CONTACTS: Questions about physics placement or advising may be directed to Professor Walter Smith (wsmith@haverford.edu). Questions regarding astronomy advising should be directed to Desika Narayanan (dnarayan@haverford.edu). Much advice is also available on the departmental web site at: http://www.haverford.edu/physics-astro

PHYSICS/ASTRO COURSES OFFERED WITHOUT PREREQUISITE
These courses are not intended for students intending to major in the natural sciences or mathematics. They are offered without scientific prerequisite and involve limited use of mathematics—straightforward algebra and trigonometry only.

Offered in 2014-15:
• Astronomy 101a Astronomical Ideas

Offered in future years:
• Astronomy 114a Planetary Astronomy
• Astronomy 112b Survey of the Cosmos
• Physics 112: Conceptual Quantum Mechanics
• Physics 113b Symmetry and the Beautiful Universe

INTRODUCTORY PHYSICS SEQUENCE AND PLACEMENT
We strongly recommend that students considering a major in physics begin their studies in the first year. Haverford offers two separate fall-spring, year-long, introductions to physics, either of which is an appropriate introduction to the physics major, although we recommend Physics 105 (or 115) and 106 as the main track for physics and astro majors.

• Physics 101 - 102 is a track for students desiring a year-long, self-contained treatment of all of physics (including 20th century physics). We emphasize applications to the life sciences that are particularly appropriate for students interested in biology and prehealth in both lecture and laboratory.

• Physics 105 - 106 is offered for those students likely to take physics-related courses beyond the introductory sequence, in the physics (e.g. physics 213a) or chemistry departments (e.g. physical chemistry). Twentieth century physics beyond Einstein's theory of relativity is not covered—these topics are treated in great depth elsewhere in the curriculum—and therefore this sequence goes into somewhat greater depth in mechanics and electromagnetism. Mathematical techniques and ideas relevant to Astronomy are covered more extensively in 105 - 106.

There is also an advanced introductory level course available by placement:
• Physics 115: Modern Introductory Physics is taught from a different textbook that assumes significant background in mechanics at the advanced placement/international baccalaureate level, as well as having a calculus prerequisite.

All of our introductory physics courses use calculus, although it is used more intensively in the Physics 105/106 and 115/106 sequences than in 101/102. As a consequence, the math requirements for these courses differ:

Physics 101: Corequisite: Math 105, BMC Math 101, or placement into Math 118 or above
Physics 102: Corequisite: Math 118, BMC Math 102, or placement into Math 121 or above

Physics 105: Prerequisite: Math 105, BMC Math 101, or placement into Math 118 or above
Physics 106 and 115: Prerequisite: Math 118, BMC Math 102, or placement into Math 121 or above

(Note that, in 2014-15, Math 105 is only offered in the spring, and Math 118 is only offered in the fall.)

We strongly recommend the following half-credit course in the spring of the freshman year. This provides a way to get to know about exciting current developments in physics and astrophysics even in your first year:

• Astronomy/Physics 152 - Freshman Seminar in Astrophysics

During the summer, all entering students will be contacted, and offered an opportunity to take an online placement questionnaire.

Second year courses: The sequence for students considering majoring in physics continues with these courses and related laboratories.

• Physics 213 - Waves and Optics; with Electronics and Waves Lab 211
• Physics 214 - Introductory Quantum Mechanics; with Physics 301, Quantum Physics Laboratory

THE ASTRONOMY SEQUENCE
There are now two majors available through the astronomy department: Astronomy and Astrophysics. The astronomy major is appropriate for students that desire an in-depth education in astronomy that can be applied to a wide-range of career trajectories, but who do not necessarily intend to pursue graduate study in astronomy. The astrophysics major is appropriate for students who wish to pursue the study of astronomy with additional attention to the physical principles that underlie astrophysical phenomena. The depth of the physics training required for a degree in astrophysics will prepare students who wish to pursue a career in astronomy or astrophysics, or to enter graduate study in astronomy or astrophysics.

In the first year, the advising for both these majors is the same. Students should take one of the introductory physics sequences: 101/102 or 105/106. In addition, we strongly recommend the following half-credit course in the spring of the freshman year:

• Astronomy/Physics 152 Freshman Seminar in Astrophysics
In the sophomore year, prospective astronomy and astrophysics majors follow the physics sequence at least through 213 and more often through 214 and also take

- Astronomy 205 and 206 - Introduction to Astrophysics, I & II.

In the junior and senior years astrophysics majors take a variety of upper-level physics and astronomy courses. Astronomy majors must take four 300 level astronomy courses, one of which can be substitute with a 300 level physics course, and frequently take other additional physics courses. Astronomy majors who are interested in a career in astronomical research are advised to study a great deal of physics as well and, therefore, often complete a double astronomy/physics major.

**Combining Study Abroad with a Physics, Astrophysics or Astronomy Major**

Many of our majors have done study abroad as part of their degree programs. This does require careful planning, preferably when you first enter the major, to ensure that you will be able to either continue taking physics courses abroad at a few selected institutions approved by our physics and astronomy departments, or to take enough physics and math here at Haverford to allow you to satisfy other requirements with courses abroad. Contact a departmental faculty member early on along with the Study Abroad coordinator for further information.

**Physics for Pre-Health Students not majoring in Physics**

Many students would benefit from studying physics in their freshman year, since much of introductory physics is fundamental to chemistry and in turn to biology. We recommend that students considering a pre-health curriculum take introductory physics as early as possible for this reason. Either of our introductory sequences will satisfy the premedical undergraduate competencies and either will prepare students well for the current and soon-to-be-revised MCAT Exam. Indeed, we have performed several studies that show conclusively that prehealth students who study physics at Haverford, rather than elsewhere, do significantly better on average on the physical sciences part of the MCAT exam.

**Interdisciplinary Physics Programs, Minors & Concentrations**

The Interdisciplinary Physics major option allows students to combine their physics major with study in another area flexibly defined, including pre-health studies, minors in other departments such as Astronomy and concentrations in Scientific Computing, Computer Science, Education, and Biophysics. While concentrations need not be declared until the sophomore or junior year, early advising is very important for avoiding scheduling problems during the junior and senior years. All freshmen interested in a concentration should see a member of the Department during their freshman year. Much advice is also available on the departmental web site at: [http://www.haverford.edu/physics-astro](http://www.haverford.edu/physics-astro)

**Options for Engineering**

Students interested in engineering have several options, and we recommend consulting with Walter Smith (wsmith@haverford.edu) very early on to decide on their best course of action,
especially if you wish to consider a formal degree program as the course requirements are considerable. They may elect to take engineering courses at University of Pennsylvania or Swarthmore as part of their regular physics major. Students wishing to get an engineering degree as part of their Haverford education have two options. They may elect a “4-1” program with the University of Pennsylvania, which leads to a joint B.S. from Haverford and a M.S. in engineering from Penn. Students also may enter a “3-2” program, under which they spend three years at Haverford, followed by two years in an engineering program at Cal Tech. The student receives a B.A. or B.S. from Haverford and a Bachelor’s of Engineering from Cal Tech. Admission to the final two years is dependent on above-average performance in the first three years.

Students who discover an interest in engineering during their time at Haverford are well served by spending a full four years at Haverford, then going on to a Master’s program in engineering at another institution. The Master’s program usually takes 1½ to 2 years, and the resulting degree opens significantly more employment possibilities than a Bachelor’s in Engineering. It is preferable, but not essential, for students considering this option to take some engineering courses (via cross-registration at Swarthmore or, with special permission, Penn) while enrolled at Haverford.

Another possibility is the concentration in computer science. Early advising is important and interested students should obtain the necessary information from a member of the department during the advising period. Much more information is available on the department web site. If interested, visit http://www.haverford.edu/physics-astro/academic_programs/engineering_options.php