

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 students 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. Research in chemistry intersects a variety of other fields including biology, physics, environmental science, geology, material science, medicine, and more. Faculty in the Department of Chemistry at Penn State are engaged in cutting-edge projects aimed at probing outstanding questions in biology, creating new materials for medicine or energy storage, using computational methods model and simulate a variety of processes, and more.

MORE INFORMATION ABOUT FACULTY RESEARCH PROJECTS (<https://science.psu.edu/chem/research/>)

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.
- You plan to pursue a career in chemistry research, education or outreach, or attend professional school in areas including medicine and dentistry.

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

15 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.

Requirements for the Major

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 (<https://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#82-44>).

Code	Title	Credits
Prescribed Courses		
MATH 231	Calculus of Several Variables	2
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

Prescribed Courses: Require a grade of C or better

CHEM 110	Chemical Principles I	3
CHEM 111	Experimental Chemistry I	1
CHEM 112	Chemical Principles II	3
CHEM 113	Experimental Chemistry II	1
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 316	The Professional Chemist	1
CHEM 450	Physical Chemistry - Thermodynamics	3
CHEM 452	Physical Chemistry - Quantum Chemistry	3
CHEM 457	Experimental Physical Chemistry	2
MATH 140	Calculus With Analytic Geometry I	4
MATH 141	Calculus with Analytic Geometry II	4

Additional Courses

MATH 250 or STAT 401	Ordinary Differential Equations Experimental Methods	3
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Additional Courses: Require a grade of C or better

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 of excluded courses²

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.

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 and Inter-Domain courses do not meet this requirement.)

- **Quantification (GQ):** 6 credits
- **Writing and Speaking (GWS):** 9 credits

Breadth in the Knowledge Domains (Inter-Domain courses do not meet this requirement.)

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

Integrative Studies

- **Inter-Domain Courses (Inter-Domain):** 6 credits

Exploration

- **GN**, may be completed with Inter-Domain courses: 3 credits
- **GA, GH, GN, GS, Inter-Domain courses.** This may include 3 credits of World Language course work beyond the 12th credit level or the requirements for the student's degree program, whichever is higher: 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 (<https://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.

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

Requirements for the Integrated B.S. in Chemistry and M.Ed. in Curriculum and Instruction can be found in the Graduate Bulletin (<https://bulletins.psu.edu/graduate/programs/majors/curriculum-instruction/#integratedundergradprogramstext>).

Program Learning Objectives

1. Students will acquire a foundation in chemistry of sufficient breadth and depth to integrate and apply knowledge across chemical subdisciplines.
2. Students will develop analytical reasoning and problem solving skills required for the pursuit of scientific research.
3. Students will retrieve, read, and incorporate information from the chemical literature in various media forms.
4. Students will demonstrate the necessary laboratory skills to design and safely conduct experiments and to accurately document and interpret experimental data.
5. Students will develop the ability to communicate scientific information in written and oral form using an appropriate scientific style.
6. Students will conduct themselves in a professional, ethical, and productive manner when working independently or in a team setting.
7. Students will recognize the interdisciplinary nature of chemistry and its impact on society and the environment.

8. Students will explore traditional and nontraditional career paths in chemistry and related fields.

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 needed to plan the chosen program of study, and referrals to other specialized resources.

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

University Park

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Suggested Academic Plan

The suggested academic plan(s) listed on this page are the plan(s) that are in effect during the 2023-24 academic year. To access previous years' suggested academic plans, please visit the archive (<https://bulletins.psu.edu/undergraduate/archive/>) to view the appropriate Undergraduate Bulletin edition (*Note: the archive only contains suggested academic plans beginning with the 2018-19 edition of the Undergraduate Bulletin*).

Analytical Concentration Option: Chemistry, B.S. 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, 30H, 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 an 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 Cultural Diversity 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.

General Education includes Foundations (GWS and GQ), Knowledge Domains (GHW, GN, GA, GH, GS) and Integrative Studies (Inter-domain) requirements. N or Q (Honors) is the suffix at the end of a course number used to help identify an Inter-domain course, but the inter-domain attribute is used to fill audit requirements. Foundations courses (GWS and GQ) require a grade of 'C' or better.

All incoming Schreyer Honors College first-year students at University Park will take ENGL 137H/CAS 137H in the fall semester and ENGL 138T/CAS 138T in the spring semester. These courses carry the GWS designation and satisfy a portion of that General Education requirement. If the student's program prescribes GWS these courses will replace both ENGL 15/ENGL 30H and CAS 100A/CAS 100B/CAS 100C. Each course is 3 credits.

Physical Concentration Option: Chemistry, B.S. at University Park Campus

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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, 30H, 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

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General Education includes Foundations (GWS and GQ), Knowledge Domains (GHW, GN, GA, GH, GS) and Integrative Studies (Inter-domain) requirements. N or Q (Honors) is the suffix at the end of a course number used to help identify an Inter-domain course, but the inter-domain attribute is used to fill audit requirements. Foundations courses (GWS and GQ) require a grade of 'C' or better.

All incoming Schreyer Honors College first-year students at University Park will take ENGL 137H/CAS 137H in the fall semester and ENGL 138T/CAS 138T in the spring semester. These courses carry the GWS designation and satisfy a portion of that General Education requirement. If the student's program prescribes GWS these courses will replace both ENGL 15/ENGL 30H and CAS 100A/CAS 100B/CAS 100C. Each course is 3 credits.

Synthetic/Biological Concentration Option: Chemistry, B.S. 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, 30H, 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:

US and IL are abbreviations used to designate courses that satisfy Cultural Diversity 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.

General Education includes Foundations (GWS and GQ), Knowledge Domains (GHW, GN, GA, GH, GS) and Integrative Studies (Inter-domain) requirements. N or Q (Honors) is the suffix at the end of a course number used to help identify an Inter-domain course, but the inter-domain attribute is used to fill audit requirements. Foundations courses (GWS and GQ) require a grade of 'C' or better.

All incoming Schreyer Honors College first-year students at University Park will take ENGL 137H/CAS 137H in the fall semester and ENGL 138T/CAS 138T in the spring semester. These courses carry the GWS designation and satisfy a portion of that General Education requirement. If the student's program prescribes GWS these courses will replace both ENGL 15/ENGL 30H and CAS 100A/CAS 100B/CAS 100C. Each course is 3 credits.

Chemistry, B.S. at Commonwealth Campuses

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, 30H, 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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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.

General Education includes Foundations (GWS and GQ), Knowledge Domains (GHW, GN, GA, GH, GS) and Integrative Studies (Inter-domain) requirements. N or Q (Honors) is the suffix at the end of a course number used to help identify an Inter-domain course, but the inter-domain attribute is used to fill audit requirements. Foundations courses (GWS and GQ) require a grade of 'C' or better.

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.

MORE INFORMATION ABOUT POTENTIAL CAREER OPTIONS FOR GRADUATES OF THE CHEMISTRY PROGRAM (<https://www.acs.org/careers/exploring-career-options.html>)

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 (<https://www.acs.org>)

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 ABOUT ACCREDITATION BY THE AMERICAN CHEMICAL SOCIETY (<https://science.psu.edu/chem/undergrad/academic-planning-advising/>)

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