

Physics, B.A.

B.A. in Physics

The Bachelor of Arts degree in Physics offers a flexible program that allows students to combine the study of Physics with the opportunity to do intensive work in substantive areas such as liberal arts, teaching, business or law. With up to 80 units of free electives, it is feasible for students to obtain, for example, an additional major with a department in the Dietrich College of Humanities and Social Sciences, the College of Fine Arts, or the Tepper School of Business. It is expected that students will focus their elective courses in a well-defined academic area. Students must meet with the Director of Undergraduate Affairs and construct an approved plan of study.

The core requirements for the B.A. degree are very similar as for the B.S. degree, but 6 fewer Technical Electives are required for the B.A. than the B.S., making room for more Free Electives. All of the B.A. requirements are listed below.

Degree Requirements

Physics Core

All physics majors take these courses in physics, which are designed to teach the fundamentals required for any specialty. Most students take the 100-level courses in their first year of study, the 200-level courses in their second year, and the 300-level courses in their third or fourth year.

	Units
33-121 Physics I for Science Students	12
or 33-151 Matter and Interactions I	
33-142 Physics II for Engineering and Physics Students	12
or 33-152 Matter and Interactions II	
33-104 Experimental Physics	9
33-201 Physics Sophomore Colloquium I	2
33-211 Physics III: Modern Essentials	10
33-231 Physical Analysis	10
33-202 Physics Sophomore Colloquium II	2
33-228 Electronics I	10
33-232 Mathematical Methods of Physics	10
33-234 Quantum Physics	10
33-301 Physics Upperclass Colloquium I	1
33-331 Physical Mechanics I	10
33-338 Intermediate Electricity and Magnetism I	10
33-341 Thermal & Statistical Physics	10
33-302 Physics Upperclass Colloquium II	1
33-340 Modern Physics Laboratory	10
Total Physics Core Units	129

Mathematics Core

All Physics Majors take these courses from the Department of Mathematics to support their studies in Physics.

	Units
21-120 Differential and Integral Calculus	10
21-122 Integration and Approximation	10
21-259 Calculus in Three Dimensions	10
Total Mathematics Core Units	30

Technical Core

All students in the Mellon College of Science take courses in the Life Sciences, Physical Sciences, and Mathematics, Statistics, or Computer Science to gain the technical breadth necessary for interdisciplinary work. The following three courses are required for physics majors to give them the technical breadth they need while also satisfying the college-level requirements.

	Units
03-121 Modern Biology ⁹	9
09-105 Introduction to Modern Chemistry I ¹⁰	10

15-112 Fundamentals of Programming and Computer Science ¹¹	10-12
or 15-110 Principles of Computing	
or 02-120 Programming for Scientists	

Total Technical Core Units 29-31

⁹ If 03-121 is satisfied through placement credit, students should refer to the Mellon College of Science's Life Sciences list to fulfill technical breadth requirement A.

¹⁰ If 09-105 is satisfied through placement credit, students should refer to the Mellon College of Science's Physical Sciences list to fulfill technical breadth requirement B.

¹¹ If 15-110 or 15-112 is satisfied through placement credit, students should refer to the Mellon College of Science's STEM course list to fulfill technical breadth requirement D.

Technical Electives

While students pursuing a B.S. in Physics are required to take a minimum of 8 Physics, Mathematics, and STEM electives, students pursuing a B.A. in Physics need only take a minimum of 2 Qualifying Physics Electives. (p.)

	Units
33-xxx Two Qualifying Physics Electives	18-24
Total Technical Electives	18-24

Non-Technical Electives

The Mellon College of Science requires that all students take a variety of non-technical courses to strengthen their understanding of both themselves and the world at large.

	Units
99-101 Core@CMU	3
76-101 Interpretation and Argument	9
38-101 EUREKA!: Discovery and Its Impact	6
38-110 ENGAGE in Service	1
38-220 ENGAGE in the Arts	2
38-230 ENGAGE in Wellness: Looking Inward	1
38-330 ENGAGE in Wellness: Looking Outward	1
38-304 Reading and Writing Science ¹²	6
38-430 ENGAGE in Wellness: Looking Forward	1
xx-xxx Cultural/Global Understanding Elective ¹³	9
xx-xxx Four Non-Technical Breadth Electives ¹⁴	36
Total Non-Technical Elective Units	75

¹² Refer to the Mellon College of Science's Science and Society list for alternate courses that will fulfill this requirement. Placement credit may not be used.

¹³ Refer to the Mellon College of Science's Cultural/Global Understanding list for courses that will fulfill this requirement. Placement credit may not be used.

¹⁴ Refer to the Mellon College of Science's Arts, Humanities, and Social Sciences section for courses that will fulfill the non-technical electives requirement. Up to 18 units may be fulfilled through placement credit.

Free Electives

All students must complete a minimum of 360 units to earn a bachelor's degree in the Mellon College of Science. Students are welcome to take more than the minimum 360 units required. The B.A. in Physics replaces 6 Technical Electives with Free Electives, compared to the B.S. in Physics.

	Units
xx-xxx Free Electives ¹⁵	72-80
Total Free Electives	72-80

¹⁵ A maximum of 9 units of physical education and/or military science and/or STUCO courses may be counted towards degree requirements as free electives.

Physics Electives

Physics Breadth Electives

Students pursuing a B.S. in Physics must take at least one course from the Physics Breadth Elective list to gain experience in a subfield of physics. Some tracks have this course prescribed, while others allow free choice from this list. All of these courses may also be taken as Qualifying Physics Electives, but they may not fulfill both requirements simultaneously.

		Units
33-224	Stars, Galaxies and the Universe	9
33-226	Physics of Energy	9
33-353	Intermediate Optics	12
33-355	Nanoscience and Nanotechnology	9
33-431	Stars and Black Holes	9
33-432	Galaxies	9
33-433	Cosmology	9
33-441	Introduction to Biophysics	10
33-444	Introduction to Nuclear and Particle Physics	9
33-448	Introduction to Solid State Physics	9
33-650	General Relativity	9

Total Physics Breadth Elective Units 9-12

Qualifying Physics Electives

Students pursuing a B.S. in Physics must take at least three courses totaling at least 27 units from the Qualifying Physics Elective list, not including the 100-level courses. Some tracks have these courses prescribed, while others allow free choice from this list, enabling students to choose between broad and in-depth study.

Students pursuing a B.A. in Physics must take at least two courses totaling at least 18 units from this list and may take **only one** of the 100-level courses.

Students pursuing a Minor in Physics must take at least three courses totaling at least 27 units from this list or non-prescribed courses from the Physics Core list.

While all courses on the Physics Breadth Elective list are also on the Qualifying Physics Elective list, a course may not fulfill both requirements simultaneously. Certain courses are offered only in alternate years, as indicated.

33-114	Physics of Musical Sound (B.A. and Minor only) ^a	9
33-115	Physics for Future Presidents (B.A. and Minor only) ^a	9
33-120	Science and Science Fiction (B.A. and Minor only) ^a	9
33-224	Stars, Galaxies and the Universe	9
33-226	Physics of Energy	9
33-241	Introduction to Computational Physics	9
33-332	Physical Mechanics II	10
33-339	Intermediate Electricity and Magnetism II	10
33-342	Advanced Thermal & Statistical Physics	10
33-350	Undergraduate Research ^b	Var.
33-353	Intermediate Optics	12
33-355	Nanoscience and Nanotechnology	9
33-431	Stars and Black Holes	9
33-432	Galaxies	9
33-433	Cosmology	9
33-441	Introduction to Biophysics	10
33-444	Introduction to Nuclear and Particle Physics	9
33-445	Advanced Quantum Physics I	9
33-446	Advanced Quantum Physics II	9
33-448	Introduction to Solid State Physics	9
33-451	Senior Research ^b	Var.
33-456	Advanced Computational Physics	9
33-499	Supervised Reading ^b	Var.
33-650	General Relativity	9

33-658	Quantum Computation and Quantum Information Theory	10
33-659	Modern Topics in Condensed Matter Physics	12
33-7xx	Physics Graduate Level Courses (see list below)	

Total Qualifying Physics Electives Units 27-37

- a Only one of these three courses (33-114, 33-115, and 33-120) may be used for the B.A. These classes may not be used as Qualifying Physics Electives for the B.S.
- b Only one of these three courses (33-350, 33-451, and 33-499) of 9 units may be used as a Qualifying Physics Elective. To be counted as a Qualifying Physics Elective, all 9 units must be taken in a single semester. Any exceptions must be approved by the Director of Undergraduate Affairs.

Qualifying Physics Electives Recommended for Physics Graduate School

Students planning to undertake graduate studies in physics are strongly advised to take the following courses, which may count as Qualifying Physics Electives and STEM Electives.

		Units
33-332	Physical Mechanics II	10
33-339	Intermediate Electricity and Magnetism II	10
33-445	Advanced Quantum Physics I	9
33-446	Advanced Quantum Physics II	9

Physics Graduate Courses

These courses are intended for graduate students in physics, but may be taken by advanced undergraduates as Qualifying Physics or STEM Electives. **Undergraduate students require special permission of both the course instructor and the Director of Undergraduate Affairs to register for these classes.**

		Units
33-731	Stars and Black Holes	12
33-732	Galaxies	12
33-733	Cosmology	12
33-755	Quantum Mechanics I	12
33-756	Quantum Mechanics II	12
33-757	Classical Mechanics	12
33-761	Classical Electrodynamics I	12
33-762	Classical Electrodynamics II	12
33-765	Statistical Mechanics	12
33-767	Biophysics: From Basic Concepts to Current Research	12
33-769	Quantum Mechanics III: Many Body and Relativistic Systems	12
33-770	Field Theory I	12
33-771	Field Theory II	12
33-779	Introduction to Nuclear and Particle Physics	12
33-780	Nuclear and Particle Physics II	12
33-783	Solid State Physics	12