University-wide General Education Requirements and the specific L&S requirements listed below.

To complete a major, students must satisfy all the requirements of the major as stated in this catalog. Students who declare their majors within five years of entering the UW System as a degree candidate may satisfy the requirements outlined in any catalog issued since the time they entered. Credits used to satisfy the major also may be used to satisfy other degree requirements.

University General Education Requirements (GER)

Code	Title	Credits
Oral and Written Communication		
<i>Part A</i>		
ENGLISH 102	College Writing and Research (or equivalent)	
<i>Part B</i>		

Course designated as OWC-B; may be completed through a major-specific course requirement

Quantitative Literacy

Part A

Select one of the following:

MATH 103	Contemporary Applications of Mathematics
MATH 105	Introduction to College Algebra
MATH 108	Algebraic Literacy II
MATH 111	Introduction to Logic - Critical Reasoning ¹
or PHILOS 111	Introduction to Logic - Critical Reasoning

Or equivalent course

Part B

Course designated as QL-B; may be completed through a major-specific course requirement

Arts

Select 3 credits 3

Humanities

Select 6 credits 6

Social Sciences

Select 6 credits 6

Natural Sciences

Select 6 credits (At least two courses including one lab) 6

UWM Foreign Language Requirement

Complete Foreign Language Requirement through:

- Two years (high school) of a single foreign language
- Two semesters (college) of a single foreign language

Or equivalent

UWM Cultural Diversity Requirement

One course from the Arts, Humanities, or Social Sciences must also satisfy UWM's Cultural Diversity requirement

¹ Math 111 and Philosophy 111 are jointly offered and count as repeats of one another. Students cannot receive credit for both courses.

College of Letters & Science Requirements

I. English Writing Requirement

Students must satisfy the English Writing Requirement by completing ENGLISH 102 with a grade of C or higher or by placing beyond English 102 on the English Placement Test (EPT).

Note: This requirement is the same as the University General Education Requirement for Oral and Written Communication Part A. The College of Letters & Science does not have a specific requirement for a writing course beyond English 102, but students must complete the university-wide requirement for Oral and Written Communication Part B listed above.

II. Mathematics and Formal Reasoning

To satisfy the Mathematics and Formal Reasoning Requirement, Bachelors of Sciences degree students must satisfy the following two requirements:

1. Complete one of the following courses or an equivalent course:

Code	Title	Credits
MATH 211	Survey in Calculus and Analytic Geometry	4
MATH 213	Calculus with Life Sciences Applications	4
MATH 221	Honors Calculus I	5
MATH 231	Calculus and Analytic Geometry I	4

2. Complete one course (at least 3 credits) at the 200 level or above chosen from courses in Mathematics, PHILOS 212, or Letters and Science statistics courses:

Code	Title	Credits
Complete one of the following:		
3 or more credits in any 200-level or above Math course		
AFRIC 220	Introduction to Statistics in African and African Diaspora Studies	
ANTHRO 568	Introduction to Anthropological Statistics	
ATM SCI 500	Statistical Methods in Atmospheric Sciences	
BIO SCI 465	Biostatistics	
ECON 210	Economic Statistics	
GEOG 247	Quantitative Analysis in Geography	
HIST 595	The Quantitative Analysis of Historical Data	
MTHSTAT 215	Elementary Statistical Analysis	
PHILOS 211	Elementary Logic	
POL SCI 390	Political Data Analysis	
POL SCI 392	Survey Research	
PSYCH 210	Psychological Statistics	
SOCIOL 261	Introduction to Statistical Thinking in Sociology	

Note: This requirement is NOT the same as the University General Education Requirement for Quantitative Literacy Part B. To complete the BS, students must take one of the L&S approved courses. The courses listed here will satisfy the QL-B requirement.

III. Foreign Language Requirement

Two courses (minimum of 6 credits) in a language (including American Sign Language) other than English at the 100 level or above are required.

Placement testing may be used to satisfy all or part of this requirement. Language courses (including American Sign Language) other than English taken in high school may be used to satisfy all or part of this requirement. One year of high school language equates to one semester of college work.

Completion of the L&S Language Requirement also satisfies the university-wide Foreign Language GER, but not vice versa.

IV. International Requirement

See Approved Courses for the L&S International Requirement (<http://catalog.uwm.edu/letters-science/approved-courses-international-requirement>) for course options.

Code	Title	Credits
Completed in one of the following ways:		9
Complete 3 courses (min. 9 cr) in a single foreign language (not including literature-in-translation or American Sign Language) at the 3rd semester level and above		
Complete 3 non-language courses (min. 9 credits) with an international content chosen from at least 2 curricular areas.		
Complete 9 credits in combination of the two options above.		

V. Breadth Requirement

Along with completing the University General Education Requirements of 3 credits in the Arts (A); 6 credits in the Humanities (HU), Social Sciences (SS), and Natural Sciences (NS/NS+); and a course with the Cultural Diversity (CD/+) designation, L&S students must complete the Breadth requirement.

Code	Title	Credits
Arts		
Select 3 credits		3
Humanities		
Complete 12 credits of L&S courses with Humanities Breadth designation; no more than 6 credits from a single subject area. *		12
Social Sciences		
Complete 12 credits of L&S Courses with Social Science Breadth designation; no more than 6 credits from a single curricular area. *		12
Natural Sciences		
Complete 12 credits of L&S Courses with Natural Sciences Breadth designation, including laboratory or field courses from three different curricular areas. *		12
Cultural Diversity		
Complete 3 credits in a course with Cultural Diversity (CD) designation. **		3

* Students should check their course selections carefully with the list of approved L&S Breadth Courses (<http://catalog.uwm.edu/letters-science/breadth-requirement-course-list>). Students are advised to select at least 6 credits worth of courses in each of the Humanities, Social Science, and Natural Sciences areas that can satisfy both the campus-wide General Education Requirements and the L&S Breadth requirement.

** Students are advised to select a course that satisfies the Cultural Diversity requirement as well as a Humanities or Social Science breadth/GER requirement.

VI. The Major

The College requires that students attain at least a 2.0 GPA in all credits in the major attempted at UWM. In addition, students must attain a 2.0 GPA on all major credits attempted, including any transfer work. Individual departments or programs may require higher GPAs for graduation. Some departmental majors require courses from other departments. Contact your major department for information on whether those credits will count as part of the major GPA. The College requires that students must complete in residence at UWM at least 15 credits in upper-division (numbered 300 or above) courses in their major.

Research Requirement

Within their majors, students must complete a research experience approved by the L&S faculty. A list of courses satisfying the research

requirement in each major can be found here (<http://catalog.uwm.edu/letters-science/approved-courses-research-requirement>).

VII. The Minor

The College requires that students attain at least a 2.0 GPA in all credits in the minor attempted at UWM. In addition, students must attain a 2.0 GPA on all minor credits attempted, including any transfer work.

Individual departments or programs may require higher GPAs for graduation.

Physics Major Requirements

Freshmen who enter with scores of 4 or 5 on the Physics Advanced Placement exam given by CEEB are given partial credit for the introductory courses.

Students who have a combined GPA of 2.500 or above in all mathematics and physics courses taken in the first two years will be approved for a major in physics. This requirement will be waived in those cases where students are able to show evidence of unusual circumstances.

The department offers two study options. The standard physics major is for students who seek a general physics degree. The physics major with astronomy emphasis is for students who wish to pursue their interest in astronomy. While the standard physics major generally is followed by students who plan to go on to graduate school, the major with astronomy emphasis also enables students to pursue graduate work in physics.

Both options require that students take at least 15 credits in advanced-level (numbered 300 and above) courses in residence at UWM. The College of Letters & Science requires that students attain at least a 2.0 GPA on all credits in the major attempted at UWM. In addition, students must attain a 2.0 GPA on all major credits attempted, including any transfer work. All students in the College are required to complete a research experience in their majors. Physics majors meet this requirement by successfully completing an upper-level, 3-credit laboratory courses.

Code	Title	Credits
Research Experience Requirement		
Select one of the following:		3
PHYSICS 406	Introduction to Infrared Microspectroscopy	
PHYSICS 408	Experiments in Linear Electronics	
PHYSICS 409	Modern Physics Laboratory	
PHYSICS 391 or PHYSICS 670	Undergraduate Research Participation ¹ Electron Microscopy Laboratory	
Study Options		
Select one of the following:		43-55
Standard Physics Major		
<i>Physics Major with Astronomy Emphasis</i>		
Total Credits		46-58

¹ The research proposal must be approved by the undergraduate advisor and the Departmental Undergraduate Committee; it must demonstrate clear pedagogical value. Unfocused laboratory internships are not acceptable.

Standard Physics Major

A minimum of 43 credits in physics, including:

Code	Title	Credits
Select one of the following options: ¹		
Option 1:		
PHYSICS 219	Physics I: Calculus-Based, Studio Format	
PHYSICS 220	Physics II: Calculus-Based, Studio Format	
Option 2:		
PHYSICS 209 & PHYSICS 214	Physics I (Calculus Treatment) and Lab Physics I (Calculus Treatment)	
PHYSICS 210 & PHYSICS 215	Physics II (Calculus Treatment) and Lab Physics II (Calculus Treatment)	
PHYSICS 309	Physics III: Modern Physics	3
PHYSICS 270 or PHYSICS 370	Introduction to Computational Physics Analytical and Numerical Methods in Physics	3
PHYSICS 317	Thermodynamics	3
PHYSICS 325	Optics	4
Select one of the following: ²		
PHYSICS 406	Introduction to Infrared Microspectroscopy	
PHYSICS 408	Experiments in Linear Electronics	
PHYSICS 409	Modern Physics Laboratory	
PHYSICS 670	Electron Microscopy Laboratory	
PHYSICS 391	Undergraduate Research Participation ³	
PHYSICS 411	Mechanics	4
PHYSICS 420	Electricity and Magnetism I	3
PHYSICS 422	Electricity and Magnetism II	3
PHYSICS 441	Introduction to Quantum Mechanics I	4
PHYSICS 442	Introduction to Quantum Mechanics II ⁴	3

Electives

Selecting electives are encouraged (see below)

Total Credits 43

¹ PHYSICS 219 and PHYSICS 220 are strongly recommended; however, PHYSICS 209/PHYSICS 214 and PHYSICS 210/PHYSICS 215 courses may be taken with the consent of the undergraduate advisor.

² These courses are **not** offered every semester; check with the undergraduate advisor to plan for completing this requirement.

³ The research proposal must be approved by the undergraduate advisor and the Departmental Undergraduate Committee, and it must demonstrate pedagogical value. Unfocused laboratory internships are not acceptable.

⁴ Students who major in both physics and engineering are not required to take PHYSICS 442; however, it is recommended strongly that they do so.

Electives

No elective courses are required, but students are encouraged to select electives from Physics or Astronomy courses 300 level or above from the following list. Only the courses identified in the list below with the phrase "if not selected above" will be counted in the student's major GPA.

Code	Title	Credits
ASTRON 400	Astrophysics I	3
ASTRON 401	Astrophysics II	3
PHYSICS 305	Medical Physics	3

PHYSICS 306	Introduction to Biophysics	3
PHYSICS 351	Basics of Condensed Matter Physics	3
PHYSICS 370	Analytical and Numerical Methods in Physics (if not selected above)	3
PHYSICS 391	Undergraduate Research Participation	1-6
PHYSICS 406	Introduction to Infrared Microspectroscopy (if not selected above)	3
PHYSICS 408	Experiments in Linear Electronics (if not selected above)	3
PHYSICS 409	Modern Physics Laboratory (if not selected above)	3
PHYSICS 515	Statistical Mechanics	3
PHYSICS 517	Special Relativity	3
PHYSICS 531	Principles of Quantum Mechanics I	3
PHYSICS 532	Principles of Quantum Mechanics II	3
PHYSICS 541	Elementary Particles	3
PHYSICS 551	Introduction to Solid State Physics I	3
PHYSICS 651	Introduction to Solid State Physics II	3
PHYSICS 670	Electron Microscopy Laboratory (if not selected above)	3

Physics Major with Astronomy Emphasis

A minimum of 55 credits in physics and astronomy courses, including:

Code	Title	Credits
Required		
Select one of the following options: ¹		10
Option 1:		
PHYSICS 219	Physics I: Calculus-Based, Studio Format	
PHYSICS 220	Physics II: Calculus-Based, Studio Format	
Option 2:		
PHYSICS 209 & PHYSICS 214	Physics I (Calculus Treatment) and Lab Physics I (Calculus Treatment)	
PHYSICS 210 & PHYSICS 215	Physics II (Calculus Treatment) and Lab Physics II (Calculus Treatment)	
PHYSICS 309	Physics III: Modern Physics	3
PHYSICS 270 or PHYSICS 370	Introduction to Computational Physics or Analytical and Numerical Methods in Physics	3
PHYSICS 325	Optics	4
PHYSICS 317	Thermodynamics	3
Select one of the following: ²		3
PHYSICS 406	Introduction to Infrared Microspectroscopy	
PHYSICS 408	Experiments in Linear Electronics	
PHYSICS 409	Modern Physics Laboratory	
PHYSICS 670	Electron Microscopy Laboratory	
PHYSICS 391	Undergraduate Research Participation ³	
PHYSICS 411	Mechanics	4
PHYSICS 420	Electricity and Magnetism I	3
PHYSICS 422	Electricity and Magnetism II	3
PHYSICS 441	Introduction to Quantum Mechanics I	4
PHYSICS 442	Introduction to Quantum Mechanics II	3

ASTRON 400	Astrophysics I	3
ASTRON 401	Astrophysics II	3

Electives

Select 6 credits from the following: 6

ASTRON 103	Survey of Astronomy	
or ASTRON 211	Principles of Astronomy	
ATM SCI 110	The Origin, Composition, and Structure of the Planetary Atmospheres	
GEO SCI 120	Geology of the Planets	
PHYSICS 391	Undergraduate Research Participation	
PHYSICS 517	Special Relativity	
PHYSICS 541	Elementary Particles	

Or another course approved by the undergraduate advisor

Recommended

Students are advised strongly to take the following courses as part of their electives:

CHEM 102	General Chemistry	
CHEM 104	General Chemistry and Qualitative Analysis	
COMMUN 103	Public Speaking	
ENGLISH 206	Technical Writing	

Total Credits 55

- ¹ PHYSICS 219 and PHYSICS 220 are strongly recommended; however, PHYSICS 209/PHYSICS 214 and PHYSICS 210/PHYSICS 215 courses may be taken with the consent of the undergraduate advisor.
- ² These courses are **not** offered every semester; check with the undergraduate advisor to plan for completing this requirement.
- ³ The research proposal must be approved by the undergraduate advisor and the Departmental Undergraduate Committee, and it must demonstrate pedagogical value. Unfocused laboratory internships are not acceptable.

Possible Course Substitutions for Students with Physics and Engineering Double Majors

Note: Students who major in both physics and engineering are not required to take PHYSICS 442; however, it is recommended strongly that they do so.

One of the following courses may be substituted for PHYSICS 270 or PHYSICS 370:

Code	Title	Credits
CIV ENG 280	Computer Based Engineering Analysis	3
COMPSCI 151	Introduction to Scientific Programming in Fortran	3
COMPSCI 250	Introductory Computer Programming	3

The following course may be substituted for PHYSICS 317:

Code	Title	Credits
MECHENG 301	Basic Engineering Thermodynamics	3

The combination of both of the following may substitute for PHYSICS 411:

Code	Title	Credits
CIV ENG 201	Statics	3
CIV ENG 202	Dynamics	3

15% will be calculated based on statistics from the previous comparable semester. Please note that for honors calculation, the GPA is **not** rounded and is truncated at the third decimal (e.g., 3.499).

Letters & Science Advising

The College of Letters and Science provides general academic advising for all students with a major in the College, particularly as it relates to campus' general education requirements and the College's degree requirements. We also provide specialized advising for pre-professional students (pre-med, pre-dental, pre-pharmacy, etc.) regardless if their major is in Letters and Science or not. Prospective students, including high school students and students seeking to transfer to a program in Letters and Science may also receive advising from our admissions counselors.

Upon admission, students are assigned an advisor in the College advising office. Academic advising is available Monday through Friday from 8:30 a.m. to 4:30 p.m. by appointment. Appointments outside of these times may be available and phone appointments are available for online students. The advising office (<https://uwm.edu/letters-science/advising/contact-advising>) is located on the first floor of Holton Hall. Current students should call (414) 229-4654 to schedule an appointment or use the Student Success Collaborative website (<https://uwmilwaukee.campus.eab.com>) to make an appointment with your assigned advisor; online scheduling is only available if you already have a Letters & Science advisor assigned to you. Prospective students should call (414) 229-7711 or email let-sci@uwm.edu.

When students declare a major, they will receive an additional faculty advisor located within the major department who will assist with requirements for that major. Students should read the "Declaration of Major" information on the website of the major that they are interested in. In some cases, the student will need to choose a faculty advisor as part of the declaration process.

All students are cautioned to consult their Letters & Science academic advisor AND their major advisor prior to each registration period to ensure they understand all requirements. Do not rely on pre-printed sample plans, as they are intended to be samples only and may not be right for your particular situation.

Honors in the College of Letters and Science

Dean's Honor List

GPA of 3.750 or above, earned on a full-time student's GPA on 12 or more graded credits in a given semester.

Honors Degree and Honors Degree with Thesis

Granted to graduating seniors who complete Honors College requirements, as listed in the Honors College (<http://catalog.uwm.edu/opportunities-resources/honors-college>) section of this site.

Commencement Honors

Students with a cumulative GPA of 3.500 or above, based on a minimum of 40 graded UWM credits earned prior to the final semester, will receive all-university commencement honors and be awarded the traditional gold cord at the December or May Honors Convocation. In schools and colleges in which fewer than 15% of the traditional students have a 3.500 GPA, all-university honors will be awarded to approximately the top 15% of graduating students. A criterion GPA (not lower than 3.200) for this

Final Honors

Earned on a minimum of 60 graded UWM credits: Cum Laude - 3.500 or above; Magna Cum Laude - 3.650 or above; Summa Cum Laude - 3.800 or above.

Contact Information

Current Students contact the Department directly, physics-ugadvisor@uwm.edu

Prospective Students contact a Letters & Science Admissions Counselor at

(414) 229-7711 or let-sci@uwm.edu

<https://uwm.edu/physics/undergraduate/>