

CHEMISTRY, B.S. (SCIENCE)

Begin Campus: Any Penn State Campus

End Campus: University Park

Program Description

This major provides a strong foundation in the theory and practice of chemistry. Mathematics and physics are emphasized, since these subjects are essential to the understanding of chemistry. Courses in English and electives ensure study in non-technical subjects which broaden the student's general education and enables him or her to relate the major to other fields of knowledge.

What is Chemistry?

Chemistry is the study of matter and its transformations. Chemists seek a molecular-level understanding of the ways in which atoms combine to form molecules and bulk materials, how molecular structure and interactions lead to macroscopic material properties, and how chemical transformations can be used to create useful materials and store energy.

You Might Like This Program If...

- You are curious about why the materials you encounter in daily life have certain properties and interact in myriad ways.
- You want to use advanced instrumentation to measure the composition, behaviors, and properties of molecules, atoms, and materials.
- You want to help create new and better chemicals for personal care, medicine, construction, agriculture, or energy storage.

Entrance to Major

In order to be eligible for entrance to the Chemistry major, a student must have:

1. Attained at least a 2.00 cumulative grade-point average
2. Completed and earned both a grade of C or better and a combined grade point average of at least 2.50 in each of the following courses: CHEM 110, CHEM 111, CHEM 112, CHEM 113, CHEM 210, MATH 140, and MATH 141. Note: If courses are repeated, only the higher grade will be used in this calculation.

Degree Requirements

For the Bachelor of Science degree in Chemistry, a minimum of 125 credits is required:

Requirement	Credits
General Education	45
Requirements for the Major	94

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 (<http://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

15 of these 45 credits are included in the Requirements for the Major.

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

This requirement includes 15 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses.

A cumulative grade point average of at least a 2.00 is required in these courses. A grade of C or better is required in all courses within 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>).

Code	Title	Credits
Prescribed Courses		
PHYS 211	General Physics: Mechanics	4
PHYS 212	General Physics: Electricity and Magnetism	4
PHYS 213	General Physics: Fluids and Thermal Physics	2
PHYS 214	General Physics: Wave Motion and Quantum Physics	2
MATH 231	Calculus of Several Variables	2
CHEM 316	The Professional Chemist	1
<i>Prescribed Courses: Require a grade of C or better</i>		
CHEM 110	Chemical Principles I	3
CHEM 111	Experimental Chemistry I	1
CHEM 112	Chemical Principles II	3
CHEM 113	Experimental Chemistry II	1
MATH 140	Calculus With Analytic Geometry I	4
MATH 141	Calculus with Analytic Geometry II	4
CHEM 210	Organic Chemistry I	3
CHEM 212	Organic Chemistry II	3
CHEM 213	Laboratory in Organic Chemistry	2
CHEM 227	Analytical Chemistry	4
CHEM 310	Introductory Inorganic Chemistry	3
CHEM 450	Physical Chemistry - Thermodynamics	3
CHEM 452	Physical Chemistry - Quantum Chemistry	3
CHEM 457	Experimental Physical Chemistry	2
Additional Courses		
MATH 250 or STAT 401	Ordinary Differential Equations Experimental Methods	3
<i>Additional Courses: Require a grade of C or better</i>		
Select one of the following advanced laboratory courses:		4
CHEM 423W	Chemical Spectroscopy	
CHEM 425W	Chromatography and Electrochemistry	
CHEM 431W	Organic and Inorganic Preparations	
CHEM 459W	Advanced Experimental Physical Chemistry	
Select 16 credits of chemistry at the 400 level ¹		16
Supporting Courses and Related Areas		

Select 17 credits of any courses not on the Chemistry Department list 17 of excluded courses ²

¹ Up to 6 co-op credits (2 each of SC 295, SC 395, SC 495) may be used in this category. CHEM 494 may be used, but the total of CHEM 494 credits plus co-op credits may not exceed 8.

² CHEM 494 may not be used, and only one credit of each SC 295, SC 395, and SC 495 is allowed in this category.

Integrated B.S. in Chemistry/M.Ed. in Curriculum and Instruction

These Integrated Undergraduate/Graduate (IUG) degree programs combine the Bachelor of Science in Chemistry with the Master of Education in Curriculum and Instruction, Science Education emphasis. The programs are designed to be completed in five years. The programs enable highly qualified and motivated students to delve deeply into a scientific content area and to pursue graduate level preparation in the theory and practice of teaching.

For detailed instructions on applying to the program, please consult the "Application Process" section of the IUG description for the Chemistry B.S. degree in the Undergraduate Bulletin. Application materials to be submitted include an undergraduate transcript, statement of purpose, draft plan of study, two letters of recommendation, and concurrent submission of an application for master's study to the graduate program in Curriculum and Instruction, Science Education emphasis area. Additional details about the graduate application procedure can be found above in the section, "Admissions Requirements."

IUG students fulfill all degree requirements for a B.S. in the Eberly College of Science. If a student chooses to leave the program without completing M.Ed. requirements, he or she may still receive the relevant B.S. degree, after all B.S. requirements are completed.

For the M.Ed. degree, students must earn at least 30 credits at the 400/500 level, at least 18 of them at the 500 level. One graduate semester is devoted to full time student teaching. Additional graduate coursework is completed in a second graduate semester. Courses required for the M.Ed. degree include:

Code	Title	Credits
SCIED 552	Science Teaching and Learning	3
SCIED 558	Research Problems in Science Teaching	3
	500-level EDTHP course	3
CI 590	Colloquium	1
CI 595	Internship in Curriculum, Supervision, or Instruction	12
CI 550	Overview of Contemporary School Curriculum (or other 500-level course in curriculum)	3

Of these, SCIED 558 and CI 595 comprise the student teaching semester course load.

124 credits are required for the B.S. degree and 30 credits for the M.Ed. degree. The following courses may be double-counted toward both the B.S. and the M.Ed. degrees, up to a limit of 12 credits:

Code	Title	Credits
500-level EDTHP courses		3
SCIED 411 & SCIED 412	Teaching Secondary Science I and Teaching Secondary Science II	6
500-level SCIED courses		

Note that at least 50% of credits proposed for double-counting must be at the 500 level.

There are a number of other requirements for Pennsylvania teacher certification, including state-required tests and clearances, as well as coursework that can be completed at either the undergraduate or graduate level. Some courses, not enumerated above, that are usually required to satisfy teacher certification requirements include the following:

Code	Title	Credits
CI 280	Introduction to Teaching English Language Learners	3
SPLED 400	Inclusive Special Ed Foundations: Legal, Characteristics, Collaboration, Assessment, and Management	3
CI 495C	Clinical Application of Instruction -- Secondary Education	3

Please note that changes in Pennsylvania certification requirements are common; students should check the Certification FAQ page at the Penn State Science Education website for updates and clarification about the specific requirements that affect them, based on their admission date to the IUG program option. Note also that students in the IUG program option are not required to complete all Penn State teacher certification requirements in order to receive their B.S. and M.Ed. degrees, as long as they have completed the requirements for those degrees, as described in the undergraduate and graduate Bulletins. For example, a student who has completed all degree requirements but has not yet received a score for the Pennsylvania-required Biology PRAXIS exam may be awarded both of his or her earned degrees.

Academic Advising

The objectives of the university's academic advising program are to help advisees identify and achieve their academic goals, to promote their intellectual discovery, and to encourage students to take advantage of both in-and-out-of class educational opportunities in order that they become self-directed learners and decision makers.

Both advisers and advisees share responsibility for making the advising relationship succeed. By encouraging their advisees to become engaged in their education, to meet their educational goals, and to develop the habit of learning, advisers assume a significant educational role. The advisee's unit of enrollment will provide each advisee with a primary academic adviser, the information need to plan the chosen program of study, and referrals to other specialized resources.

READ SENATE POLICY 32-00: ADVISING POLICY (<http://senate.psu.edu/policies-and-rules-for-undergraduate-students/32-00-advising-policy>)

University Park

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Suggested Academic Plan Analytical Concentration Option at University Park Campus

The course series listed below provides **only one** of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an **Academic Requirements** or **What If** report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

First Year

Fall	Credits Spring	Credits
PSU 16	1 CHEM 112H or 112 ^{**}	3
CHEM 110H or 110 ^{**}	3 CHEM 113 ^{**}	1
CHEM 111 ^{**}	1 MATH 141B or 141 ^{*†††}	4
MATH 140B or 140 ^{*†††}	4 General Education Course	3
ENGL 15, 30, or ESL 15 [†]	3 PHYS 211 [†]	4
General Education Course	3	
	15	15

Second Year

Fall	Credits Spring	Credits
CHEM 210H or 210 ^{**}	3-4 CHEM 212H or 212 [*]	3
CHEM 227 [*]	4 CHEM 213W or 213M [*]	2
MATH 231	2 CHEM 310 [*]	3
PHYS 212 [†]	4 PHYS 213 & PHYS 214 [†]	4
General Education Course	3 CHEM 400	1
	CHEM 430	3
	16-17	16

Third Year

Fall	Credits Spring	Credits
CHEM 316	1 CHEM 452 [*]	3
CHEM 450 [*]	3 CHEM 457 [*]	2
CHEM 400 Level Selection (consult with and academic adviser for options)	3 General Elective Course	3
ENGL 202C, 202A, 202B, or 202D [†]	3 CAS 100A, 100B, or 100C	3
General Education Course	3 STAT 401 or MATH 250	3
Supporting course (consult with an academic adviser for options)	3 General Education Course (GHW)	1.5
General Education Course (GHW)	1.5	
	17.5	15.5

Fourth Year

Fall	Credits Spring	Credits
CHEM 425W (or CHEM 400 level selection - consult with an academic adviser for options)	4 CHEM 423W [*]	4

CHEM 400 Level Elective Selection (consult with an academic adviser for options)	4 CHEM 400 Level Elective (consult with an academic adviser for options)	3
General Education Course	3 General Education Course	3
Supporting course (consult with an academic adviser for options)	3 Supporting course (consult with an academic adviser for options)	3
Supporting course (consult with an academic adviser for options)	3 Supporting course (consult with an academic adviser for options)	3
	17	16
Total Credits 128-129		

* Course requires a grade of C or better for the major

‡ Course requires a grade of C or better for General Education

Course is an Entrance to Major requirement

† Course satisfies General Education and degree requirement

University Requirements and General Education Notes:

US and IL are abbreviations used to designate courses that satisfy University Requirements (United States and International Cultures).

W, M, X, and Y are the suffixes at the end of a course number used to designate courses that satisfy University Writing Across the Curriculum requirement.

GWS, GQ, GHW, GN, GA, GH, and GS are abbreviations used to identify General Education program courses. General Education includes Foundations (GWS and GQ) and Knowledge Domains (GHW, GN, GA, GH, GS, and Integrative Studies). Foundations courses (GWS and GQ) require a grade of 'C' or better.

Integrative Studies courses are required for the General Education program. N is the suffix at the end of a course number used to designate an Inter-Domain course and Z is the suffix at the end of a course number used to designate a Linked course.

All incoming Schreyer Honors College first-year students at University Park will take ENGL/CAS 137 in the fall semester and ENGL/CAS 138 in the spring semester. These courses carry the GWS designation and replace both ENGL 30 and CAS 100. Each course is 3 credits.

Physical Concentration Option at University Park Campus

The course series listed below provides **only one** of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an **Academic Requirements** or **What If** report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

First Year

Fall	Credits Spring	Credits
PSU 16	1 CHEM 112H or 112 ^{*#}	3
CHEM 110H or 110	3 CHEM 113 ^{*#}	1
CHEM 111 ^{*#}	1 MATH 141B or 141 ^{*‡#†}	4

MATH 140B or 140 ^{*‡#†}	4 General Education Course	3
ENGL 15, 30, or ESL 15 [‡]	3 PHYS 211 [†]	4
General Education Course	3	
	15	15

Second Year

Fall	Credits Spring	Credits
CHEM 210H or 210 ^{*#}	3 CHEM 212H [*]	3
CHEM 227 [*]	4 CHEM 213 [*]	2
MATH 231	2 CHEM 310 [*]	3
PHYS 212 [†]	4 PHYS 213 [†]	2
General Education Course (GHW)	1.5 PHYS 214 [†]	2
CHEM 400	1 General Education Course	3
	15.5	15

Third Year

Fall	Credits Spring	Credits
CHEM 316	1 CHEM 457 [*]	2
CHEM 450 [*]	3 CHEM 464	3
CHEM 452	3 MATH 405	3
MATH 251	4 ENGL 202C, 202A, 202B, or 202D [‡]	3
CAS 100A, 100B, or 100C	3 General Education Course	3
General Education Course	3 General Education Course (GHW)	1.5
	17	15.5

Fourth Year

Fall	Credits Spring	Credits
CHEM 400 Level Elective Selection (consult with an academic adviser for options)	3 CHEM 459W [*]	4
CHEM 400 Level Elective Selection (consult with an academic adviser for options)	3 CHEM 400 Level Elective Selection (consult with an academic adviser for options)	3
CHEM 400 Level Elective Selection (consult with an academic adviser for options)	3 Supporting course (consult with an academic adviser for options)	3
General Education Course	3 Supporting course (consult with an academic adviser for options)	3
Supporting course (consult with an academic adviser for options)	3 Supporting course (consult with an academic adviser for options)	3
General Education Course (GHW)	1.5	
	16.5	16

Total Credits 125.5

* Course requires a grade of C or better for the major

‡ Course requires a grade of C or better for General Education

Course is an Entrance to Major requirement

† Course satisfies General Education and degree requirement

University Requirements and General Education Notes:

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GWS, GQ, GHW, GN, GA, GH, and GS are abbreviations used to identify General Education program courses. General Education includes Foundations (GWS and GQ) and Knowledge Domains (GHW, GN, GA, GH, GS, and Integrative Studies). Foundations courses (GWS and GQ) require a grade of 'C' or better.

Integrative Studies courses are required for the General Education program. N is the suffix at the end of a course number used to designate an Inter-Domain course and Z is the suffix at the end of a course number used to designate a Linked course.

All incoming Schreyer Honors College first-year students at University Park will take ENGL/CAS 137 in the fall semester and ENGL/CAS 138 in the spring semester. These courses carry the GWS designation and replace both ENGL 30 and CAS 100. Each course is 3 credits.

Synthetic/Biological Concentration Option at University Park Campus

The course series listed below provides **only one** of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an **Academic Requirements** or **What If** report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

First Year

Fall	Credits	Spring	Credits
PSU 16		1 CHEM 112H or 112**	3
CHEM 110H or 110**		3 CHEM 113**	1
CHEM 111**		1 MATH 141B or 141*†#†	4
MATH 140B or 140*†#†		4 General Education Course	3
ENGL 15, 30, or ESL 15†		3 PHYS 211†	4
General Education Course		3	
	15		15

Second Year

Fall	Credits	Spring	Credits
CHEM 210H or 210**		3-4 CHEM 212H or 212*	3
CHEM 227*		4 CHEM 213W or 213M*	2
MATH 231		2 CHEM 310*	3
PHYS 212†		4 CHEM 400	1
General Education Course		3 CHEM 430	3
		General Education Course	3
	16-17		15

Third Year

Fall	Credits	Spring	Credits
CHEM 316		1 CHEM 452*	3
CHEM 431W*		4 CHEM 457*	2

CHEM 450*		3 PHYS 213†	2
ENGL 202C, 202A, 202B, or 202D†		3 PHYS 214†	2
Supporting course (consult with an academic adviser for options)		3 CAS 100A, 100B, or 100C†	3
General Education Course (GHW)		1.5 General Education Course	3
	15.5		15

Fourth Year

Fall	Credits	Spring	Credits
CHEM 425W*		4 CHEM 400 Level Elective Selection (consult with an academic adviser for options)	3
CHEM 432		3 CHEM 400 Level Elective Selection (consult with an academic adviser for options)	3
CHEM 476		3 General Education Course	4
STAT 401		3 Supporting course (consult with an academic adviser for options)	3
General Education Course		3 Supporting course (consult with an academic adviser for options)	3
General Education Course (GHW)		1.5	
	17.5		16

Total Credits 125-126

* Course requires a grade of C or better for the major

‡ Course requires a grade of C or better for General Education

Course is an Entrance to Major requirement

† Course satisfies General Education and degree requirement

University Requirements and General Education Notes:

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GWS, GQ, GHW, GN, GA, GH, and GS are abbreviations used to identify General Education program courses. General Education includes Foundations (GWS and GQ) and Knowledge Domains (GHW, GN, GA, GH, GS, and Integrative Studies). Foundations courses (GWS and GQ) require a grade of 'C' or better.

Integrative Studies courses are required for the General Education program. N is the suffix at the end of a course number used to designate an Inter-Domain course and Z is the suffix at the end of a course number used to designate a Linked course.

All incoming Schreyer Honors College first-year students at University Park will take ENGL/CAS 137 in the fall semester and ENGL/CAS 138

in the spring semester. These courses carry the GWS designation and replace both ENGL 30 and CAS 100. Each course is 3 credits.

2 + 2 Option at University Park Campus

The course series listed below provides **only one** of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an **Academic Requirements** or **What If** report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

First Year

Fall	Credits Spring	Credits
PSU 16	1 CHEM 112H or 112**	3
CHEM 110H or 110**	3 CHEM 113**	1
CHEM 111**	1 MATH 141†#†	4
MATH 140†#†	4 General Education Course	3
ENGL 15, 30, or ESL 15†	3 PHYS 211†	4
General Education Course	3 General Education Course (GHW)	1.5
	15	16.5

Second Year

Fall	Credits Spring	Credits
CHEM 210H or 210**	3 CHEM 212H or 212*	3
MATH 231	2 CHEM 213W or 213M*	2
PHYS 212†	4 ENGL 202C, 202A, 202B, or 202D	3
CAS 100A, 100B, or 100C	3 PHYS 213†	2
General Education Course	3 PHYS 214†	2
Supporting course (consult with an academic adviser for options)	3 General Education Course	3
	18	15

Third Year

Fall	Credits Spring	Credits
CHEM 227*	4 CHEM 310*	3
CHEM 316	1 CHEM 400	1
CHEM 450	3 CHEM 430	3
MATH 250	3 CHEM 452*	3
General Education Course	3 CHEM 457*	2
General Education Course (GHW)	1.5 General Education Course	3
	Supporting course (consult with an academic adviser for options)	3
	15.5	18

Fourth Year

Fall	Credits Spring	Credits
CHEM 431W or 425W*	4 CHEM 423W or 459W*	4
CHEM 459W*	4 CHEM 400 Level Selection (consult with and academic adviser for options)	3

CHEM 400 Level Elective Selection (consult with an academic adviser for options)	3 CHEM 400 Level Selection (consult with and academic adviser for options)	3
Supporting course (consult with an academic adviser for options)	3 Supporting course (consult with an academic adviser for options)	3
Supporting course (consult with an academic adviser for options)	3 Supporting course (consult with an academic adviser for options)	3
	17	16

Total Credits 131

* Course requires a grade of C or better for the major

‡ Course requires a grade of C or better for General Education

Course is an Entrance to Major requirement

† Course satisfies General Education and degree requirement

University Requirements and General Education Notes:

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Integrative Studies courses are required for the General Education program. N is the suffix at the end of a course number used to designate an Inter-Domain course and Z is the suffix at the end of a course number used to designate a Linked course.

Career Paths

The technical background and hands-on experiences in the chemistry major provides students with a wide variety of post-graduate career and educational options. A BS in Chemistry prepares students for jobs in industry, government, and research and discovery laboratories. Many graduates with the BS in chemistry go on to pursue advanced degrees in chemistry and related disciplines, or to professional schools including medical, dental, law, and business.

Opportunities for Graduate Studies

Penn State students with a BS in Chemistry often choose to pursue graduate education in chemistry, focusing on one or more of the sub-disciplines of analytical, biological, inorganic, organic, or physical chemistry, or graduate programs in related disciplines such as materials science, forensics, toxicology, and others.

Professional Resources

- American Chemical Society (<http://www.acs.org/content/acs/en.html>)

Accreditation

The Penn State Chemistry Department is approved by the American Chemical Society to confer ACS-certified degrees to chemistry majors who meet certain requirements beyond those required by the major. Courses in biological chemistry and chemical literature must be included among a student's 400-level chemistry electives, and two additional credits of laboratory work, typically chemical research, are required.

MORE INFORMATION (<http://chem.psu.edu/undergrad/academic-planning>)

Contact

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