Chemistry and Physics

Professor Howard Georgi, Director of Undergraduate Studies

The concentration in Chemistry and Physics is supervised by a committee comprised of members of the Departments of Physics and of Chemistry, and is administered through the office of the Director of Undergraduate Studies. As the name implies, the concentration has been established to serve those students desiring to develop a strong foundation in both physics and chemistry, rather than to specialize in one or the other. Because of the need to cover a wide range of material in considerable depth, only an honors program is available in this concentration.

Concentrators in Chemistry and Physics obtain an education which is a suitable preparation for graduate work in the science of matter on the scale of atoms, molecules and bulk materials, a broad area including, but not restricted to, physical chemistry and chemical physics. Such graduate work could be carried on in a Department of Physics or of Chemistry, depending on the particular institution and on the specific area chosen for advanced study. The concentration is also often chosen by students whose career goals lie in medicine. In addition, the intellectual disciplines involved provide a suitable background for careers in quite different professions.

Because the requirements of the concentration lie between those of Chemistry and of Physics, it is possible that a given set of courses could satisfy the requirements of one of those concentrations as well as those of the concentration in Chemistry and Physics. By the same token, a transfer to or from one of these concentrations, even as late as the junior year, normally causes little difficulty.

The concentration is structured to assure that all concentrators are introduced to the core subjects of chemistry (organic, inorganic, and physical), of physics (mechanics, electromagnetism, and quantum theory), and of mathematics. Beyond this core, students take additional half-courses in chemistry, physics, or related sciences, according to their personal interests and objectives.

Tutorial or individual study and research are optional, and may be undertaken within the framework of Physics 90r and/or 91r, or of Chemistry 98r and 99r, to the extent that facilities and staff are available.

**REQUIREMENTS**

**Honors Only: 13–16 half-courses**

1. **Required courses:**
   a. *General Chemistry*: Chemistry 5 and 7, or satisfactory placement out of the requirement.
   b. *Inorganic Chemistry*: Chemistry 154 or 158, or equivalent.
   c. *Organic Chemistry*: Chemistry 20 and 30, or Chemistry 17 and 27. Chemistry 20 and 30 are strongly recommended; but, particularly for students preparing for medical school, Chemistry 17 and 27 may be a preferred alternative.
   d. *Physical Chemistry or Statistical Mechanics*: Chemistry 60 or one of Chemistry 161, Physics 181 or Engineering Sciences 181. One of the statistical mechanics courses is strongly recommended.
   e. *Mechanics, Electromagnetism, and Waves*: Physics 15a (or Physics 16), 15b, and 15c.
   f. *Quantum Mechanics*: Physics 143a or Chemistry 160.
   g. *Mathematics*: Two courses at the level of Mathematics or Applied Mathematics 21a, 21b or above. While not required, taking one or more additional mathematics courses is strongly recommended. Among those courses to choose from, consider
especially Applied Mathematics 105a or Mathematics 113, Applied Mathematics 105b, Mathematics 115, and Mathematics 119. Students planning to go into research should consider taking a course in computer science and/or numerical analysis.

h. Additional half-courses from the list below, to complete the requirement of thirteen to sixteen half-courses (see item 5b). It is strongly recommended that one course be a laboratory course. In all cases, the student must take at least four physics courses and four chemistry courses.

- A course of independent research from the following: Chemistry 91r, 98, 99 or Physics 90r.
- Any 100- or 200-level Chemistry course.
- Any 100- or 200-level Physics or Applied Physics course (see 5f).
- Any 100- or 200-level Math or Applied Math course.
- An intermediate or advanced-level course in a science, Engineering Sciences or Computer Science with significant direct application to chemistry or physics. These courses should be approved in advanced by the Director or Assistant Director of Undergraduate Studies. To fulfill particular needs, a concentrator, with the adviser’s consent, may petition the Committee to use other intermediate or advanced-level science courses for this requirement.

2. **Tutorials:** Optional. Admission to tutorials requires prior approval by the Director of Undergraduate Studies of the Chemistry Department.
   a. Junior year: Chemistry 98r.
   b. Senior year: Chemistry 99r.

3. **Thesis:** Optional.

4. **General Examination:** None.

5. **Other information:**
   a. **Pass/Fail:** Two half-courses counted for concentration may be taken Pass/Fail, but not Physics 15a, 15b, 15c, or 16.
   b. The number of required courses is reduced by one half-course (up to a maximum reduction of three; the number of required courses cannot drop below thirteen) for each of the half-courses, Mathematics 1a, 1b and/or Chemistry 5, 7, that a student is permitted to skip by virtue of his or her performance on the appropriate Advanced Placement Examination.
   c. **Substitutions:** Students can substitute a more advanced course for one or more of the required elementary courses on the same topics, provided they have the written permission of the Director or Assistant Director of Undergraduate Studies. Students granted course credit by the College toward the AB degree for work done prior to admission will receive concentration credit on the same basis as corresponding work done in residence. However, with the exception of transfer students, the total number of half-courses taken at Harvard in this concentration cannot drop below a minimum of thirteen.
   d. **Advanced Placement:** Students who have Advanced Placement in physics should consult the prerequisites printed in *Courses of Instruction* under Physics 16 for the conditions of entering that course directly.
   e. **Teaching:** Students who are interested in receiving eligibility for the certification needed to teach both physics and chemistry in public schools are invited to look at Degree in Physics with Teacher Certification in both Physics and Chemistry on page 228. Completing the Chemistry and Physics concentration with eligibility for teacher certification in both physics and chemistry requires taking the UTEP pro-
gram, described on page 42, in addition to the required courses listed in items 1a–h.

f. Individual Study and Research courses: Physics 90r and/or 91r, and Chemistry 91r are optional.

g. Applied Physics and Engineering Science courses listed in the requirements for the Physics concentration as “counting as Physics” for Physics concentrators are also counted as Physics courses in the Chemistry and Physics concentration.

**ADVISING**

Students interested in concentrating in Chemistry and Physics should discuss their Plans of Study with the Assistant Director of Undergraduate Studies. When Plans of Study are approved, each undergraduate who elects to concentrate in the field is assigned a faculty adviser from either the Physics or Chemistry department. If students do not request a change in adviser, they have the same adviser until they graduate. It is expected that students will discuss their programs and review their progress with faculty advisers at the beginning of each term. Students are told to seek advice at any time and can see their advisers at regularly scheduled office hours or by making an appointment. Students may also seek advice from the Director or Assistant Director of Undergraduate Studies or Chair of the Chemistry and Physics Committee at anytime.

**RESOURCES**

The resources and facilities available to this concentration are essentially those of the Chemistry and Physics departments combined. Hence the descriptions of those concentrations should be consulted for further information.

**HOW TO FIND OUT MORE**

The pamphlet *Physics and Related Fields*, available from the Assistant Director of Undergraduate Studies in Lyman 233, provides useful information about the opportunities for the study of physics and physics-related areas at Harvard. Much of this information is also relevant to the concentration in Chemistry and Physics.

Advice and personal consultation concerning the concentration can be obtained from the Director of Undergraduate Studies, Professor Howard Georgi, Jefferson 456, georgi@physics, (617-496-8293) and the Assistant Director of Undergraduate Studies, Dr. David Morin, Lyman Laboratory 233, morin@physics, (617-495-3257). For office hours, check the website: schwinger.harvard.edu/~georgi/schedule.htm.

Official acceptance into the concentration program is made only through the office of the Assistant Director of Undergraduate Studies who must sign the Plan of Study.
## ENROLLMENT STATISTICS

### Number of Concentrators as of November

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### Degrees Awarded Academic Year 2004–2005

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