

# Department of Chemistry and Physics

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## College of Arts and Sciences

### Faculty

**Randy F. Johnston** (1994). Professor of Chemistry and Department Chair. B.S., University of Missouri, St. Louis; Ph.D., Texas Tech University.

**Charles M. Baldwin** (1970-81, 1988). O.P. and Evalyn Hammons University Professor of Pre-Medical Studies. B.A., University of Corpus Christi; Ph.D., Texas Tech University; CChem FRSC. Additional study, University of Texas, Stanford University, Imperial College (London).

**Jimmy H. Davis** (1978). Professor of Chemistry and Associate Provost. B.S., Union University; Ph.D., University of Illinois; Additional study, University of Florida, Oak Ridge Associated Universities, Argonne National Laboratory, Harvard University and Oxford University (England).

**Kyle L. Hathcox** (1974-88, 1994). Professor of Physics and Coordinator of Physics. B.S. and Ph.D., University of North Texas; Additional study, Oak Ridge Associated Universities.

**Sally A. Henrie** (1998). Associate Professor of Chemistry. B.S., University of Arizona; Ph.D., South Dakota State University.

**Carol Leslie** (1985). Associate Professor of Chemistry. B.S., University of Tennessee at Martin; M.S., University of Tennessee at Knoxville.

**Glenn A. Marsch** (1996). Associate Professor of Physics. B.S., Clemson University; Ph.D., Florida State University. Additional study, Iowa State University, Lawrence Livermore National Laboratory, University of California at San Francisco, Calvin College, and Vanderbilt University.

**Marlyn Newhouse** (1992). Associate Professor of Chemistry. M.A. and B.S.Ed., Northern Arizona University; D.A., Middle Tennessee State University.

**Michael R. Salazar** (2001). Assistant Professor of Chemistry. B.S., New Mexico State University; Ph.D., University of Utah; Additional study, Los Alamos Laboratory.

**David A. Ward** (1992, 1999). Professor of Physics, B.S. and M.A., University of South Florida; Ph.D., North Carolina State University.

The programs in chemistry/physics at Union University seek to serve effectively all students within the institution, recognizing their different needs, interests, and career goals. The chemistry/physics faculty seeks to help students understand the physical world, the methods by which it may be studied, and its relationship to other aspects of the human experience. It is the intention of the chemistry/physics faculty to create an environment in which students are challenged to acquire skills in problem solving utilizing the modern methods of science and to study in-depth the chemical and physical processes which characterize life systems and the physical universe while developing an inquiring attitude toward scientific exploration. Specifically, the chemistry/physics curriculum is intended to provide general liberal arts students with a working knowledge of science and to meet the needs of students who wish to:

- teach science at the elementary or secondary school level,
- prepare to enter one of the health science professions such as medicine, dentistry, medical technology, pharmacy, nursing, physical therapy, or other allied health fields,

- become a professional/industrial chemist physicist, or
- continue study in chemistry or physics at the graduate level.

## Chemistry

Students pursuing a major in Chemistry must complete Math 211, 212; Physics 231, 232, and meet the following requirements in Chemistry:

### I. Major in Chemistry—46 hours

- CHE 111, 112, 211, 221, 314, 315, 317, 318, 319, 324, 325, 327, 335, 498
- Research, 3 hours from: 424 or 425
- One of: 405, 430, 435

### II. Major in Medical Technology

Leading to the Bachelor of Science in Medical Technology

- Chemistry 111, 112, 211-21, 314-15, 319, 324-25
- Biology 112, 211, 221, 222, 315, 316, 320
- Physics 213-214 or 231-232
- Computer Science (3 hours) and MAT 111 or preferably MAT 211
- A minimum of 33 hours of Medical Technology at an affiliated hospital as the fourth year of study.

### III. Major in Chemical Physics\*—105 semester hours

- Chemistry 111, 112, 211, 221, 314, 315, 324, 325, 317, 318, 327, 319, 335 ..... 34
- Physics 231, 232, 311, 313, 314; 325 or 420; 430 ..... 26
- PHY 424 or CHE 424; PHY 498 or CHE 498; Upper level PHY or CHE ..... 6
- Math 211, 212, 213, 314 ..... 15
- English 111, 112; 201 or 202 ..... 9
- Art 210; CHR 111, 112; and 9 hours of social science ..... 18

\*This is a three year program for talented students. Qualifications are listed below. Students who are not qualified for the 3-year program may extend the program to four years and must meet all graduation requirements in doing so.

### IV. Teacher Licensure with Endorsement in Chemistry 7-12

- Complete the requirements for the Chemistry major as shown above including CHE 405.
- Professional Education: EDU 150, 250, 326, 418, 433; PSY 213, 318; SE 225
- Completion of applicable portions of the Praxis II.
- For additional information, see the Director of Teacher Education.

### V. Teacher Licensure With Dual Endorsements in Chemistry 7-12 and Physics 7-12

- Complete the requirements for the Chemical Physics major including both PHY 498 and CHE 498 plus PHY 317.
- Professional Education: EDU 150, 250, 326, 418, 433; PSY 213, PSY 318, SE 225.
- Completion of applicable portions of the Praxis II.
- For additional information, see the Director of Teacher Education.

### VI. Minor in Chemistry—26 or 27 hours

- CHE 111, 112, 211, 221, 314, 315, 324 325
- Elective, one of: 317, 319, 335, 405, 430

## Bachelor of Science in Chemical Physics

This program is designed for a student seeking a broad background in the physical sciences with the intention of doing graduate work in chemistry or physics or pursuing secondary teacher licensure in chemistry and physics. It will permit the student to take full advantage of his previous experiences in the sciences and shorten the total time spent in formal education, without reducing the quality of the degree obtained.

Students admitted into this program will be selected from those entering with an above-average preparation in high school science and mathematics, or from those who after one year of college decide to enter the program and who are properly qualified.

Entrance into the program as a freshman will be permitted under the following conditions:

1. Minimum ACT mathematics score of 25
2. Four years of high school mathematics with a B average or better
3. High school chemistry and physics with a B average or better
4. Minimum ACT composite of 26
5. A successful personal interview with a committee appointed from the faculty of the science department

Entrance into the program as a sophomore or junior will be permitted under the following conditions:

1. The student is prepared to enter MAT 211, CHE 111, and PHY 231.
2. He/she has a GPA of 2.5 based on all work attempted. It is expected that the GPA in Natural Science courses will be higher than 2.5.
3. A successful personal interview with a committee appointed from the science faculty.

### Assessment of Majors

The Department of Chemistry/Physics utilizes standardized tests, generated and distributed by the American Chemical Society, as final examinations for the second semester of all one-year courses. These courses include General Chemistry (CHE 111-112), Organic Chemistry (CHE 314-315), and Physical Chemistry (CHE 317-318). Standardized examinations are also used as the final examination in Fundamentals of Chemistry (CHE 105), Analytical Chemistry (CHE 211), and Biochemistry (CHE 319), Inorganic (CHE 435). The results of these examinations are used to monitor the progress of students as a group through their course of study at Union University. The strengths and weaknesses of courses are also assessed by comparing class averages with national norms. Students who major in chemistry are also required to complete a senior research project (CHE 424), and give a seminar to faculty and colleagues in the department (CHE 498).

### Student Organizations

**Student Affiliate of the American Chemical Society** has been organized to better acquaint those students interested in chemical science with professional opportunities in the field and the mechanics of preparing and presenting technical material. The organization instills professional pride in the chemical sciences, while stimulating awareness of the responsibilities and challenges of the modern chemist. Membership is open to any student pursuing an undergraduate degree in chemistry or physics.

**Sigma Zeta** is a national honorary science society for those who have completed fifteen hours in natural science and mathematics and who have a minimum grade point average of 3.0 in these courses. Membership advantages include recognition for academic achievements by the Sigma Zeta Honor Award, participation in nationally recognized research projects, and a means of cooperation in similar areas of interest by students of different colleges.

### Student Awards

**The Academic Excellence Medal** is awarded to the graduating senior with the highest average in the major provided the average is not less than 3.5. Before Awards Day, the student must have completed at least 15 credit hours in the major at Union University, exclusive of pass/fail courses. If no major is eligible, the medal will be given to the minor meeting the minimum requirements.

The **Chemistry Research Award** is given by the faculty of the Department of Chemistry and Physics to the student who presents the best research paper of the year. The research must have been an original piece of work and must have been presented at a state, regional, or national professional chemistry meeting prior to graduation.

The **C.R.C. Freshman Chemistry Award**, given to encourage and sustain interest in the sciences, is awarded in recognition of outstanding scholastic achievement in Freshman Chemistry.

**Whiteaker Freshman Chemistry Award.** The Chemistry Department selects a freshman chemistry major or minor to receive this award based on outstanding scholastic achievement, financial need, Christian service, and school spirit.

### Course Offerings in Chemistry (CHE)

( )-Hours Credit; F-Fall; W-Winter; S-Spring; Su-Summer

#### 105. Fundamentals of Chemistry I (4) F, S, Su

An introductory general chemistry course for nursing students. It includes study of both physical and chemical properties, structure and reaction of matter. Not applicable to pre-health professions with the exception of Nursing. Science credit will not be given to a student who has completed a course in either Chemistry or Physical Science. Three lectures and one two-hour laboratory period per week.

#### 106. Fundamentals of Chemistry II (4)

Prerequisite: CHE 105 or 111.

A beginning course in organic and biochemistry with emphasis on topics specifically related to the health sciences. The traditional classification of functional groups is studied; each is related to carbohydrates, fats, proteins, vitamins, and hormones. Normal and abnormal metabolic processes and the role of ATP are discussed. Not open to science majors other than physical science and nursing majors. Three one-hour lectures and one three-hour laboratory period per week.

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#### 111. General Chemistry (4) F, W

Prerequisite: high school chemistry, Physical Science 111 or permission of the instructor.

A strong mathematics background (especially in algebra) is recommended.

A comprehensive study of the fundamental experiments, principles, and theories of chemistry with emphasis on the quantitative relationships. The structure and properties of matter with their energy relationships are stressed. Three lectures and one three-hour laboratory per week.

#### 112. Chemical Equilibrium (4) W, S

Prerequisite: CHE 111.

A rigorous and detailed study of the principles of equilibrium in chemical systems. The laboratory is qualitative analysis. The equivalent of three lectures and one three-hour laboratory period each week.

#### 211. Analytical Chemistry (3) S

Prerequisite: CHE 112; Corequisite: CHE 221.

A continuation of the study of fundamental principles including topics in statistics, gravimetric analysis, titrimetric analysis (neutralization, precipitation, complex formation, oxidation-reduction), and spectrophotometric analysis.

#### 221. Analytical Chemistry Laboratory (2) S

Prerequisite: CHE 112; Corequisite: CHE 211.

The application of gravimetric, titrimetric and spectrophotometric quantitative analysis to the study of chemistry. Two three-hour laboratory periods per week.

**300. Chemical Safety and Health (1) S**

A survey of proper safety policies and procedures associated with the use of hazardous chemicals. Topics include safety awareness, routes of chemicals into the body, personal safety apparatus and its use, identification and types of chemical hazards, literature on chemical hazards, and proper ways to label, handle, store, and dispose of hazardous chemicals.

**301. Perspectives in Science (4) F, W**

See PHY 301 for course description.

**314. Organic Chemistry I (3) F**

Prerequisite: CHE 112; Corequisite: CHE 324.

An introduction to the compounds of carbon, with emphasis on the relationship between structure and properties. Applications of bonding theory, reaction mechanism, and stereochemistry are included. Some functional groups containing halogen and oxygen will be examined in detail. Three lectures per week.

**315. Organic Chemistry II (3) S**

Prerequisite: CHE 314; Corequisite: CHE 325.

An in-depth examination of the common oxygen and nitrogen functional groups with respect to structure and chemistry. Continued application of basic theory is included. Heterocyclic and biomolecules will also be examined. Three lectures per week.

**317. Physical Chemistry I (3) F**

Prerequisites: CHE 211, MAT 212, and PHY 232.

An introduction to the application of physical techniques to chemical systems with emphasis on thermodynamics. The laws of thermodynamics will be derived and applied to phase and chemical equilibria, electrochemical cells, and surface phenomena. Three lectures.

**318. Physical Chemistry II (3) S**

Prerequisite: CHE 317.

A continuation of CHE 317 with emphasis on dynamics and quantum chemistry. Dynamics include kinetics, mechanisms, and photochemistry. Quantum chemistry includes atomic and molecular electronic structure and their application to spectroscopy. Three lectures.

**319. Biochemistry (4) F**

Prerequisite: CHE 315, CHE 325, and BIO 112.

An introduction to the organic chemistry of living systems. Topics include structure and function of proteins, enzymic control of chemical reactions, catabolism, anabolism, bioenergetics, biosynthesis, and molecular biology. Three lectures and one 3-hour lab per week.

**324. Organic Chemistry I Laboratory (2) F**

Corequisite: CHE 314.

An introduction to the basic techniques for the physical characterization and isolation of organic compounds. Use of spectrometric methods as applied to the determination of structure is included, as are some synthetic methods. Two three-hour laboratory periods per week.

**325. Organic/Inorganic Synthesis Laboratory (2) S**

Prerequisite: CHE 314 and CHE 324; Corequisite: CHE 315.

Application of laboratory techniques in synthesis and characterization of organic and inorganic compounds. Two three-hour laboratory periods per week.

**327. Physical Chemistry Laboratory (2) S**

Corequisite: CHE 318.

The application of physical methods in the study of chemical compounds. Two three-hour laboratory periods per week.

**335. Intermediate Inorganic Chemistry (3) S**

Prerequisite: CHE 315.

An introduction to inorganic compounds with an emphasis on coordination, bioinorganic, nuclear, and organometallic chemistry. The relationships between structure, physical properties and reactivity will be examined in detail.

**405. Environmental Chemistry (4) S**

Prerequisite: CHE 315.

A study of the rapid changes in the earth's atmosphere, water and soil caused by the activities of humankind. Attention will be given to the ozone layer, air quality and water cycles at the surface of the earth. The vectors, fate, and treatment/removal strategies for organic and heavy metal pollutants will be discussed in depth. Three lectures and one 3-hour lab per week.

**424-5. Introduction to Research (1-3) 424—F, 425—S**

The student's knowledge is integrated by application of a simple piece of original work. Prerequisite: 20 hours of chemistry and a junior/senior standing. Each course will be three hours per week per credit hour.

**430. Advanced Inorganic Chemistry (4) F—Even Years**

Prerequisite: CHE 211. Prerequisite or Corequisite: CHE 318 and 335.

A theoretical treatment of fundamental inorganic topics such as chemical bonding, periodic relationships, stereochemistry of inorganic complexes, acids and bases, and physical properties of inorganic compounds. Three lectures and one 3 hour lab per week.

**435. Advanced Organic Chemistry (4) F—Odd Years**

Prerequisite: CHE 315.

An extensive treatment of selected topics including reaction mechanisms, stereochemistry, heterocyclic chemistry, and molecular rearrangements. Three lectures and one three hour lab per week.

**498. Seminar (1-3) S**

Prerequisite: 20 hours of chemistry and junior/senior standing.

Skills in scientific and technical presentations, written and oral, will be polished. To be used at the discretion of the department for majors and minors only.

**Medical Technology****Hospital-in-Residence Curriculum (Course numbers are Union University numbers)****411. Clinical Chemistry (6)**

The chemical analysis by manual and automated methods of various body fluids (blood, urine, CSF) and the study of their relationship to disease states. Includes instruction in theory and practical laboratory methods.

**412. Instrumentation (1)**

A study of basic electricity and electronics and the principles, use, and care of instruments found in up-to-date laboratories.

**421. Hematology and Coagulation (7)**

Application of theory to technical performance in hematological procedures which aid in the classification of anemias, leukemias, and other red and white blood cell abnor-

malities. Identification of factors involved in bleeding disorders, patient response to therapeutic agents, and principles and practice of quality control and instrumentation.

#### **422. Advanced Microbiology (7)**

A lecture and lab course covering the role of microorganisms as they cause disease in man. Methods employed in the identification of bacteria, fungi, viruses, and rickettsiae. Basic principles of the pathogenesis of infection are covered with particular emphasis on theory and techniques for lab diagnosis.

#### **423. Serology (2)**

A lecture and lab course in immunology, which presents the basic principles of immunity as related to pathogenic organisms and the more complex reactions of the host. Laboratory methods of demonstrating reactions between antigens and antibodies are considered. Use of these reactions as a serodiagnostic tool is presented.

#### **424. Immunohematology (5)**

Includes selection, testing and bleeding of donors, identification of blood group antigens and antibodies, procedures employed in providing compatible blood for patients, and principles and procedures used in blood component therapy. Lecture and lab exercises are employed.

#### **425. Parasitology (2)**

A study of parasites of medical significance, both indigenous and foreign, with particular emphasis on life cycles and identification, is presented through lectures and laboratory practice.

#### **431. Urinalysis (2)**

A lecture and lab course which includes the gross, physical, microscopic, and chemical analysis of urine.

#### **432. Clinical Correlations (1)**

Basic understanding of altered physiology in disease; correlation between laboratory test results and anatomical/physiological changes.

#### **440. Principles of Management and Ethics (0)**

Preparation for the the medical graduate for positions of leadership as supervisors and instructors. General principles of management and of education are discussed through lecture, student projects, and audio-visual aids.

Union University students may enroll for courses taught at the Gulf Coast Research Laboratory during the summer and courses taught at Oak Ridge Associated Universities. For information see the Chemistry/Physics Department Chair.

### **Physics**

It is the purpose of the department to help the student understand the workings behind many of the physical phenomena that occur around him/her every day and to stimulate his/her interest in realizing and utilizing the powers of analysis in all aspects of life. The courses are designed to provide basic content for students classified as physics majors/minors, non-science majors, pre-professionals, and those preparing to teach physics in high school. Included also are courses of general interest open to all students.

#### **I. Major in Physics—38 semester hours**

- A. Physics 231-232, 311, 313, 314, 317, 325, 395\*, 420, 430, 424, 498
- B. Prerequisites in Math: 211, 212, 213, 314

\*Must be approved Special Studies

#### **II. Major in Physical Science—48 hours**

- A. Chemistry 111-112, 211, 221, + three hours CHE electives ..... 16

- B. Physics 112, 231-232, 311, 310 or 301, + 2 hours PHY elective ..... 24  
 C. Biology 8 hours ..... 8

### III. Teacher Licensure in Physics (Grades 7-12)

- A. Complete the requirements shown above for the Physics major.  
 B. Professional Education minor: EDU 150, 250, 326, 418, 433, PSY 213, 318, SE 225.  
 C. Complete the applicable portions of the Praxis II.  
 D. For additional information, see the Director of Teacher Education.

### IV. Minor in Physics—24 semester hours

Physics 231-232, 311, + 10 hours of Physics electives except PHY 111, 112, 301, 310

## Course Offerings in Physics (PHY)

( )-Hours Credit; F-Fall; W-Winter; S-Spring; Su-Summer

### 111. Principles of the Physical Sciences (4) F, W, S, Su

An introduction to physics and chemistry for non-science majors designed to acquaint the student with the historical, philosophical, and social significance of the physical sciences. Exercises are indicative of various scientific methods. Knowledge of basic algebra is assumed. Science credit will not be given after completion of a course in either CHE or PHY. Three lectures, one 2-hour laboratory per week.

### 112. Earth and Space Science (4) F, W, Su

Prerequisite: PHY 111. Reciprocal credit: GEO 112.

An overview of earth science and astronomy with their nature, history, divisions, and relation to other sciences being discussed. The physical laws of nature will be examined as they apply to physical geography, meteorology, and astronomy. Three lectures & one 2-hour laboratory per week.

### 78 213-4. Introduction to Physics (4) 213—F, 214—S

Prerequisite: MAT 111-2.

The first semester involves the study of classical mechanics, wave motion, fluid flow, sound, temperature, and heat. The second involves the study of electricity, magnetism, light, optics, and modern physics. Three lectures and one 3 hour lab per week.

### 231-2. General Physics with Calculus (5) 231—F, 232—S

Pre- or Corequisite: MAT 211-2.

The first semester involves the study of classical mechanics, wave motion, fluid flow and sound. The second involves the study of temperature and heat, electricity, magnetism, light, optics, and modern physics. Four lectures and one laboratory per week.

### 301. Perspectives in Science (4) F, W

Prerequisite: PHY 111-2.

The course approaches the study of science from a historical and philosophical perspective in an interdisciplinary manner, exploring the complementarity of the physical and biological sciences, while addressing relationships to other disciplines such as art, religion, and politics. Examines the role of science in global issues—environment, health, energy—and life issues. Three lecture & 2 laboratory hours per week.

### 310. Energy, Environment, and Society (4) W, S

Prerequisite: PHY 111.

A non-technical course for the general student presenting a broad view of energy and its relationship to man and the environment. Topics include past and future demands, energy sources, storage and transportation of energy, environmental considerations, conservation, politics, economics, and national policy. Three lecture & 3 laboratory hours per week. Laboratories include tours.

**311. Modern Physics (4) F—Even Years**

Prerequisite: MAT 212 & PHY 232.

An introduction to special relativity, quantum mechanics, atomic, and nuclear physics. The laboratory involves investigations in radioactivity, as well as performing some of the classic experiments of modern physics. Three lectures, one 3-hour lab per week.

**313. Intermediate Mechanics (3) F—Odd Years**

Prerequisite: PHY 232 & MAT 212.

An introduction to the rectilinear and curvilinear dynamics of particles and rigid bodies. Both Lagrangian and Hamiltonian formulations of mechanics will be developed and applied.

**314. Intermediate Electricity and Magnetism (3) S—Even Years**

Prerequisite: MAT 212 & PHY 232.

A study of electric and magnetic fields both in media and in a vacuum. Maxwell's equations are used to determine the electromagnetic fields produced by a variety of charge and current distributions.

**317. Introductory Electronics (4) S—Odd Years**

Prerequisite: MAT 212. Reciprocal credit: EGR 262.

An introduction to the field of electronics beginning with DC and AC circuit theory, and continuing through the semiconductor devices. Digital electronics are also introduced. Three lectures and one 3-hour lab per week.

**325. Thermodynamics & Statistical Mechanics (3) F—Odd Years**

Prerequisites: MAT 212 & PHY 232.

An intermediate survey of heat and thermodynamics including the concepts of temperature and heat, the laws of thermodynamics, thermodynamics potentials, the Maxwell relations and statistical methods applied to the thermodynamics of various states of matter, including gases, liquids, and quantum fluids.

**420. Quantum Mechanics (3) S—Even Years**

Prerequisites: PHY 311 & MAT 314.

Fundamental principles of quantum mechanics, methods of calculation, and solutions to Schrodinger's equation. Applications to atomic, molecular, and nuclear physics with an introduction to operator notation. Three lecture hours per week.

**424. Physics Research (1-3) S**

Prerequisite: PHY 311.

The student's knowledge is integrated by application of a simple piece of original work to include a literature search and summary paper on a topic of current interest in physics. Under the supervision of a faculty member, this work may be done off site at a national laboratory or comparable research facility.

**430. Experimental Physics Laboratory (3) F—Even Years**

Prerequisite: PHY 311 & MAT 213.

Introduction to modern experimentation, research, data acquisition and analysis. The theory, practice and reporting of research in a scientific format is demonstrated through experiments in atomic, nuclear, solid state, thermodynamics, and optics. One lecture & four laboratory hours per week.

**498. Seminar (1-3) S**

Prerequisite: 20 hours of physics and junior/senior standing.

Skills in scientific and technical presentations, written and oral, will be polished. To be used at the discretion of the department for majors/minors only.

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**180-280-380-480. Study Abroad Programs (1-4) As Needed**

All courses and their application must be defined and approved prior to travel.

**195-6-7. Special Studies (1-4) On Demand**

Lower-level group studies which do not appear in the regular departmental offerings.

**395-6-7. Special Studies (1-4) On Demand**

Upper-level group studies which do not appear in the regular departmental offerings.

**495-6-7. Independent Study (1-4) On Demand**

Individual study under the guidance of a faculty member(s).

**499. Seminar (1-3) As Needed**

To be used at the discretion of the department.