PHYSICS AND ASTRONOMY, B.SC. HONOURS

Physics and Astronomy Honours Entrance, Continuation, and Graduation Requirements

To enter the Honours programs in Physics and Astronomy, a student must have completed at least 24 credit hours with a minimum DGPA of 3.00, and also obtained a minimum grade of "B" in PHYS 1070, or a "B+" in PHYS 1030. Students are strongly encouraged to complete MATH 1300, MATH 1500 and MATH 1700 in Year 1. Not only are these courses required in the Physics and Astronomy programs, they are required prerequisites to several second year Physics and Astronomy required courses.

To continue in the Physics and Astronomy Honours program, students must maintain a minimum DGPA of 3.00, and complete a minimum of 9 credit hours during each Fall and Winter Term.

To graduate with the B. Sc. Honours degree, a student must achieve a minimum DGPA of 3.00 and minimum grade of "C" in each course that contributes to the 120 credit hours of the degree.

There are a number of awards — the Coish, the C.P. Loewen, the Neamtan, the Roulston, and the Sen Scholarships — available in this program.

Double Honours

Students may pursue a double Honours degree with Physics and Astronomy and the Biochemistry program. Students should consult with a Faculty of Science Academic Advisor for more information.

Honours Co-operative Option

A co-operative education option is available to Honours students. Students should refer to the Co-operative Education (p. 4) section for further information on the Co-op programs.

The course, grade requirements and the minimum DGPA requirement for entry and continuation in the Co-operative Option are the same as that for the regular Honours program.

Degree Requirements

Honours: Astronomy and Astrophysics (Including Co-operative Option if Selected)

Note[1]

Course	Title	Hours
Year 1		
One of: [2]		3
PHYS 1050	Physics 1: Mechanics	
PHYS 1020	General Physics 1	
One of: [2]		3
PHYS 1070	Physics 2: Waves and Modern Physics (B)	
PHYS 1030	General Physics 2 (B+)	
MATH 1300	Vector Geometry and Linear Algebra (C+) [2]	3
MATH 1500	Introduction to Calculus [2]	3
MATH 1700	Calculus 2 [2]	3
ASTR 1810	Introduction to Astronomy: The Magnificent Universe	3
COMP 1012	Computer Programming for Scientists and Engineers [3]	3
6 credit hours from the Faculty of Arts including the "W" requirement		6
3 credit hours of electives [4, 5]		3
	Hours	**30**
Year 2		
PHYS 2600	Electromagnetic Field Theory	3
PHYS 2650	Classical Mechanics 1	3
PHYS 2386	Introduction to Quantum Mechanics and Special Relativity	3
PHYS 2496	Mathematical Physics 1	3
PHYS 2260 or PHYS 2610	Optics or Circuit Theory and Introductory Electronics	3
ASTR 2000	Foundations of Astrophysics	3
ASTR 2070	Observational Astronomy Techniques	3
MATH 2090	Linear Algebra 2	3
MATH 2720 or MATH 2150	Multivariable Calculus or Multivariable Calculus	3
3 credit hours of electives [5, 6]		3
	Hours	**30**
Year 3		
PHYS 3386	Quantum Mechanics 2	3
PHYS 3430	Honours Physics Laboratory	6
PHYS 3496	Mathematical Physics 2	3
PHYS 3630	Electro - and Magnetostatic Theory	3
PHYS 3650	Classical Mechanics 2	3
PHYS 3670	Classical Thermodynamics	3
ASTR 3180	Stars	3
ASTR 3230	The Phenomenology of Galaxies	3
3 credit hours of electives [5, 6, 7]		3
	Hours	**30**
Years 3-4		
Co-op Requirements (if selected):		
SCI 3980	Co-operative Education Work Term 1	0
SCI 3990	Co-operative Education Work Term 2	0
SCI 4980	Co-operative Education Work Term 3	0
SCI 4990	Co-operative Education Work Term 4 (if a 4th work term is selected)	0
	Hours	**0**
Year 4		
PHYS 4386	Quantum Mechanics 3	3
PHYS 4646	Electro - and Magnetodynamics and Special Relativity	3
PHYS 4676	Honours Thesis - Proposal and Preparation	3
PHYS 4678	Honours Thesis - Dissertation	3
PHYS 4680	Statistical Mechanics	3
One of:		3
PHYS 4010	General Relativity and Gravitation	
PHYS 4250	Computational Physics	

PHYS 4516	Introduction to Nuclear and Particle Physics	
Two of:		6
ASTR 4020	Cosmology and Black Holes	
ASTR 4100	High-Energy Astrophysics	
ASTR 4200	Radio Astronomy	
ASTR 4400	Magnetohydrodynamics, Astrophysical Plasmas, and the Interstellar Medium	
6 credit hours of electives [5, 6]		6
	Hours	**30**
	Total Hours	**120**

1 Students must achieve a minimum grade of "C" in all courses contributing to the Honours program.

2
- PHYS 1050 and PHYS 1070 are recommended.
- MATH 1210 (B), or MATH 1220 (C) may be taken in place of MATH 1300;
- MATH 1230, MATH 1510, the former MATH 1520, or MATH 1524 may be taken in place of MATH 1500;
- MATH 1232 or MATH 1710 may be taken in place of MATH 1700.

3 Students who have already taken COMP 1010 before joining the program may count COMP 1010 in lieu of COMP 1012. However, students who have not taken COMP 1010 before entering the program must then take COMP 1012.

4 ASTR 1830 is recommended.

5 PHYS 1018 may not count towards the 120 credit hours required for this degree.

6 Although they are not required courses in the Physics programs, MATH 2080, MATH 2180, and MATH 3340 are recommended electives for the Physics Honours and Four Year Major degrees.

7 ASTR 3070 is recommended.

IMPORTANT: The Honours program need not be completed in the manner prescribed in the grid above. The grid indicates the recommended arrangement of the required courses and is meant to be a guide around which students can plan their program.

(Letters in brackets refer to minimum prerequisite standing required for further study.)

Honours: Physics (Including Co-operative Option if Selected)

Note[1]

Course	Title	Hours
Year 1		
One of: [2]		3
PHYS 1050	Physics 1: Mechanics	
PHYS 1020	General Physics 1	
One of: [2]		3
PHYS 1070	Physics 2: Waves and Modern Physics (B)	
PHYS 1030	General Physics 2 (B+)	
MATH 1300	Vector Geometry and Linear Algebra (C+) [2]	3
MATH 1500	Introduction to Calculus [2]	3
MATH 1700	Calculus 2 [2]	3
COMP 1012	Computer Programming for Scientists and Engineers [3]	3
6 credit hours from the Faculty of Arts including the "W" requirement		6
6 credit hours of electives [4]		6
	Hours	**30**
Year 2		
PHYS 2260 or PHYS 2610	Optics or Circuit Theory and Introductory Electronics	3
PHYS 2386	Introduction to Quantum Mechanics and Special Relativity	3
PHYS 2496	Mathematical Physics 1	3
PHYS 2600	Electromagnetic Field Theory	3
PHYS 2650	Classical Mechanics 1	3
MATH 2090	Linear Algebra 2	3
MATH 2720 or MATH 2150	Multivariable Calculus or Multivariable Calculus	3
9 credit hours of electives [4, 5]		9
	Hours	**30**
Year 3		
PHYS 3386	Quantum Mechanics 2	3
PHYS 3430	Honours Physics Laboratory	6
PHYS 3650	Classical Mechanics 2	3
PHYS 3670	Classical Thermodynamics	3
PHYS 3496	Mathematical Physics 2	3
PHYS 3630	Electro - and Magnetostatic Theory	3
9 credit hours of electives [4, 5]		9
	Hours	**30**
Years 3-4		
Co-op Requirements (if selected):		
SCI 3980	Co-operative Education Work Term 1	0
SCI 3990	Co-operative Education Work Term 2	0
SCI 4980	Co-operative Education Work Term 3	0
SCI 4990	Co-operative Education Work Term 4 (if a 4th work term is selected)	0
	Hours	**0**
Year 4		
PHYS 4676	Honours Thesis - Proposal and Preparation	3
PHYS 4678	Honours Thesis - Dissertation	3
PHYS 4386	Quantum Mechanics 3	3
PHYS 4646	Electro - and Magnetodynamics and Special Relativity	3
PHYS 4680	Statistical Mechanics	3
6 credit hours of 4000-level Physics		6
9 credit hours of electives [4, 5]		9
	Hours	**30**
	Total Hours	**120**

1 Students must achieve a minimum grade of "C" in all courses contributing to the Honours program.

2
- PHYS 1050 and PHYS 1070 are recommended.
- MATH 1210 (B), or MATH 1220 (C) may be taken in place of MATH 1300;
- MATH 1230, MATH 1510, the former MATH 1520, or MATH 1524 may be taken in place of MATH 1500;
- MATH 1232 or MATH 1710 may be taken in place of MATH 1700.

[3] Students who have already taken COMP 1010 before joining the program may count COMP 1010 in lieu of COMP 1012. However, students who have not taken COMP 1010 before entering the program must then take COMP 1012.

[4] PHYS 1018 may not count towards the 120 credit hours required for this degree.

[5] Although they are not required courses in the Physics programs, MATH 2080, MATH 2180, and MATH 3340 are recommended electives for the Physics Honours and Four Year Major degrees.

IMPORTANT: The Honours program need not be completed in the manner prescribed in the grid above. The grid indicates the recommended arrangement of the required courses and is meant to be a guide around which students can plan their program.

(Letters in brackets refer to minimum prerequisite standing required for further study.)

Honours: Medical and Biological (Including Co-operative Option if Selected)

Note[1]

Course	Title	Hours
Year 1		
One of: [2]		3
PHYS 1050	Physics 1: Mechanics	
PHYS 1020	General Physics 1	
One of: [2]		3
PHYS 1070	Physics 2: Waves and Modern Physics (B)	
PHYS 1030	General Physics 2 (B+)	
MATH 1300	Vector Geometry and Linear Algebra (C+) [2]	3
MATH 1500	Introduction to Calculus [2]	3
MATH 1700	Calculus 2 [2]	3
BIOL 1020	Biology 1: Principles and Themes	3
BIOL 1030	Biology 2: Biological Diversity, Function and Interactions	3
COMP 1012	Computer Programming for Scientists and Engineers [3]	3
6 credit hours from the Faculty of Arts including the "W" requirement		6
	Hours	**30**
Year 2		
PHYS 2386	Introduction to Quantum Mechanics and Special Relativity	3
PHYS 2496	Mathematical Physics 1	3
PHYS 2600	Electromagnetic Field Theory	3
PHYS 2610	Circuit Theory and Introductory Electronics	3
PHYS 2650	Classical Mechanics 1	3
PHYS 2270 or PHYS 2272	Introductory Physics for Life Sciences: Fundamentals and Applications or Physics for Medicine & Biology	3
MATH 2090	Linear Algebra 2	3
MATH 2720 or MATH 2150	Multivariable Calculus or Multivariable Calculus	3
6 credit hours of electives [4]		6
	Hours	**30**
Year 3		
PHYS 3220	Medical Physics and Physiological Measurement	3
PHYS 3386	Quantum Mechanics 2	3
PHYS 3430	Honours Physics Laboratory	6
PHYS 3496	Mathematical Physics 2	3
PHYS 3630	Electro - and Magnetostatic Theory	3
PHYS 3670	Classical Thermodynamics	3
STAT 1150	Introduction to Statistics and Computing [5]	3
6 credit hours of electives [4]		6
	Hours	**30**
Years 3-4		
Co-op Requirements (if selected):		
SCI 3980	Co-operative Education Work Term 1	0
SCI 3990	Co-operative Education Work Term 2	0
SCI 4980	Co-operative Education Work Term 3	0
SCI 4990	Co-operative Education Work Term 4 (if a 4th work term is selected)	0
	Hours	**0**
Year 4		
PHYS 4250	Computational Physics	3
PHYS 4360 or PHYS 4400	Medical Radiation Physics or Linear Systems for Imaging	3
PHYS 4516	Introduction to Nuclear and Particle Physics	3
PHYS 4646	Electro - and Magnetodynamics and Special Relativity	3
PHYS 4676	Honours Thesis - Proposal and Preparation	3
PHYS 4678	Honours Thesis - Dissertation	3
PHYS 4680	Statistical Mechanics	3
9 credit hours of electives [4]		9
	Hours	**30**
	Total Hours	**120**

[1] Students must achieve a minimum grade of "C" in all courses contributing to the Honours program.

[2]
- PHYS 1050 and PHYS 1070 are recommended.
- MATH 1210 (B), or MATH 1220 (C) may be taken in place of MATH 1300;
- MATH 1230, MATH 1510, the former MATH 1520, or MATH 1524 may be taken in place of MATH 1500;
- MATH 1232 or MATH 1710 may be taken in place of MATH 1700.

[3] Students who have already taken COMP 1010 before joining the program may count COMP 1010 in lieu of COMP 1012. However, students who have not taken COMP 1010 before entering the program must then take COMP 1012.

[4] PHYS 1018 may not count towards the 120 credit hours required for this degree.

[5] Students may take STAT 1000 and STAT 2000 in lieu of STAT 1150.

IMPORTANT: The Honours program need not be completed in the manner prescribed in the grid above. The grid indicates the recommended arrangement of the required courses and is meant to be a guide around which students can plan their program.

(Letters in brackets refer to minimum prerequisite standing required for further study.)

Co-operative Education Option Academic Regulations: B.Sc. (Major) & B.Sc. and B.C.Sc. (Honours)

Co-operative education is a form of experiential learning which integrates the academic education (classroom-based learning) of interested and qualified students with relevant, supervised, and paid work experience (work-based learning) with employers. Co-op students gain valuable skills to guide them through their academic education and prepare them for future careers after graduation.

The Faculty of Science offers a Co-operative Education Option in the following Major programs:

- Biochemistry
- Biological Sciences
- Chemistry
- Computer Science
- Data Science
- Genetics
- Mathematics
- Microbiology
- Physics & Astronomy
- Psychology
- Statistics.

The Honours programs offering a Co-operative Education Option are:

- Biochemistry
- Biological Sciences
- Chemistry
- Computer Science
- Genetics
- Mathematics
- Microbiology
- Physics & Astronomy
- Statistics
- Joint Computer Science – Mathematics
- Joint Computer Science – Physics and Astronomy
- Joint Computer Science – Statistics
- Joint Mathematics – Physics and Astronomy
- Joint Statistics – Mathematics program.

Co-operative education is optional and supplementary to academic requirements of the chosen degree. All regulations governing regular Major and Honours programs apply to the Co-operative Education Option. In addition, the following variations apply:

Entrance

To enter the Co-operative Education Option a student must be eligible to enter the Major or Honours program offered by the department. At the time of application, students must have a minimum Degree Grade Point Average (DGPA) of 2.5 for the Major and 3.0 for the Honours Programs. For Psychology, students must have a minimum Degree Grade Point Average (DGPA) of 3.0 for the Major. Co-op is not available for students in the Honours Psychology Program.

The normal point of entry to the Co-operative Education Option is following the completion of second year in the Faculty of Science. Students seeking admission will submit an application during their second year and complete an intake process with the appropriate departmental Co-op Coordinator. Application deadlines are established by the Science Co-op Office.

Students are advised that satisfying the entrance requirements does not guarantee a place in the Co-operative Education Option. The Science Co-op Office reserves the right to determine and select the best-qualified applicants.

Students admitted into the Co-operative Education Option will complete pre-employment training, including workshops, prior to the start of their first co-op work term. The structure and content of this training is developed by the Science Co-op Office. Attendance and completion of this training is mandatory.

Structure and Sequencing

The Co-operative Education Option consists of both academic terms and co-op work terms.

Each academic term can be either four months in duration or eight months in duration, as designated by the Major or Honours department.

Each co-op work term can be either four months in duration or eight months in duration, as designated by the Science Co-op Office. An eight month work term would be counted as the equivalent of two 4 month terms.

Each academic term and each co-op work term will commence in January, May or September.

The sequence of academic terms and co-op work terms is variable to suit the needs of each department, and is designated by the Science Co-op Office in conjunction with each Major or Honours department. All Faculty of Science Co-operative Education Options must end on an academic term.

Students are expected to follow the academic/co-op work term sequence defined by their Major or Honours department from admission through to graduation.

Co-op Work Term Requirements

All Co-operative Education Options require participating students to complete at least three (3) 4-month co-op work terms for a total of a minimum of 12 months' work experience. Each co-op work term is completed with one employer.

Students are required to register in the appropriate co-op work term course and pay the work term fee prior to starting their co-op work term.

Co-operative Education Option students are required to submit a work term report at the end of each co-op work term. These reports are due at times designated by the Science Co-op Office. In order to remain in the Co-operative Education program, a student must obtain a grade of "Pass" for each work term report. The Science Co-op Office will provide students with instructions regarding the content and format requirements of the work term reports.

While on a co-op work term, students are not permitted to take more than six hours of academic credit, and may not take more than one course at a time.

Academic Term Requirements

Coursework requirements of the Co-operative Education Option are equivalent to the coursework requirements of the four-year Major program. For students completing an Honours program, the coursework requirements of the Co-operative Education Option are equivalent to the coursework requirements of the Honours program with the exception of the Biochemistry, Genetics and Microbiology programs.

Co-operative Education Option students are required to maintain full-time study while registered for an academic term.

To continue in a four year Major Co-operative Education Option, students must maintain a minimum DGPA of 2.50 at each point of assessment; except for students in Psychology where a minimum DGPA of 3.00 must be maintained at each point of assessment. A student's performance will be evaluated following each academic term. In addition, the student must meet all individual course prerequisites for further study and departmental continuation and graduation requirements. Please see department entries for further information. Continuation in the Major Co-operative Education Option is also contingent upon satisfactory performance during co-op work terms.

To continue in an Honours Co-operative Education Option a student must maintain a minimum DGPA of 3.00 or higher at each point of assessment. A student's performance will be evaluated following each academic term. In addition, the student must meet all individual course prerequisites for further study and departmental continuation and graduation requirements. Please see department entries for further information. Continuation in the Honours Co-operative Education Option is also contingent upon satisfactory performance during co-op work terms.

Students may be required to withdraw from the Co-operative Education Option for any of the following reasons:

- Failure to maintain the minimum academic requirements of the Faculty of Science and/or Major/Honours program.
- Failure to maintain the minimum credit hour requirements of the academic term in the co-op option.
- Unsatisfactory performance during a co-op work term.
- Failure to submit a co-op work term report or the submitted report does not achieve a "Pass" grade.
- Failure to observe the policies outlined in university governing documents related to Behavioural Policies and Academic Misconduct.
- Having consulted with the Co-op Director and/or Faculty Advisor, in the opinion of the Co-op Coordinator, the student does not possess sufficient ability, skills, aptitude, attitude, diligence or motivation to successfully complete the Co-operative Education Option.

Students who wish to voluntarily withdraw from the Co-operative Education Option must obtain the written approval from their Co-op Coordinator and the Science Co-op Director. Students must submit their withdrawal request to their Co-op Coordinator and receive approval by the withdrawal dates set by the Science Co-op Office for each co-op work term.

Students are not normally permitted to withdraw from the Co-operative Education Option once they have secured a position for their co-op work term; whether the position was obtained through the Science Co-op Office or through students' own self-directed job search. Enrollment in the applicable co-op course(s) will be maintained and students are responsible for all assessed fees for the duration of the co-op work term and for meeting all academic requirements.

Students who accumulate more than 18 credit hours of failed courses after entering the four-year Major program (regardless of the origin of the grade or if the course has been repeated) will be required to withdraw from the Major Co-op program. Students are also subject to the academic assessment policy found in the Faculty Academic Regulations (https://catalog.umanitoba.ca/undergraduate-studies/science/#facultyacademicregulationstext).

Students who accumulate more than 15 credit hours of failed courses after entering the Honours degree program (regardless of the origin of the grade or if the course has been repeated) will be required to withdraw from the Honours Co-op program. Students required to withdraw from the Honours program may be eligible to pursue the B.Sc. Major program or the B.Sc. General degree program. Students are also subject to the academic assessment policy found in the Faculty Academic Regulations (https://catalog.umanitoba.ca/undergraduate-studies/science/#facultyacademicregulationstext).

Four year Major Co-operative Education Option students who are required to withdraw, or voluntarily revert to an alternative degree program must fulfil all academic requirements of that degree.

Honours Co-operative Education Option students who are required to withdraw or voluntarily revert to an alternative degree program must fulfill all academic requirements of that degree.