BACHELOR OF ARTS IN PHYSICS

Undergraduate Programs in Physics and Astronomy

High school preparation for undergraduate programs in physics, astronomy, and astrophysics should include four years of math at least through pre-calculus and one year each of chemistry, physics, and computer programming. Students are strongly encouraged to periodically meet with a major advisor to review course selection and degree progress.

The B.A. degrees are ideal for students who want a strong background in physical science but desire more flexibility to blend their curriculum with "liberal arts" and other interests. Students with B.A. degrees often pursue careers in teaching, science communication & journalism, science outreach (at science museums, planetaria & public observatories), medical, dental, and other health fields, or business sub-fields in which a rigorous scientific background is beneficial. The B.S. degrees require more in-depth technical training, advanced laboratory experiences, and specialized elective topics. Students with B.S. degrees often pursue science and engineering careers in colleges & universities, industrial research & development labs, or government labs & agencies, or pursue advanced graduate degrees in physics, astronomy, planetary science, or engineering. The B.S. Physics, Concentration in Physics for Teaching allows for a very versatile curriculum that can be combined with Mathematics, Chemistry, or Earth & Climate Sciences to provide breadth across the physical sciences ideal for future K-12 teachers.

Program Learning Outcomes

Graduates with physics, astronomy, and astrophysics degrees will be able to:

1.) Describe universal physical principles in classical mechanics, electricity & magnetism, special & general relativity, thermodynamics & statistical mechanics, quantum mechanics, astronomy & astrophysics, and relate fundamental conservation principles (conservation of energy, conservation of linear momentum, conservation of angular momentum) to underlying symmetries of nature.

2.) Analyze real-world physical systems on Earth and throughout the Universe, develop simplified models of such systems, translate physical principles into the language of mathematics, and then apply the appropriate mathematical tools (vector calculus, linear algebra, differential equations, variational techniques, probability & statistics, numerical & computational methods) to determine a system's spatiotemporal evolution with an awareness of the limitations of any solutions due to the approximations of the physical models and/or mathematical/computational techniques.

3.) Demonstrate proficiency with basic laboratory skills and experimental techniques with electronics, lasers & optical devices, sensors, detectors, microscopes, and telescopes, always with appropriate safety practices (especially with respect to lasers, chemicals, radioactive materials).

4.) Articulate and apply the "scientific method," the empirical, iterative method of acquiring new knowledge through developing models to explain observations of the natural world, formulating testable hypotheses, designing and executing experimental, computational, and theoretical investigations to test predictions, analyzing data with appropriate statistics and attention to uncertainties, ascertaining consistency with existing theories, and sharing results with the broader scientific community for confirmation and validation.

5.) Demonstrate writing, speaking, and visual data presentation skills to effectively communicate science at the appropriate level of sophistication for the relevant target audience (e.g., instructors, students, scientists, public-at-large, policy-makers).

6.) Develop the social and communication skills to effectively participate in diverse scientific teams, including those that are multidisciplinary and/or interdisciplinary, and appreciate that the pursuit of science is a human endeavor and that progress is best made when the full spectrum of humanity is encouraged to participate and share their perspectives, passions, and skills.

7.) Engage local, state, national & global communities to address current and emerging scientific and technological challenges in equitable and environmentally sustainable ways.

Physics (B.A.) — 54 units

- All Major Lower-Division Prerequisites and Major Upper-Division Core courses must be taken for letter grades.
- Lower-division courses must be taken for letter grades and be passed with grades of C or better.
- Up to a maximum of 3 units of Major Upper-Division Electives may be taken on a CR/NC basis in courses where CR/NC is allowed.

Lower-Division Prerequisites (28-31 units)

Code	Title	Units
MATH 226	Calculus I	4
MATH 227	Calculus II	4
MATH 228	Calculus III	4
Select One:		3-6
MATH 245	Elementary Differential Equations and Linear Algebra	
MATH 225 & MATH 376	Introduction to Linear Algebra and Ordinary Differential Equations I	
PHYS 200	Planning for Success as a Physics & Astronomy Major	1
PHYS 220 & PHYS 222	General Physics with Calculus I and General Physics with Calculus I Laboratory	4
PHYS 230 & PHYS 232	General Physics with Calculus II and General Physics with Calculus II Laboratory	4
PHYS 240 & PHYS 242	General Physics with Calculus III and General Physics with Calculus III Laboratory	4

Upper-Division Requirements (20 units)

Code	Title	Units
Select One:		3
CSC 309	Computer Programming	
MATH 209	Mathematical Computing	
PHYS 320	Modern Physics I	3
PHYS 321	Modern Physics Laboratory	2
PHYS 330	Analytical Mechanics I	3
PHYS 360	Electricity and Magnetism I	3

PHYS 370	Thermodynamics and Statistical Mechanics	3
PHYS 385	Introduction to Theoretical Physics I	3

Electives (0-3 units)

Choose enough upper division PHYS and/or ASTR course to reach 54 units for the major. Students who take MATH 225 & MATH 376 will not need to take a PHYS or ASTR elective.

Culminating Experience (3 units)

Code	Title	Units
PHYS 491GW	Advanced Laboratory Techniques I - GWAR	3

Complementary Studies

Upon completion of the BA in Physics program, students will have taken 12 units of calculus courses that satisfy complementary studies.

Requirement	Course Level	Units	Area Designation
Oral Communication	LD	3	A1
Written English Communication	LD	3	A2
Critical Thinking	LD	3	A3
Physical Science	LD	3	B1
Life Science	LD	3	B2
Lab Science	LD	1	B3
Mathematics/ Quantitative Reasoning	LD	3	B4
Arts	LD	3	C1
Humanities	LD	3	C2
Arts or Humanities	LD	3	C1 or C2
Social Sciences	LD	3	D1
Social Sciences: US History	LD	3	D2
Lifelong Learning and Self-Development (LLD)	LD	3	E
Ethnic Studies	LD	3	F
Physical and/or Life Science	UD	3	UD-B
Arts and/or Humanities	UD	3	UD-C
Social Sciences	UD	3	UD-D
SF State Studies			
Courses certified as meeting the SF State Studies requirements may be upper or lower division in General Education (GE), a major or minor, or an elective.			
American Ethnic and Racial Minorities	LD or UD	3	AERM
Environmental Sustainability	LD or UD	3	ES
Global Perspectives	LD or UD	3	GP
Social Justice	LD or UD	3	SJ

Note: LD = Lower-Division; UD = Upper-Division.

First-Time Student Roadmap (4 Year)

The roadmaps presented in this Bulletin are intended as suggested plans of study and do not replace meeting with an advisor. For a more personalized roadmap, please use the Degree Planner (https://registrar.sfsu.edu/degreeplanner/) tool found in your Student Center.

First-Time Student Roadmap (http://bulletin.sfsu.edu/colleges/science-engineering/physics-astronomy/ba-physics/roadmap-i-ii-eng/)

Transfer Student Roadmap (2 Year)

For students with an AS-T in **Physics**.
PHYS ADT Roadmap (http://bulletin.sfsu.edu/colleges/science-engineering/physics-astronomy/ba-physics/adt-roadmap/)

This degree program is an approved pathway ("similar" major) for students earning the ADT in Physics

California legislation SB 1440 (2009) mandated the creation of the Associate Degree for Transfer (ADT) to be awarded by the California Community Colleges. Two types of ADTs are awarded: Associate in Arts for Transfer (AA-T) and Associate in Science for Transfer (AS-T).

Note: no specific degree is required for admission as an upper-division student. However, the ADT includes specific guarantees related to admission and graduation and is designed to clarify the transfer process and strengthen lower-division preparation for the major.

An ADT totals 60 units and in most cases includes completion of all lower-division General Education requirements and at least 18 units in a specific major. (The Biology, Chemistry, and Environmental Science AS-T degrees defer 3 units in lower-division GE area C and 3 units in lower-division GE area D until after transfer.) Students pursuing an ADT are guaranteed admission to the CSU if minimum eligibility requirements are met, though not necessarily to the CSU campus of primary choice.

Upon verification that the ADT has been awarded prior to matriculation at SF State, students are guaranteed B.A. or B.S. completion in 60 units if pursuing a "similar" major after transfer. Determinations about "similar" majors at SF State are made by faculty in the discipline.

Degree completion in 60 units cannot be guaranteed when a student simultaneously pursues an additional major, a minor, certificate, or credential.

A sample advising roadmap for students who have earned an ADT and continue in a "similar" major at SF State is available on the Roadmaps tab on the degree requirements page for the major. The roadmap displays:

- How many lower-division units required for the major have been completed upon entry based on the award of a specific ADT;
- Which lower-division requirements are considered complete upon entry based on the award of a specific ADT;
- How to complete the remaining 60 units for the degree in four semesters.

Students who have earned an ADT should seek advising in the major department during the first semester of attendance.

General Advising Information for Transfer Students

a. Before transfer, complete as many lower-division requirements or electives for this major as possible.
b. The following courses are not required for admission but are required for graduation. Students are strongly encouraged to complete these units before transfer; doing so will provide more flexibility in course selection after transfer.
    - a course in U.S. History
    - a course in U.S. & California Government

For information about satisfying the requirements described in (1) and (2) above at a California Community College (CCC), please visit http://www.assist.org (http://assist.org). Check any geographically accessible CCCs; sometimes options include more than one college. Use ASSIST to determine:

- Which courses at a CCC satisfy any lower-division major requirements for this major;
- Which courses at a CCC satisfy CSU GE, US History, and US & CA Government requirements.

Remedial courses are not transferable and do not apply to the minimum 60 semester units/90 quarter units required for admission.

Additional units for courses that are repeated do not apply to the minimum 60 units required for upper-division transfer (for example, if a course was not passed on the first attempt or was taken to earn a better grade).

Before leaving the last California Community College of attendance, obtain a summary of completion of lower-division General Education units (IGETC or CSU GE Breadth). This is often referred to as a GE certification worksheet. SF State does not require delivery of this certification to Admissions, but students should retain this document for verifying degree progress after transfer.

Credit for Advanced Placement, International Baccalaureate, or College-Level Examination Program courses: AP/IB/CLEP credit is not automatically transferred from the previous institution. Units are transferred only when an official score report is delivered to SF State. Credit is based on the academic year during which exams were taken. Refer to the University Bulletin in effect during the year of AP/IB/CLEP examination(s) for details regarding the award of credit for AP/IB/CLEP.

Students pursuing majors in science, technology, engineering, and mathematics (STEM) disciplines often defer 6-9 units of lower-division General Education in Areas C and D until after transfer to focus on preparation courses for the major. This advice does not apply to students pursuing associate degree completion before transfer.

Transferring From Institutions Other Than CCCs or CSUs

Review SF State's lower-division General Education requirements. Note that, as described below, the four basic skills courses required for admission meet A1, A2, A3, and B4 in the SF State GE pattern. Courses that fulfill the remaining areas of SF State's lower-division GE pattern are available at most two-year and four-year colleges and universities.

Of the four required basic skills courses, a course in critical thinking (A3) may not be widely offered outside the CCC and CSU systems. Students should attempt to identify and take an appropriate course no later than the term of application to the CSU. To review more information about the A3 requirement, please visit bulletin.sfsu.edu/undergraduate-education/general-education/lower-division/#AAEL.

Waiting until after transfer to take a single course at SF State that meets both US and CA/local government requirements may be an appropriate option, particularly if transferring from outside of California.