PHYSICAL SCIENCES

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Introduction

Graduate study with concentrations in chemistry, earth science, physics, and physical sciences is offered within the Master of Science degree.

The requirements for each of these concentrations are described separately. Each is designed to promote a high level of competence and understanding of the subject matter. These programs prepare a student to continue graduate studies at the doctoral level or obtain employment in the chosen field with government agencies, industry or education.

General Admission Requirements and Qualifying Entrance Examinations

At the time of application a degree aspirant's previous academic work is evaluated. Upon admission to the program any existing deficiencies are identified and recommendations are made to address them by the graduate advisor for the applicant's program concentration of choice. All students are required to pass the qualifying exam(s) for their discipline prior to the completion of 12 hours of graduate degree program work. If one or more parts of the exam are not passed, the student may be given another opportunity either by additional testing or coursework to satisfy this requirement. Specific qualifying exam requirements vary depending on the program concentration; therefore, students should consult with the appropriate graduate advisor for details. Admission requirements specific to the various concentrations within the Physical Sciences are outlined under the **Admission Requirements** headings for each concentration (Chemistry, Earth Science, Physics, and Physical Science).

General Degree Requirements

This degree program requires that the student write either a thesis or a research report addressing a selected topic. The thesis option requires successful completion of a minimum of 30 semester hours of approved graduate work. The research report option requires successful completion of a minimum of 32 semester hours of approved graduate work. Both options require successful completion of 15-25 semester hours in the major field(s). Specific course requirements will be determined by the individual candidate in consultation with the candidate's advisor and graduate committee. The candidate must pass an oral examination over the thesis or research report. The

following summarizes the requirements.

Thesis Option	**Hours**
Thesis and Research	3-8
(only 6 credit hours of thesis allowed)	
Major field courses (see each concentration)	15-25
Approved electives	5-10
Total (minimum)	**30**

Research Report Option	**Hours**
Graduate Research	3-6
Major field courses (see each concentration)	15-25
Approved electives	5-12
Total (minimum)	**32**

MS Degree, Physical Science, CHEMISTRY CONCENTRATION

The MS concentration in chemistry is designed to prepare graduates for employment in industrial or governmental sectors, for continued graduate work at the doctoral level, or for teaching.

Admission Requirements

For admission, the applicant must have completed an undergraduate degree from an accredited college or university, including specified courses in chemistry, physics, and mathematics. Adequate preparation for completion of the Master's degree in two years is considered to be a BS degree in chemistry. Students without such backgrounds (e.g., baccalaureate degree in a related field), can be admitted on a provisional status. Such students will be required to take additional undergraduate-level coursework that does not count toward the graduate degree, and can thus expect that the program may require more than two years to complete.

Minimum Undergraduate Preparation in Chemistry for Nonprovisional Status	
General Chemistry	two semesters
Quantitative Analysis	one semester
Organic Chemistry	two semesters
Physical Chemistry	one semester
Inorganic or Biochemistry	one semester

Placement/Qualifying Examinations

Students are required to take placement/qualifying examinations in the five major areas of chemistry (analytical, biochemistry, inorganic, organic, and physical). These examinations are to be taken at the time of the student's first enrollment for the purposes of demonstrating competency in an area and for proper placement into advanced courses. Three of the five examinations must be passed and any deficiencies addressed for the student to advance to non-provisional degree candidacy. If an examination is not passed, a recommended course will be required to be completed with a grade of B or better. This course can then serve to qualify the student in that area. (More information on the entrance examinations is available in the office of the Departments of Physical Sciences.)

Degree Requirements

Two degree options are available. In the more research-intensive **thesis option**, students are required to complete a minimum of 30 credit hours including a thesis (a maximum of 8 hours may be

research and thesis). The **research report option** requires a minimum of 32 credit hours (a maximum of 6 hours may be research). A student must earn a cumulative 3.0 grade point average in all courses used for the degree. A minimum of 60 percent of the credit hours must be in courses numbered 700 or higher. Prior to graduation a student will be expected to demonstrate proficiency in all five subject areas, either via qualifying exams or successful completion of appropriate coursework. For complete degree requirements the student should consult the current graduate policies at http://www.emporia.edu/grad/pol.htm.

Chemistry Course Requirements

The five courses listed below, which represent one advanced-level course in each of the five traditional areas of chemistry, are required as a common core for all graduate students. In addition, CH 722, Physical Chemistry II or its equivalent, must be part of a student's academic record prior to graduation.

CH 724.....Topics in Physical Chemistry
CH 725.....Advanced Inorganic Chemistry
CH 760.....Nucleic Acids Biochemistry
CH 772.....Topics in Organic Chemistry
CH 777.....Instrumental Analysis

Research Requirements

Students pursuing either degree option must complete a research project in collaboration with a faculty advisor. During the first semester of enrollment, the student is encouraged to meet with each faculty member to discuss potential research projects. Toward the end of the first semester of study, a project is chosen by mutual consent of the student and a faculty member. The student and the research advisor will then prepare a research project outline, which must be approved by the student's graduate committee. Students should begin working on the research project no later than the beginning of the second semester of study, otherwise graduation may be delayed. Prior to conferral of the degree, all graduate students are expected to present their research at a public seminar, and must pass an oral examination administered by the graduate committee based on the thesis or report and related course work.

Graduate Committee

Students pursuing a graduate degree must have their work approved and supervised by a graduate committee. This graduate committee is appointed by the recommendation of the department. The student's research advisor will generally serve as the chairperson of the committee. The primary duties of the graduate committee will be 1) to approve the program of study, including the outline of the research topic, 2) to oversee the progress of the student with respect to coursework and research each semester or as needed, and 3) to orally examine the student and approve the thesis or research report prior to graduation.

Seminar Participation

Students are expected to attend and participate in scheduled seminars during the entire period of full-time graduate study, whether enrolled in such seminars for credit or not. A maximum of two credit hours in seminar may be applied toward the degree. Students must present the results of their research at a departmental seminar prior to the oral examination over the research.

MS Degree, Physical Science, EARTH SCIENCE CONCENTRATION

The graduate earth science concentration is designed to provide a broad, flexible, and

interdisciplinary background in earth, environmental, and geological sciences. It is especially well-suited for candidates with career goals in government service, teaching, and/or industry. It can also prepare one for entry into doctoral study.

Admission Requirements
The minimum expected undergraduate preparation in earth science is course work equivalent to the BSE degree with certification in earth/space science, or a BA or BS degree with an earth science, physical geography, geology, or physical science major. Deficiencies in course background may be addressed concurrent with degree program course work.

Application for Admission

To apply for admission to the Earth Science concentration, applicants are required to do the following:

1) Submit an application for admission; see https://slim.emporia.edu/esugrad/appl2.htm.
2) Provide official transcripts from each undergraduate institution attended. Transcripts must be sent to: Office of Graduate Studies and Research, Campus Box 4003, Emporia State University, Emporia, Kansas, 66801.
3) Submit scores for the general Graduate Record Examination (GRE) or the Miller Analogies Test. Test scores should be sent to the Office of Graduate Studies and Research at Emporia State University. No minimum threshold score is set. Scores will be utilized in combination with other information in the admissions process as well as the selection of students to be offered graduate assistantships.

Note: Graduates of ESU who have an overall GPA of at least 3.0 or a GPA of at least 3.25 in ES (Earth Science) and GO (Geology) courses are not required to submit GRE or Miller test scores.

4) Provide a statement of relevant background, fields of interest in Earth Science, and career goals. This should be sent to: Graduate Advisor, Earth Science Department, Campus Box 4030, Emporia State University, Emporia, KS 66801.
5) Distance-learning students must complete or be enrolled in at least one ESU course before applying for formal admission to the degree program.
6) Priority date to submit applications for the upcoming academic year is March 1. Later applications may be considered.
7) A faculty committee will review applications and select candidates for admission. Each candidate will be matched with a prospective faculty advisor.
8) Students admitted into the degree program will be expected to maintain continuous enrollment during the academic year (Fall & Spring semesters). Students may petition for a leave of absence for special circumstances, e.g., military service, medical conditions, family emergencies, or other extraordinary situations.
9) In some cases these procedures and their schedule may be modified for students with special circumstances.

Graduate Committee
Each individual who is pursuing a graduate degree in earth science must have his/her work approved and supervised by a graduate committee. This graduate committee is appointed by the recommendation of the department, and is generally chaired by the student's research advisor. A student's graduate committee must approve the program of study, including the outline of the

research topic. Before the degree is awarded, the committee will examine the candidate orally over the thesis or research report and related topics.

Presentation of Research
A student is expected to present his/her research at a professional scientific conference or meeting. The presentation may take the form of a poster display, oral lecture, field-trip guide, workshop or other suitable format.

MS Degree, Physical Science, PHYSICAL SCIENCE CONCENTRATION

The physical science concentration is an option for in-service teachers or non-teaching professionals. If an inservice teacher, the physical science concentration is designed to provide graduate work to enhance the chemistry, earth-space science, physics and/or physical science background of a licensed teacher. This concentration can also be preparatory for additional graduate work at the doctoral level in science education. A non-teaching physical science concentration is designed to provide graduate work to those professionals for whom a broad foundation in the physical sciences is appropriate.

Admission Requirements
For in-service teachers, the required undergraduate preparation is completion of course work equivalent to the Departments of Physical Sciences' requirements for secondary teaching licensure in one of chemistry, earth/space science, or physics. For non-teaching professionals, the required preparation is a bachelor's degree with similar preparation from an accredited institution.

Program Options
Two program options are available for students wishing to pursue this degree concentration.

Program Option A is designed for those individuals who want to take the maximum number of hours of course work within the disciplines and who will be full-time graduate students during the academic year.

Required Courses/Degree Requirements	**Hours**
Physical Sciences (CH, ES, GO, PH, or PS)	15-25
History of Science	2-3
CH, PH, ES, PS Thesis hours	3
or	
CH, PH, ES, PS Research hours	3-5
Approved electives, if needed, to bring the total hours to 30 (thesis) or 32 (research report) will be decided by the graduate committee and candidate.	
Minimum hours required, thesis option	**30**
Minimum hours required, research report option	**32**

Program Option B is designed for those individuals who want to do course work within the disciplines and also gain additional competence in science education techniques and curriculum development. This program is specifically designed to be completed during summer sessions, and potentially augmented with academic year course work.

Required Courses/Degree Requirements	**Hours**
History of Science	2-3

PS 768 Workshop in Physical Science Teaching 1-3
PS 801 Modern Developments in the Physical Sciences.....3

Approved Electives **Hours**

First Physical Science Discipline.....12
Second Physical Science Discipline 6

Thesis Option **Hours**

Thesis (offered under several course numbers) 3-5
ER 851 Research Design and Writing 3
Minimum hours required, thesis option **30**

Research Report Option **Hours**

Graduate Research or Research Problem (offered under several course numbers)..... 3-6
ER 752 Analysis of Research 3
Minimum hours required, research report option **32**

MS Degree, Physical Science, PHYSICS CONCENTRATION

The physics concentration is designed to serve the needs of those planning to advance in a teaching career, enter industrial or governmental work, or continue graduate education at the doctoral level. Students benefit from small classes, a student-oriented faculty, research opportunities, and a flexible curriculum.

Admission Requirements

For admission to the physics concentration program, the applicant must have completed at least two physics courses for which introductory physics is a prerequisite and must have a demonstrated proficiency in calculus. Students may be admitted on a provisional status, and will be informed upon admission of any specific deficiencies which must be addressed.

Qualifying Examination

Students are required to pass a qualifying examination covering specific topics in physics including classical mechanics, electromagnetism, waves, optics, thermodynamics, atomic physics, subatomic physics and special relativity. (Two semesters of introductory physics and one semester of modern physics can provide adequate preparation for the exam.) This examination will be administered prior to the completion of 12 graduate credit hours. More information on the qualifying examination is available from the Departments of Physical Science Office.

Graduate Committee

Students pursuing a graduate degree must have their work approved and supervised by a graduate committee. This graduate committee is appointed by the recommendation of the department. The student's research advisor will generally serve as the chairperson of the committee. A student's graduate committee must approve the program of study including the outline of the research topic.

Degree Requirements

Two degree options are available. In the more research-intensive thesis option, students are required to complete a minimum of 30 credit hours including a thesis (a maximum of 8 hours may be research or thesis). The research report option requires a minimum of 32 credit hours (a maximum of 6 hours may be research). A student must earn a cumulative 3.0 grade point average in all courses used for the degree. A minimum of 60 percent of the credit hours must be in courses numbered 700 or higher.

Students must present the results of their thesis or research project at a scheduled departmental seminar. Immediately following the seminar, the student's graduate committee will examine the candidate orally over the thesis or research report and related topics.

Required Courses

A master's degree program with a physics concentration requires a minimum of 15 credit hours in physics courses. Advanced-level courses in classical mechanics, electromagnetism, and an advanced laboratory course are required as a common core for all graduate students. PH 760, Mechanics I and PH 762, Electricity and Magnetism I are required. The advanced laboratory requirement can be met with any physics laboratory course at the 500-level or above. The degree program will include additional hours of approved electives to meet the minimum number of hours required.

Seminar Participation

Students are expected to attend and participate in scheduled physics seminars during the entire period of full-time graduate study, whether enrolled in such seminars for credit or not. A maximum of two credit hours in seminar may be applied toward the degree.

GRADUATE COURSES IN THE PHYSICAL SCIENCES

CHEMISTRY	**Hours**
CH 500. TOPICS IN CHEMISTRY	1-5
CH 506. ENVIRONMENTAL CHEMISTRY	3-4
CH 508. INDUSTRIAL CHEMISTRY	1-3
CH 525. DESCRIPTIVE INORGANIC CHEMISTRY	3
CH 560. FUNDAMENTALS OF BIOCHEMISTRY	3
CH 561. FUNDAMENTALS OF BIOCHEMISTRY LABORATORY	2
CH 572. ORGANIC CHEMISTRY I	3
CH 573. ORGANIC CHEMISTRY I LAB	2
CH 574. ORGANIC CHEMISTRY II	3
CH 575. ORGANIC CHEMISTRY II LAB	2
CH 578. WATER ANALYSIS	3
CH 620. ELEMENTS OF PHYSICAL CHEMISTRY	3
CH 627. INTERMEDIATE CHEMISTRY	3
CH 645. NUCLEAR TECHNIQUES	3
CH 660. BIOCHEMISTRY I	3
CH 661. LABORATORY METHODS IN BIOCHEMISTRY	2
CH 662. BIOCHEMISTRY II	3
CH 700. ADVANCED TOPICS IN CHEMISTRY	1-5
CH 720. PHYSICAL CHEMISTRY I	3
CH 721. PHYSICAL CHEMISTRY LABORATORY	2
CH 722. PHYSICAL CHEMISTRY II	3
CH 723. ADVANCED PHYSICAL CHEMISTRY LABORATORY	2
CH 724. TOPICS IN PHYSICAL CHEMISTRY	3
CH 725. ADVANCED INORGANIC CHEMISTRY	3
CH 726. ADVANCED INORGANIC CHEMISTRY LAB	1-3
CH 728. CHEMICAL LITERATURE	1-2
CH 729. RESEARCH PROBLEM IN CHEMISTRY	1-3
CH 730. SEMINAR IN CHEMISTRY	0-1
CH 760. NUCLEIC ACIDS BIOCHEMISTRY	3

CH 765. ADVANCED BIOTECHNOLOGY LABORATORY 4
CH 772. TOPICS IN ORGANIC CHEMISTRY 1-3
CH 773. QUALITATIVE ORGANIC ANALYSIS 3
CH 776. TOPICS IN BIOCHEMISTRY 1-3
CH 777. INSTRUMENTAL METHODS OF ANALYSIS 5
CH 778. TOPICS IN ANALYTICAL CHEMISTRY 1-3
CH 801. TRENDS IN HIGH SCHOOL CHEMISTRY CURRICULA 3
CH 802. MODERN DEVELOPMENTS IN CHEMISTRY 3
CH 826. TOPICS IN INORGANIC CHEMISTRY 1-3
CH 829. GRADUATE RESEARCH 1-5
CH 871. TOPICS IN ADVANCED PHYSICAL CHEMISTRY 1-3
CH 875. THESIS M.S. 1-5

EARTH SCIENCE **Hours**

ES 518. SPACE SCIENCE 3
ES 539. SOIL SCIENCE AND LABORATORY 4
ES 545. GEOMORPHOLOGY 3
ES 546. FIELD GEOMORPHOLOGY 2-5
ES 551. COMPUTER MAPPING SYSTEMS 3
ES 555. SMALL-FORMAT AERIAL PHOTOGRAPHY 3
ES 567. TOPICS IN EARTH SCIENCE 1-4
ES 703. SEMINAR IN PHYSICAL GEOGRAPHY 1-3
ES 730. GEOLOGIC TOPICS OF THE GREAT PLAINS 1-3
ES 739. RESEARCH PROBLEM IN EARTH SCIENCE 1-3
ES 747. FIELD STUDIES IN EARTH SCIENCE 1-6
ES 767. TOPICS IN EARTH SCIENCE 1-4
ES 769. WORKSHOP IN EARTH SCIENCE 2-6
ES 771. REMOTE SENSING 4
ES 775. ADVANCED IMAGE PROCESSING 3
ES 875. THESIS M.S. 1-5

GEOLOGY **Hours**

GO 521. HISTORY OF GEOLOGY 2-3
GO 533. ECONOMIC GEOLOGY 3
GO 536. OPTICAL MINERALOGY 3
GO 547. FIELD GEOLOGY 5
GO 548. FIELD STRATIGRAPHY 2
GO 568. STRUCTURAL GEOLOGY 3
GO 569. INVERTEBRATE PALEONTOLOGY 3
GO 570. SEDIMENTATION AND STRATIGRAPHY 3
GO 571. HYDROGEOLOGY 4
GO 572. CONTAMINANT HYDROGEOLOGY 3
GO 580. ENVIRONMENTAL FIELD METHODS 3
GO 766. PETROLOGY AND PETROGRAPHY 4
GO 769. VERTEBRATE PALEONTOLOGY 3

PHYSICAL SCIENCE **Hours**

PS 500. TOPICS IN PHYSICAL SCIENCE 1-5
PS 516. TEACHING PHYSICAL SCIENCES IN MIDDLE/HIGH SCHOOL 3

PS 517. PHYSICAL SCIENCE TECHNIQUES II 3
PS 520. ENERGY IN TRANSITION 2-4
PS 700. ADVANCED TOPICS IN PHYSICAL SCIENCE 1-5
PS 730. NATURE OF THE SCIENTIFIC ENTERPRISE 2
PS 768. WORKSHOP IN PHYSICAL SCIENCE TEACHING 1-5
PS 801. MODERN DEVELOPMENTS IN THE PHYSICAL SCIENCES 3
PS 810. SEMINAR IN PHYSICAL SCIENCE 0-4
PS 839. GRADUATE RESEARCH 1-5
PS 875. THESIS, M.S. 1-5

PHYSICS **Hours**

PH 500. TOPICS IN PHYSICS 1-5
PH 510. COMPUTER APPLICATIONS IN PHYSICS 3
PH 520. LIGHT 3
PH 530. HEAT AND THERMODYNAMICS 3
PH 540. MODERN PHYSICS 3
PH 541. ATOMIC AND NUCLEAR PHYSICS I 3
PH 547. ANALOG ELECTRONICS 3
PH 548. ANALOG ELECTRONICS LABORATORY 2
PH 550. DIGITAL ELECTRONICS 3
PH 551. DIGITAL ELECTRONICS LABORATORY 2
PH 635. INTERMEDIATE PHYSICS 3
PH 645. NUCLEAR TECHNIQUES 3
PH 700. TOPICS IN PHYSICS 1-5
PH 730. SEMINAR IN PHYSICS 0-2
PH 741. ADVANCED PHYSICS LABORATORY I 3
PH 742. ADVANCED PHYSICS LABORATORY II 3
PH 752. ATOMIC AND NUCLEAR PHYSICS II 3
PH 760. MECHANICS I 3
PH 761. MECHANICS II 3
PH 762. ELECTRICITY AND MAGNETISM I 3
PH 763. ELECTRICITY AND MAGNETISM II 3
PH 770. RESEARCH PROBLEM IN PHYSICS 1-3
PH 775. MICROCOMPUTER SYSTEMS 3
PH 780. INTRODUCTION TO SOLID STATE 3
PH 785. NUCLEAR PHYSICS 3
PH 790. THEORETICAL PHYSICS 3
PH 795. INTRODUCTION TO QUANTUM MECHANICS 3
PH 801. TRENDS IN HIGH SCHOOL PHYSICS CURRICULA 3
PH 802. MODERN DEVELOPMENTS IN PHYSICS 3
PH 810. PLASMA PHYSICS 3
PH 820. ASTROPHYSICS 3
PH 840. MATHEMATICAL PHYSICS 3
PH 845. TOPICS IN PHYSICS 1-3
PH 860. GRADUATE RESEARCH 1-5
PH 890. THESIS M.S. 1-5