PHYSICS, B.S. (BEHRENDRAND)

Begin Campus: Any Penn State Campus
End Campus: Erie

Degree Requirements
For the Bachelor of Science degree in Physics, a minimum of 122 credits is required:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Education</td>
<td>45</td>
</tr>
<tr>
<td>Electives</td>
<td>1</td>
</tr>
<tr>
<td>Requirements for the Major</td>
<td>94</td>
</tr>
</tbody>
</table>

18 of the 45 credits for General Education are included in the Requirements for the Major. This includes: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GWS courses.

Per Senate Policy 83.80.5, the college dean or campus chancellor and program faculty may require up to 24 credits of coursework in the major to be taken at the location or in the college or program where the degree is earned.

General Education
Connecting career and curiosity, the General Education curriculum provides the opportunity for students to acquire transferable skills necessary to be successful in the future and to thrive while living in interconnected contexts. General Education aids students in developing intellectual curiosity, a strengthened ability to think, and a deeper sense of aesthetic appreciation. These are requirements for all baccalaureate students and are often partially incorporated into the requirements of a program. For additional information, see the General Education Requirements (https://bulletins.psu.edu/undergraduate/general-education/baccalaureate-degree-general-education-program/) section of the Bulletin and consult your academic adviser.

The keystone symbol appears next to the title of any course that is designated as a General Education course. Program requirements may also satisfy General Education requirements and vary for each program.

Foundations (grade of C or better is required.)
- Quantification (GQ): 6 credits
- Writing and Speaking (GWS): 9 credits

Knowledge Domains
- Arts (GA): 6 credits
- Health and Wellness (GHW): 3 credits
- Humanities (GH): 6 credits
- Social and Behavioral Sciences (GS): 6 credits
- Natural Sciences (GN): 9 credits

Integrative Studies (may also complete a Knowledge Domain requirement)
- Inter-Domain or Approved Linked Courses: 6 credits

University Degree Requirements
First Year Engagement
All students enrolled in a college or the Division of Undergraduate Studies at University Park, and the World Campus are required to take 1 to 3 credits of the First-Year Seminar, as specified by their college First-Year Engagement Plan.

Other Penn State colleges and campuses may require the First-Year Seminar; colleges and campuses that do not require a First-Year Seminar provide students with a first-year engagement experience.

First-year baccalaureate students entering Penn State should consult their academic adviser for these requirements.

Cultures Requirement
6 credits are required and may satisfy other requirements
- United States Cultures: 3 credits
- International Cultures: 3 credits

Writing Across the Curriculum
3 credits required from the college of graduation and likely prescribed as part of major requirements.

Total Minimum Credits
A minimum of 120 degree credits must be earned for a baccalaureate degree. The requirements for some programs may exceed 120 credits. Students should consult with their college or department adviser for information on specific credit requirements.

Quality of Work
Candidates must complete the degree requirements for their major and earn at least a 2.00 grade-point average for all courses completed within their degree program.

Limitations on Source and Time for Credit Acquisition
The college dean or campus chancellor and program faculty may require up to 24 credits of course work in the major to be taken at the location or in the college or program where the degree is earned. Credit used toward degree programs may need to be earned from a particular source or within time constraints (see Senate Policy 83-80 (http://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#83-80)). For more information, check the Suggested Academic Plan for your intended program.

Requirements for the Major
Each student must earn at least a grade of C in each 300- and 400-level course in the major field.

To graduate, a student enrolled in the major must earn a grade of C or better in each course designated by the major as a C-required course, as specified by Senate Policy 82-44 (http://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#82-44).

Common Requirements for the Major (All Options)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 111</td>
<td>Experimental Chemistry I</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 112</td>
<td>Chemical Principles II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 113</td>
<td>Experimental Chemistry II</td>
<td>1</td>
</tr>
<tr>
<td>CMPSC 121</td>
<td>Introduction to Programming Techniques</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 202C</td>
<td>Effective Writing: Technical Writing</td>
<td>3</td>
</tr>
<tr>
<td>MATH 220</td>
<td>Matrices</td>
<td>2</td>
</tr>
<tr>
<td>MATH 230</td>
<td>Calculus and Vector Analysis</td>
<td>4</td>
</tr>
<tr>
<td>MATH 251</td>
<td>Ordinary and Partial Differential Equations</td>
<td>4</td>
</tr>
</tbody>
</table>
## Prescribed Courses: Require a grade of C or better

<table>
<thead>
<tr>
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</tr>
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<tbody>
<tr>
<td>CHEM 110</td>
<td>Chemical Principles I</td>
<td>3</td>
</tr>
<tr>
<td>MATH 140</td>
<td>Calculus With Analytic Geometry I</td>
<td>4</td>
</tr>
<tr>
<td>MATH 141</td>
<td>Calculus with Analytic Geometry II</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 211</td>
<td>General Physics: Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 212</td>
<td>General Physics: Electricity and Magnetism</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 213</td>
<td>General Physics: Fluids and Thermal Physics</td>
<td>2</td>
</tr>
<tr>
<td>PHYS 214</td>
<td>General Physics: Wave Motion and Quantum Physics</td>
<td>2</td>
</tr>
<tr>
<td>PHYS 237</td>
<td>Introduction to Modern Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 400</td>
<td>Intermediate Electricity and Magnetism</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 419</td>
<td>Theoretical Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 420</td>
<td>Thermal Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 421W</td>
<td>Research Methods in Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 458</td>
<td>Intermediate Optics</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 494</td>
<td>Physics Research Project</td>
<td>3</td>
</tr>
</tbody>
</table>

## Additional Courses

### Additional Courses: Require a grade of C or better

Select 12 credits of the following:

- MATH 421 Complex Analysis
- MATH 455 Introduction to Numerical Analysis I
- MATH 456 Introduction to Numerical Analysis II
- PHYS 402 Electronics for Scientists
- PHYS 414 Solid State Physics
- PHYS 446 The Year in Physics: A Seminar on the Latest Research
- PHYS 494 Physics Research Project (1-3 credits)
- PHYS 495 Internship (1-3 credits)

## Supporting Courses and Related Areas

Select one of the following two sequences:

### Sequence A

- Select 8 credits of a foreign language
- Select 5 credits from a school-approved list

### Sequence B

- CMPSC 122 Intermediate Programming
- Select one of the following:
  - CMPSC 459 Scientific Visualization
  - CMPSC 465 Data Structures and Algorithms
  - CMPSC 474 Operating System & Systems Programming
- Select 7 credits from a school-approved list

1. Proficiency demo by examination or coursework to the level of the second semester in a foreign language is required. If fewer than 8 credits are needed to reach the required proficiency, students choose selections from a school-approved list to make a total of 8 credits.
2. Course requires a grade of C or better.

## Requirements for the Option

### Computational Physics Option (28 credits)

#### Prescribed Courses

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<tr>
<td>CMPSC 122</td>
<td>Intermediate Programming</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Additional Courses

### Additional Courses: Require a grade of C or better

Select one of the following:

- CMPSC 459 Scientific Visualization
- CMPSC 465 Data Structures and Algorithms
- CMPSC 474 Operating System & Systems Programming

Select 12 credits of the following:

- EE 352: Signals and Systems: Continuous and Discrete-Time
- EE 453: Fundamentals of Digital Signal Processing
- MATH 456: Introduction to Numerical Analysis II
- ME 410: Heat Transfer
- ME 428: Applied Computational Fluid Dynamics
- PHYS 410: Introduction to Quantum Mechanics I
- PHYS 414: Solid State Physics
- PHYS 446: The Year in Physics: A Seminar on the Latest Research
- PHYS 494: Physics Research Project (1-3 credits)
- PHYS 495: Internship (1-3 credits)

### Supporting Courses and Related Areas

Select 3 credits from a school-approved list

## General Physics Option (28 credits)

#### Prescribed Courses

### Prescribed Courses: Require a grade of C or better

- PHYS 410: Introduction to Quantum Mechanics I

Select one of the following two sequences:

### Sequence A

- Select 8 credits of a foreign language
- Select 5 credits from a school-approved list

### Sequence B

- Select 7 credits from a school-approved list

1. Proficiency demo by examination or coursework to the level of the second semester in a foreign language is required. If fewer than 8 credits are needed to reach the required proficiency, students choose selections from a school-approved list to make a total of 8 credits.
2. Course requires a grade of C or better.