Physics Programs Self-Study
Prepared Fall 2012 as part of the Arkansas Higher Education Coordinating Board (AHECB) Mandated Academic Program Review

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Introduction

Arkansas State University-Jonesboro (ASUJ) is a four year, public institution with a Fall 2012 enrollment of 13,877 students (10,168 undergraduate, 3,709 graduate), and a basic Carnegie classification of Master's, large programs. Additional Carnegie classification information is provided in Table I1.

Table I1
Carnegie Foundation Institution Classifications
Arkansas State University Jonesboro

Classification	Category
Undergraduate Instructional Program	Professions plus arts & sciences, some graduate coexistence (Prof+A&S/SGC)
Graduate Instructional Program	Doctoral, professional dominant (Doc/Prof)
Enrollment Profile	High undergraduate (HU)
Undergraduate Profile	Full-time four-year, inclusive (FT4/I)
Size and Setting	Medium four-year, primarily nonresidential (M4/NR)

Over the last ten years the university has maintained a focus of transitioning to a more research-intensive institution, while enhancing its historical mission of dedication to student learning. The ASU physics programs contributes to achieving these goals, and the economic growth of the state, by providing university level education for 1) STEM and non-STEM degree programs (i.e., service courses), and 2) education/training of future physicists and physics teachers.

Service Courses

The ASU general education program mission is to develop "a foundation and motivation for the lifelong pursuit of learning in undergraduate students at Arkansas State University by introducing them to a broad range of essential areas of knowledge that will enable them to think critically and participate ethically in a democratic nation and a global society." The program includes several goals, including

> **Using science to accomplish common goals.** Students should understand how science is conducted and the criteria for scientific evidence so that they will be able to make informed decisions about the health and well-being of their communities and the natural environment. They should be aware of the ethical and political issues raised by science.

All associate and baccalaureate degree programs offered within Arkansas require the completion of approved general education courses. At ASU this includes completion of two courses; a three credit hour physical science lecture and a one credit hour physical science laboratory. All general education approved physical science courses are offered through the Department of Chemistry and Physics, and are identified in Table SC1 by the description general education.

Table SC1 Physical Science General Education and Service Courses					
Course Number	**Course Title**	**Description**	**Delivery Method**	**Course Description**	**Primary Colleges Served**
PHYS 1103	Introduction to Space Science	general education	online	A survey of the basic principles of science with emphasis on physics through their application to study about our place in the cosmos. Lecture three hours. Prerequisite, MATH 0013 or ACT Math score of 16. Demand	All
PHYS 1101	Introduction to Space Science Laboratory	general education	online	To be taken concurrently with PHYS 1103. Demand.	All
PHYS 2054	General Physics I	general education	traditional	The essential of mechanics, heat, materials and simple harmonic motion in a unified lecture and laboratory format utilizing multimedia computers at each student station. Prerequisite, MATH 1033 or higher. Fall, Spring, Summer.	Sciences and Mathematics, Education, Agriculture & Technology
PHYS 2064	General Physics II	service	traditional	Continuation of PHYS 2054, the essentials of electricity, magnetism, wave motion, light and modern physics in a unified lecture and laboratory format utilizing multimedia computers at each student station. Prerequisite, PHYS 2054 or 2034. Fall, Spring, Summer.	Sciences and Mathematics, Agriculture & Technology
PHYS 2034	University Physics I	general education	traditional	Basic principles of mechanics, thermodynamics, materials and wave motion utilizing calculus with multimedia computers, at each station, in a unified lecture and lab format. Corequisite, MATH 2204. Fall, Spring.	Sciences and Mathematics, Engineering
PHYS 2044	University Physics II	service	traditional	Continuation of PHYS 2034 covering the basic principles of electricity, magnetism, waves, optics and topics from modern physics utilizing calculus with multimedia computers, at each station, in a unified lecture and lab format. Prerequisite, Physics 2034 or 2054. Corequisite, MATH 2214. Fall, Spring.	Sciences and Mathematics, Engineering

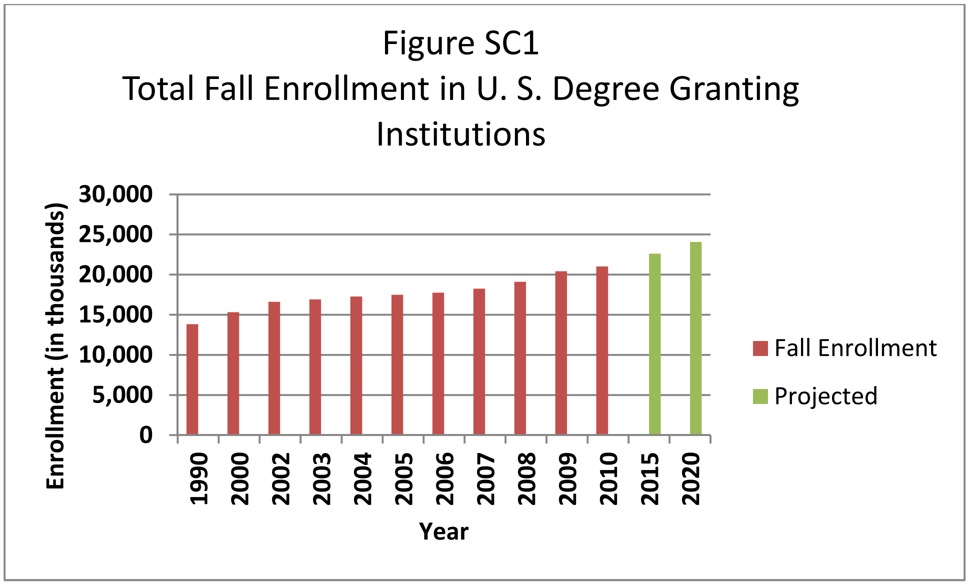
Table SC1 Physical Science General Education and Service Courses					
Course Number	**Course Title**	**Description**	**Delivery Method**	**Course Description**	**Primary Colleges Served**
PHYS 2133	Survey of Physics for the Health Professions	service	traditional	A survey for introductory mechanics, waves, electricity, magnetism, optics and modern physics with applications for students of the health professions. Fall.	Nursing & Health Professions
CHEM 1003	Introduction to Chemistry	service	traditional	Fundamentals of chemical terms and applications to laboratory studies. Extensive drills on calculations and use of hand held calculator in problem solving. Recommended for those with no prior study of chemistry. Corequisite or prerequisite, MATH 0003, MATH 0013, or MATH 1023. Fall, Spring.	
CHEM 1013	General Chemistry I	general education	traditional	Study of chemical reactions and equations, periodic relationships, the gaseous state, and the fundamentals of atomic theory, quantum theory, electronic structure, chemical bonding, stoichiometry and thermochemistry. Prerequisite MATH 1023. Fall, Spring, Summer.	Sciences and Mathematics, Engineering, Education, Agriculture & Technology, Nursing & Health Professions
CHEM 1011	General Chemistry I Laboratory	general education	traditional	Credit for this course is contingent upon earlier or simultaneous completion of CHEM 1013. Fall, Spring, Summer.	Sciences and Mathematics, Engineering, Education, Agriculture & Technology, Nursing & Health Professions
CHEM 1023	General Chemistry II	service	traditional	Study of liquids, solids, solutions and the fundamentals of chemical kinetics, chemical equilibria, acids and bases, thermodynamics, and electrochemistry. Prerequisites, CHEM 1011 and CHEM 1013. Fall, Spring, Summer.	Sciences and Mathematics, Engineering, Agriculture & Technology, Nursing & Health Professions

Table SC1 Physical Science General Education and Service Courses					
Course Number	**Course Title**	**Description**	**Delivery Method**	**Course Description**	**Primary Colleges Served**
CHEM 1021	General Chemistry II Laboratory	service	traditional	Corequisite or prerequisite, CHEM 1023. Prerequisite, CHEM 1011. Credit for this course is contingent upon earlier or simultaneous completion of CHEM 1023. Fall, Spring, Summer.	Sciences and Mathematics, Engineering, Agriculture & Technology, Nursing & Health Professions
CHEM 1043	Fundamental Concepts of Chemistry	general education	traditional, online	A one semester chemistry survey course introducing selected fundamental concepts including dimensional analysis, mole concept, atomic and molecular structure, nomenclature, chemical reactions, thermochemistry, intermolecular interactions, gases, mixtures, kinetics, equilibrium and acid base chemistry. Fall, Spring.	Nursing & Health Professions, Agriculture & Technology
CHEM 1041	Fund Concepts of Chemistry Laboratory	general education	traditional, online	Prerequisite or corequisite of CHEM 1043. Fall, Spring.	Nursing & Health Professions, Agriculture & Technology
CHEM 1052	Fund Concepts of Chemistry II	service	online	A continuation of CHEM 1043 with a focus on the role of chemistry in human body functions. Prerequisites CHEM 1043 and CHEM 1041. Fall, Spring	Agriculture & Technology, Nursing & Health Professions
CHEM 3103	Organic Chemistry I	service	traditional	Study of the nomenclature, bonding, preparations and reactions of compounds of carbon, including aliphatic and aromatic hydrocarbons, haloalkanes, alcohols, and ethers. Prerequisites, CHEM 1023 and CHEM 1021. Fall, Spring, Summer	Sciences and Mathematics, Agriculture & Technology, Nursing & Health Professions
CHEM 3101	Organic Chemistry I Laboratory	service	traditional	Laboratory skills illustrating the principles of Organic Chemistry I. Corequisite or prerequisite, CHEM 3103. Credit for this course is contingent upon earlier or simultaneous completion of CHEM 3103. Fall, Spring, Summer.	Sciences and Mathematics, Agriculture & Technology, Nursing & Health Professions, Education

Table SC1 Physical Science General Education and Service Courses					
Course Number	**Course Title**	**Description**	**Delivery Method**	**Course Description**	**Primary Colleges Served**
CHEM 3113	Organic Chemistry II	service	traditional	Continuation of Organic Chemistry I, including the study of phenols, aldehydes, ketones, carboxylic acids and their derivatives, amines, proteins, carbohydrates, lipids and nucleic acids. Spectroscopic methods of structure determination are also presented. Prerequisite, CHEM 3103. Fall, Spring, Summer.	Sciences and Mathematics, Agriculture & Technology
CHEM 3111	Organic Chemistry II Laboratory	service	traditional	Laboratory skills illustrating the principles of Organic Chemistry II. Prerequisite, CHEM 3101. Credit for this course is contingent upon earlier or simultaneous completion of CHEM 3113. Fall, Spring, Summer.	Sciences and Mathematics, Agriculture & Technology
CHEM 4243	Biochemistry	service	traditional	Presentation of the important areas of modern biochemistry and a description of methods commonly employed in biochemical research. Prerequisites, CHEM 3113 and 3111. Fall, Spring, Summer.	Sciences and Mathematics
PHSC 1014	Energy and the Environment	general education	online	A hybrid lecture and lab course that studies energy. What it is, how it is produced and used, and its effect on the environment. Special attention will be paid to individual energy usage and economical methods by which to reduce usage. Prerequisite, MATH 0013 or ACT Mathematics core of 16. Demand.	All
PHSC 1203	Physical Science	general education	traditional, online	The relationship of man to his physical world, content of the course is centered on the development of our modern concepts about matter and energy and how this development is related to the social order of which man is a part. To be taken concurrently with PHSC 1201. Prerequisite, MATH 0013 or ACT Mathematics score of 16. Fall, Spring, Summer.	All
PHSC 1201	Physical Science Laboratory	general education	traditional, online	To be taken concurrently with PHSC 1203. Fall, Spring, Summer.	All

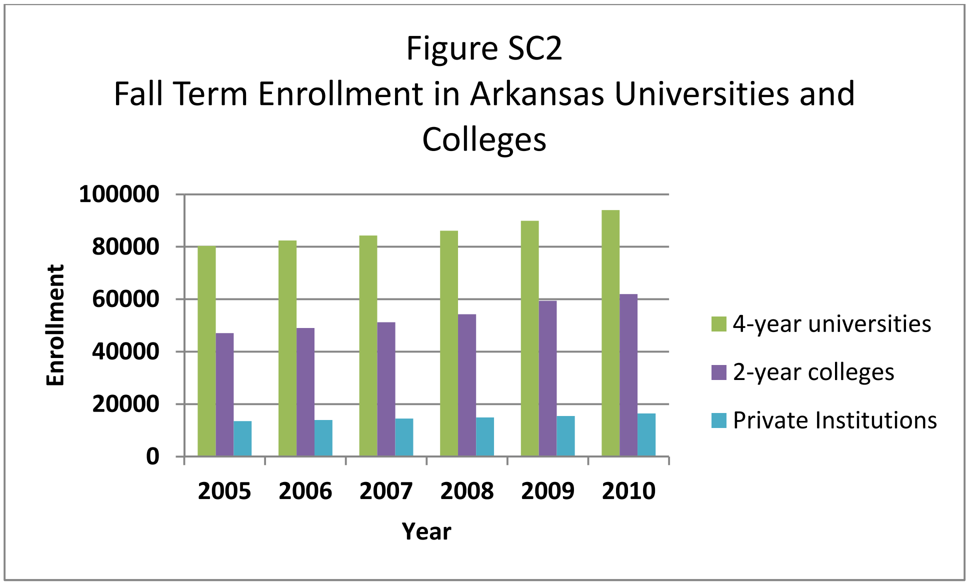
Table SC1 Physical Science General Education and Service Courses					
Course Number	**Course Title**	**Description**	**Delivery Method**	**Course Description**	**Primary Colleges Served**
GSP 3203	Science for Teachers	service	traditional	Gives early childhood and middle school teachers an overall view of the role of science in the development of modern civilization, and enables teachers to use content knowledge to properly direct the learning activities of pupils in science classes. Prerequisite Fulfillment of the General Education Biological and Physical Science courses requirement. Fall, Spring, Summer	Education

Evidence of the continued demand for general education and service courses can be appreciated by considering the enrollment growth in higher education. Figure 1 shows a 52% growth in total fall enrollment at U.S. degree granting institutions from 1990 to 2010. Moreover, an additional 14.5% enrollment increase is projected between 2010 and 2020.

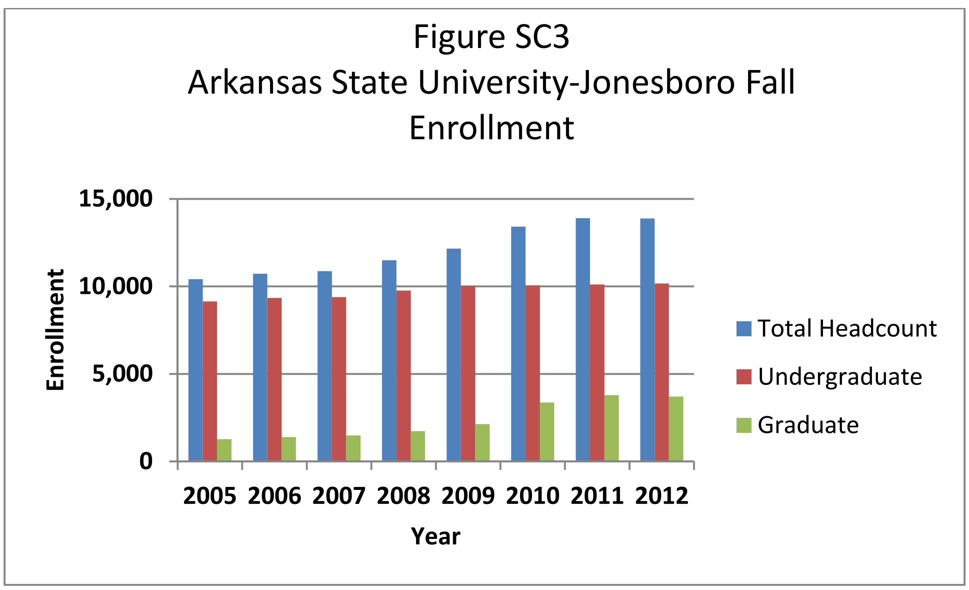


While Figure SC1 includes post-baccalaureate programs, the National Center for Education Statistics (NCES) also indicates undergraduate fall enrollment increased 51.2% between 1990 and 2010 (Fall 1990, 11,959,106; Fall 2010, 18,078,672).

As indicated in Figure SC2, fall enrollment has increased 17.0 % at Arkansas 4-year universities between 2005 and 2010. Arkansas Department of Higher Education (ADHE) data also indicates total fall enrollment (4-year, 2-year, and private) in Arkansas institutions increased 22.3% during this period (Fall 2005, 140,955; Fall 2010, 172,445), which is similar to the 20.2% enrollment increase indicated by the NCES data for this period (see Figure SC1). Clearly, there is a state level need for physical science general education and physics service courses.

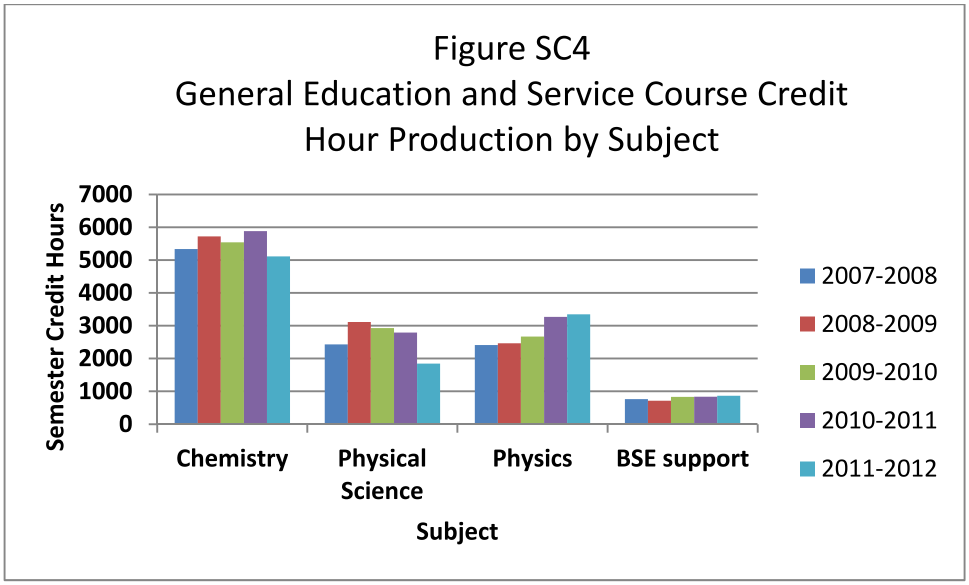


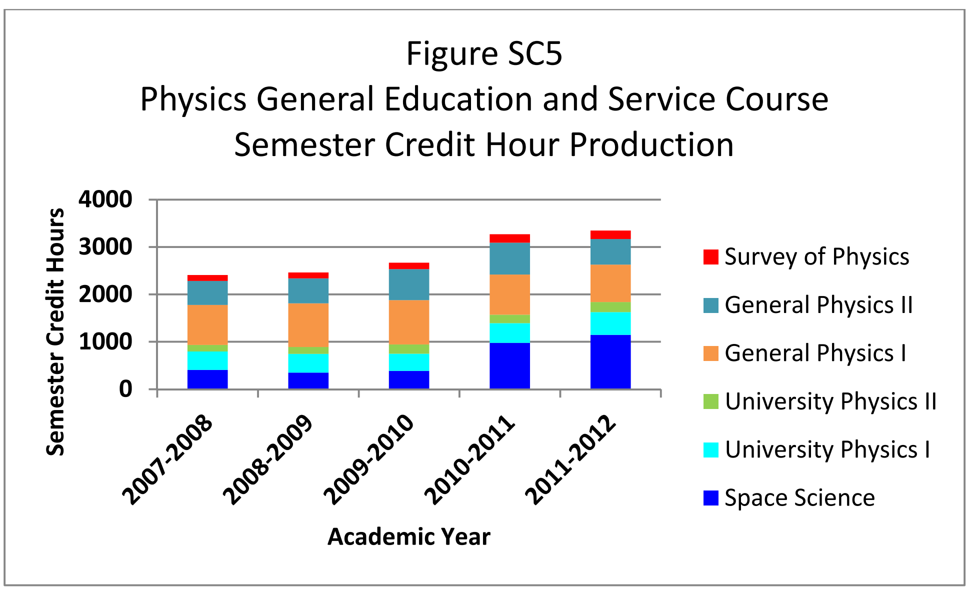
In-line with the national and state growth trend, ASU Jonesboro fall enrollment has increased 28.8% between Fall 2005 and Fall 2010 (See Figure SC3, Fall 2005—10,414; Fall 2010—13,415) with the major contribution to growth coming from graduate students.



As indicated in Figure SC4, there has been 38.9% increase in semester credit hour production from physics service and general education course offerings over the past five academic years (2007-2008, 2,409 semester credit hours; 2011-2012, 3,347 semester credit hours). Over this same time period physics has been responsible for generating nearly 25% of the total 58,863 general education and service semester credit hours provided by the Department of Chemistry and Physics. Much of this observed increase is attributed to enrollment growth in Introduction to Space Science (PHYS 1103 and 1101), general education lecture and laboratory courses currently being offered online (see Figure SC5).

Continued growth can also be expected in the physics service courses as undergraduate fall enrollment for the Colleges of Sciences and Mathematics (fall 2007, 775; fall 2012, 878), Agriculture and Technology (fall 2007, 357; fall 2012, 438), and Engineering (fall 2007, 264; fall 2012, 353), have increased by 13.3%, 22.7%, and 33.7% respectively from 2007 to 2012. Additionally, during fall 2012 the College of Engineering had an on sight review of their programs by the Accreditation Board for Engineering and Technology (ABET) which will likely result in ABET accredited civil, mechanical, and electrical degree programs. It is expected this will result in significant enrollment increases in engineering programs and corresponding demand for calculus based introductory physics courses.





The data provided above clearly demonstrates an increase in higher education enrollment at the national level as well as within Arkansas, and at ASU Jonesboro. This growth contributes to an increasing and essential need for physics general education and service courses.

Physics Degree Programs

The ASU Jonesboro physics program offers BS physics and BSE physics emphasis degrees. Degree program outcomes, updated during the spring 2011 semester, are provided in Tables PDP1 and PDP2.

Table PDP1
BS Physics Degree Learning Outcomes/Objectives

Objective	Description
Phenomena	Describe observed and modeled phenomena using fundamental physical principles and calculus-based mathematics.
Communication	Effectively communicate, both oral and written, to various audiences (layperson and professional) using appropriate terminology.
Instrumentation	Demonstrate appropriate use of and the ability to troubleshoot standard research laboratory instrumentation.
Literature	Use commercially available databases to search the primary scientific literature.
Ethics	Demonstrate the development of standards expected of professional scientists.
Post Degree	Secure a position in the work force or gain acceptance to a post-baccalaureate program which utilizes the earned BS Physics degree.

Table PDP2
BSE Physics Emphasis Degree Learning Outcomes/Objectives

Objective	Description
Phenomena	Describe observed and modeled chemical phenomena using fundamental chemical, physics, and earth science principles.
Communication	Understand and articulate the knowledge and practices of contemporary chemistry, physics, and earth science as related to the (physical/earth science licensure area.
Understanding of Science	Demonstrate an understanding of the history, philosophy, and practice of science.
Pedagogy 1	Understand the processes, tenets, and assumptions of multiple methods of inquiry leading to scientific knowledge.
NSTA	Understand and successfully convey to secondary science students the major concepts, principles, theories, laws, and interrelationships of the major fields of licensure and supporting fields as recommended by the National Science Teachers Association.
Pedagogy 2	Demonstrate the ability to use and justify a variety of secondary science classroom arrangements, groupings, actions, strategies, and methodologies.
Assessment	Construct and use effective assessment strategies in the secondary science classroom to determine the backgrounds and achievements of learners and facilitate their intellectual, social, and personal development.

Table PDP2 BSE Physics Emphasis Degree Learning Outcomes/Objectives	
Objective	**Description**
Safety	Demonstrate the knowledge and ability to practice safe and proper techniques for the preparation, storage, dispensing, supervision, and disposal of all materials used in secondary science instruction.
Post Degree	Secure a position in the work force or gain acceptance to a post-baccalaureate program which utilizes the earned BSE degree.

Table PDP3 is a summary of degree credit hour requirements. All first semester freshman are required to complete Making Connections, a course design to aid students as they transition to college, including development of academic performance, problem solving, critical thinking, self-management and group building skills, and university policies. Incoming freshman that have declared physics or chemistry as a major are encouraged to fulfill this requirement by registering for PHSC 1003, Making Connections Physics and Chemistry, which can include major related content. Freshman may also fulfill this requirement by completing a Making Connections course offered by another department or University College (UC 1013).

The university requires each degree program include at least 45 credit hours of 3000 or 4000 level courses. The major requirements of the BS physics degree includes 35 credit hours of 3000 or 4000 level courses, and thus at least 10 of 26 credit hours of electives must be at the 3000 or 4000 level.

Table PDP3 Physics Degree Credit Hour Requirements		
Requirement	**BS Physics**	**BSE Physics Emphasis**
First Year Making Connections	3	3
General Education	36	36
Major Requirements	55	80
Electives	26 (at least 10 of which must be at the 3000/4000 level)	1
Total	120	120

Additional degree requirements details are provided in Tables PDP4 and PDP5 which include all BS Physics and BSE Physics course requirements, including First Year Making Connections (PHSC 1003) and the 36 credit hours of general education courses. BSE physics general education social science elective choices are limited relative to the BS physics degree because of additional requirements associated with this degree. The BSE physics degree major requirements include 45 credit hours of STEM related courses, 32 credit hours of professional education course work, and a 3 credit hour health requirement. A grade of “C” or better is required for all Professional Education Requirements.

Table PDP4 BS Physics Curriculum	
University Requirements	
	Credit hours
First Year Making Connections (select one course) PHSC 1003, Making Connections - Chemistry and Physics **OR** UC 1013 Making Connections	**3**
General Education Requirements	
Communication ENG 1003 Composition I ENG 1013 Composition II SCOM 1203 Oral Communication	9
Math MATH 2204 Calculus I	4
Science	
Physical Science PHYS 2034 University Physics	4
Life Science (select one option) BIO 2013 AND 2011 Biology of the Cell and Laboratory BIOL 1003 AND 1001 Biological Science and Laboratory BIOL 1033 AND 1001 Biology of Sex and Laboratory BIOL 1043 AND 1001 Plants & People and Laboratory BIOL 1063 AND 1001 People & Environment and Laboratory BIO 2103 AND 2101 Microbiology for Nursing and Allied Health and Laboratory **AND** BIO 2203 AND 2201 Anatomy and Physiology I and Laboratory **OR** BIO 2223 AND 2221 Anatomy and Physiology II and Laboratory	4
Fine Arts & Humanities	
Fine Arts (select one course) ART 2503 Fine Arts – Visual MUS 2503 Fine Arts – Musical THEA 2503 Fine Arts - Theatre	3
Humanities (select one course) ENG 2003 Introduction to World Literature I ENG 2013 Introduction to World Literature II PHIL 1103 Introduction to Philosophy	3
Social Sciences	
3 credit hours (select one course) HIST 2763 United States History to 1876 HIST 2773 United States History since 1876 POSC 2103 Introduction to US Government	3
6 credit hours (select two courses) ANTH 2233 Introduction to Cultural Anthropology HIST 1023 World Civilization since 1660 ECON 2313 Principles of Macroeconomics JOUR/RTV 1003 Mass Communication ECON 2333 Economic Issues & Concepts	6

Table PDP4 BS Physics Curriculum	
University Requirements	
	Credit hours
POSC 1003 Introduction to Politics GEOG 2613 Introduction to Geography PSY 2013 Introduction to Psychology HIST 1013 World Civilization to 1660 SOC 2213 Introduction to Sociology	
General education requirements subtotal	**36**
Major Requirements	
CHEM 1011 General Chemistry I Laboratory	1
CHEM 1023 General Chemistry	3
CHEM 1021 General Chemistry I Laboratory	1
CHEM 1023 General Chemistry II	3
CS 2114 Structured Programming	4
MATH 2214 Calculus II	4
MATH 3254 Calculus III	4
MATH 4403 Differential Equations	3
PHYS 2044 University Physics II	4
PHYS 3103 Thermal Physics	3
PHYS 3153 Mechanics	3
PHYS 3203 Electromagnetic Theory	3
PHYS 3303 Modern Physics	3
PHYS 3253 Optics	3
Physics Laboratory Experience (select one of the following combinations): PHYS 3272 Physical Instrumentation I **AND** PHYS 3282 Physical Instrumentation II **OR** PHYS 4432 Advanced Physics Laboratory I **AND** PHYS 4442 Advanced Physics Laboratory II	4
PHYS 4353 Mathematical Physics	3
PHYS 4553 Principles of Quantum Mechanics	3
PHYS 4693 Research in Physics - Capstone	3
Electives	**26**
Major requirements subtotal	**81**
Total Required Credit Hours:	**120**

Table PDP5 BSE Physics Curriculum	
University Requirements	
	Credit hours
First Year Making Connections (select one course) PHSC 1003 Making Connections - Chemistry and Physics **OR** UC 1013 Making Connections	**3**
General Education Requirements	
Communication ENG 1003 Composition I ENG 1013 Composition II SCOM 1203 Oral Communication	9
Math MATH 2204 Calculus I	4
Science	
Physical Science PHYS 2034 University Physics I	4
Life Science (select one option) BIO 2013 AND 2011 Biology of the Cell and Laboratory BIOL 1003 AND 1001 Biological Science and Laboratory BIOL 1033 AND 1001 Biology of Sex and Laboratory BIOL 1043 AND 1001 Plants & People and Laboratory BIOL 1063 AND 1001 People & Environment and Laboratory BIO 2103 AND 2101 Microbiology for Nursing and Allied Health and Laboratory **AND** BIO 2203 AND 2201 Anatomy and Physiology I and Laboratory **OR** BIO 2223 AND 2221 Anatomy and Physiology II and Laboratory	4
Fine Arts & Humanities	
Fine Arts (select one course) ART 2503 Fine Arts – Visual MUS 2503 Fine Arts – Musical THEA 2503 Fine Arts - Theatre	3
Humanities (select one course) ENG 2003 Introduction to World Literature I ENG 2013 Introduction to World Literature II PHIL 1103 Introduction to Philosophy	3
Social Sciences	
PSY 2013 Intro to Psychology POSC 2103 Introduction to US Government (select one of the following courses) HIST 2763 United States History to 1876 **OR** HIST 2773 United States History since 1876	9
General education requirements subtotal	**36**
Major Requirements	
CHEM 1013 General Chemistry I	3
CHEM 1011 General Chemistry I Laboratory	1

Table PDP5 BSE Physics Curriculum	
University Requirements	
	Credit hours
CHEM 1023 General Chemistry II	3
CHEM 1021 General Chemistry II Laboratory	1
CS 2114 Structured Programming	4
MATH 2214 Calculus II	4
MATH 3254 Calculus III	4
MATH 4403 Differential Equations	3
PHYS 2044 University Physics II	4
PHYS 3153 Mechanics	3
PHYS 3203 Electromagnetic Theory	3
PHYS 3303 Modern Physics	3
Any three of the following: GEOG 3723 Introduction to Physical Geography GEOL 1003 Environmental Geology PHYS 1103 Introduction to Space Science **OR** PHYS 3133 Astronomy PHYS 3043 Atmospheric Dynamics	9
subtotal	**45**
Professional Education Requirements	
EDSC 4593 Methods and Materials for Teaching Science in the Secondary School	3
ELSE 3643 The Exceptional Student in the Regular Classroom	3
PSY 3703 Educational Psychology	3
SCED 2513 Introduction to Secondary Teaching	3
SCED 3515 Performance Based Inst. Design	5
SCED 4713 Educational Measurement with Computer Applications	3
TIPH 4826 Physics Teaching Internship in the Secondary School	12
subtotal	**32**
Additional Teacher Education Requirements	
HLTH 2513 Principles of Personal Health	3
Electives	**1**
Total Required Credit Hours:	**120**

Table PDP6 provides information about degree major requirements, including course descriptions, prerequisite/corequisites, credit hours, lecture and lab contact hours per week, and terms offered. Syllabi for physics courses offered during fall 2011 and spring 2012 are included in Appendix I. While most of the major requirements are physics courses, chemistry, several departments of the College of Education (BSE professional education requirements), and the Departments of Mathematics and

Statistics and Computer Science also service the physics degrees. The 11 courses listed at the end of Table PDP6 are physics electives that are offered on demand.

Table PDP6 Physics Degree Major Requirements								
Requirement of Physics degree program	**Course prefix and number**	**Course title**	**Credit (hrs)**	**Description**	**Prerequisite/ corequisite**	**Lecture contact hours per week**	**Lab contact hours per week**	**Terms offered**
BS, BSE	CHEM 1013	General Chemistry I	3	Study of chemical reactions and equations, periodic relationships, the gaseous state, and the fundamentals of atomic theory, quantum theory, electronic structure, chemical bonding, stoichiometry and thermochemistry.	MATH 1023 College Algebra	2.5		Fall, Spring, Summer
BS, BSE	CHEM 1011	General Chemistry I Laboratory	1		CHEM 1013 corequisite or prior completion		3	Fall, Spring, Summer
BS, BSE	CHEM 1023	General Chemistry II	3	Study of liquids, solids, solutions and the fundamentals of chemical kinetics, chemical equilibria, acids and bases, thermodynamics, and electrochemistry.	CHEM 1013 and 1011 General chemistry I and General Chemistry I lab	2.5		Fall, Spring, Summer
BS, BSE	CHEM 1021	General Chemistry II Laboratory	1		CHEM 1011 prerequisite, CHEM 1023 corequisite		3	Fall, Spring, Summer
BS, BSE	CS 2114	Structured Programming	4	First course in programming, emphasis on programming methodology, procedural abstraction, and top down design. Introduction to string processing, file input and output, recursion, and simple data structures.	MATH 1023 College Algebra	2.5	2	Fall, Spring
BS, BSE	MATH 2204	Calculus I	4	Limits, derivatives, implicit differentiation, applications of the derivative, indefinite integrals, definite integrals, substitution techniques for integrals and applications of the integral.	MATH 1054 Precalculus Mathematics, or MATH 1023 & 1033 College Algebra and Plane Trigonometry	3.3		Fall, Spring, Summer

Table PDP6 Physics Degree Major Requirements								
Requirement of Physics degree program	**Course prefix and number**	**Course title**	**Credit (hrs)**	**Description**	**Prerequisite/ corequisite**	**Lecture contact hours per week**	**Lab contact hours per week**	**Terms offered**
BS, BSE	MATH 2214	Calculus II	4	Inverse trigonometric functions, hyperbolic functions, integration by parts, trigonometric substitution, partial fractions, integral tables, approximating definite integrals, Taylors Theorem, L'Hopital's Rule, improper integrals, sequences, series, power series, Taylor series, parametric curves, arc length, surface area and polar coordinates.	MATH 2204 Calculus I	3.3		Fall, Spring, Summer
BS, BSE	MATH 3254	Calculus III	4	Vectors, lines, and planes in two and three dimensions, vector valued functions, space curves, curvature and torsion, partial and directional derivatives, extrema of functions of several variables, optimization problems, double and triple integrals with applications, cylindrical and spherical coordinates, vector fields and line integrals, Greens Theorem and the divergence theorem.	MATH 2214 Calculus II	3.3		Fall, Spring, Summer
BS, BSE	MATH 4403	Differential Equations	3	Topics in the elementary theory of differential equations, including existence theorems.	MATH 3254 Calculus III	2.5		Fall, Spring
BS, BSE	PHYS 2034	University Physics I	4	Basic principles of mechanics, thermodynamics, materials and wave motion utilizing calculus with multimedia computers, at each station, in a unified lecture and lab format.	MATH 2204 Calculus I corequisite	2.5	2	Fall, Spring

Table PDP6 Physics Degree Major Requirements								
Requirement of Physics degree program	**Course prefix and number**	**Course title**	**Credit (hrs)**	**Description**	**Prerequisite/ corequisite**	**Lecture contact hours per week**	**Lab contact hours per week**	**Terms offered**
BS, BSE	PHYS 2044	University Physics II	4	Continuation of PHYS 2034 covering the basic principles of electricity, magnetism, waves, optics and topics from modern physics utilizing calculus with multimedia computers, at each station, in a unified lecture and lab format.	PHYS 2034 or 2054 University Physics I or General Physics I, Math 2214 Calculus II corequisite	2.5	2	Fall, Spring
BS	PHYS 3103	Thermal Physics	3	The first and second laws of thermodynamics, the kinetic theory of gases, and an introduction to statistical mechanics.	PHYS 2044 or 2064 University Physics II or General Physics II, MATH 3254 Calculus III corequisite	2.5		Spring even
BS, BSE	PHYS 3153	Mechanics	3	Particle dynamics in inertial and accelerated reference frames. Newton's law of gravitation, orbit theory, and elementary rigid body dynamics.	MATH 2214 and PHYS 2044 Calculus II and University Physics II	2.5		Fall
BS, BSE	PHYS 3203	Electromagnetic Theory	3	Electrostatics, electric and magnetic properties of materials. Amperes and Faradays laws, and Maxwell's equations.	MATH 3254 and PHYS 2044 Calculus III and University Physics II	2.5		Spring
BS, BSE	PHYS 3303	Modern Physics	3	An elementary study of the atomic nature of matter and nuclear structure of the atom.	MATH 2214 and PHYS 2044 Calculus II and University Physics II	2.5		Fall
BS	PHYS 3253	Optics	3	Geometrical optics and physical optics, including interference, diffraction, dispersion, absorption, and polarization of light.	MATH 2214 and PHYS 2044 Calculus II and University Physics II	2.5		Spring odd
BS	PHYS 3272	Physical Instrumentation I	2	Design and use of physical instruments, including data reduction.	PHYS 2044 University Physics II		4	Fall odd

Table PDP6 Physics Degree Major Requirements								
Requirement of Physics degree program	**Course prefix and number**	**Course title**	**Credit (hrs)**	**Description**	**Prerequisite/ corequisite**	**Lecture contact hours per week**	**Lab contact hours per week**	**Terms offered**
BS	PHYS 3282	Physical Instrumentation II	2	A continuation of PHYS 3272, including advanced data reduction techniques.	PHYS 2044 University Physics II		4	Spring even
Or								
BS	PHYS 4432	Advanced Physics Laboratory I	2	Experiments in classical and modern physics.	PHYS 2044 University Physics II		4	Fall even
BS	PHYS 4442	Advanced Physics Laboratory II	2	Continuation of PHYS 4432, including individual student projects.	PHYS 2044 University Physics II		4	Spring odd
BS	PHYS 4353	Mathematical Physics	3	The mathematical aspects of classical physics including Newton's laws, Lagrangian and Hamiltonian dynamics, Electrodynamics and Relativity.	PHYS 3303 and MATH 3254 Modern Physics and Calculus III	2.5		Fall even
BS	PHYS 4553	Principles of Quantum Mechanics	3	Solutions of the Schrodinger wave equation, including the harmonic oscillator, the hydrogen atom, and perturbation theory, and associated topics.	20 hours of Physics	2.5		Spring even
BS	PHYS 4693	Research in Physics - Capstone	3	Students will conduct research with a physics faculty member, write a paper and present a talk on their research, and take an exit exam. Physics majors are required to take this course in their senior year.	20 hours of Physics	2.5		Fall, Spring
BSE	EDSC 4593	Methods and Materials for Teaching Science in the Secondary School	3	Philosophical bases, teaching techniques, curriculum development, classroom management, facility resources, and equipment are emphasized.	Admitted to Teacher Education Program	2.5		Fall, Spring

Table PDP6 Physics Degree Major Requirements								
Requirement of Physics degree program	**Course prefix and number**	**Course title**	**Credit (hrs)**	**Description**	**Prerequisite/ corequisite**	**Lecture contact hours per week**	**Lab contact hours per week**	**Terms offered**
BSE	ELSE 3643	The Exceptional Student in the Regular Classroom	3	Introduction to exceptional students, with the major focus on serving these individuals in regular education classroom environments.	Admitted to Teacher Education Program, passed writing portion of Praxis 1	2.5		Fall, Spring, Summer
BSE	PSY 3703	Educational Psychology	3	Survey of principles as they apply to education.		2.5		Fall, Spring, Summer
BSE	SCED 2513	Introduction to Secondary Teaching	3	Providing prospective educators with an introduction to teaching and education in a pluralistic society, and an understanding of the historical, multicultural, sociological, philosophical, legal, political, curricular, and technological dimensions of American education.		2.5		Fall, Spring
BSE	SCED 3515	Performance Based Inst. Design	5	Performance based instructional procedures and techniques for secondary education majors. Application of various teaching models and appropriate classroom management techniques will be emphasized. Reflective journals, application of technology, micro teaching and field experiences will be required.	Admitted to Teacher Education Program; SCED 2513, Introduction to Secondary Teaching			Fall, Spring
BSE	SCED 4713	Educational Measurement with Computer Applications	3	Students will learn to, 1. construct, administer, and interpret tests and rating scales to measure student achievement and performance, and 2. use the computer to assess, record, and report student achievement and performance.	Admitted to Teacher Education Program	2.5		Fall, Spring

Table PDP6 Physics Degree Major Requirements								
Requirement of Physics degree program	**Course prefix and number**	**Course title**	**Credit (hrs)**	**Description**	**Prerequisite/ corequisite**	**Lecture contact hours per week**	**Lab contact hours per week**	**Terms offered**
BSE	TIPH 4826	Teaching Internship in the Secondary School	12	Full semester of teaching internship.				Fall, Spring
	PHYS 2393	Special Topics	3	Selected special or current topics of interest to faculty and students that require no prerequisite courses. This course is appropriate for a general student audience.	Permission of instructor	2.5		Demand
	PHYS 3043	Atmospheric Dynamics	3	A study of the physical dynamics of the atmosphere and the oceans and the interactions between the two. Topics to be discussed include basic atmospheric and geophysical fluid dynamics, An integrated laboratory component will have students build instruments and analyze the local atmosphere.	PHYS 2034 or 2054 University Physics I or General Physics I	2.5		Spring
	PHYS 3052	Relativity	3	Quantitative introduction to the special theory of relativity with a brief qualitative introduction to general relativity. Demand.	PHYS 2044 or 2064 University Physics II or General Physics II	2.5		Demand
	PHYS 3133	Astronomy	3	Theories of the origin, development, present state, and future of the universe, with special emphasis on the place of astronomy in man's cultural and scientific development.		2.5		Demand
	PHYS 4393	Special Topics	3	Selected special or current topics of interest to faculty and students that require prerequisite coursework.	Permission of instructor	2.5		Demand

Table PDP6 Physics Degree Major Requirements								
Requirement of Physics degree program	**Course prefix and number**	**Course title**	**Credit (hrs)**	**Description**	**Prerequisite/ corequisite**	**Lecture contact hours per week**	**Lab contact hours per week**	**Terms offered**
	PHYS 4403	Nuclear and Particle Physics	3	Introduction to the structure of the nucleus, nuclear scattering and decay processes, mesons, nucleons, and quarks.	PHYS 3033 Modern Physics	2.5		Spring odd
	PHYS 4463	Advanced Mechanics	3	The Lagrangian and Hamiltonian formulations, rigid body mechanics, and special relativity.	PHYS 3153 Mechanics	2.5		Demand
	PHYS 4513	Advanced Electromagnetic Theory	3	Maxwell's equations as applied to waveguides, radiation, and wave propagation in various media. Lecture three hours per week. Special course fees may apply. Prerequisite, PHYS 3203. Demand.	PHYS 3203 Electromagnetic Theory	2.5		Demand
	PHYS 4533	Solid State Physics	3	Introductory study of the structure and physical properties of crystalline solids, including X-ray diffraction, specific heats, free electron theory, and band approximation.	20 hours of Physics	2.5		Demand
	PHYS 4571	Physics Seminar	1		14 hours of Physics	0.83		Demand
	PHYS 459V	Research in Physics	1-3		14 hours of Physics	variable		Demand

In March 2011 the Arkansas Legislature passed ACT 747, which included the requirement baccalaureate degree programs at state-funded institutions should be 120 credit hours by July 1, 2012. Accordingly, Tables PDP7 and PDP8 provide evidence, that with faculty advising and appropriate student performance, the BS and BSE physics degrees can be earned in four years.

Table PDP7
BS Physics 4-Year Degree Plan
2012-2013

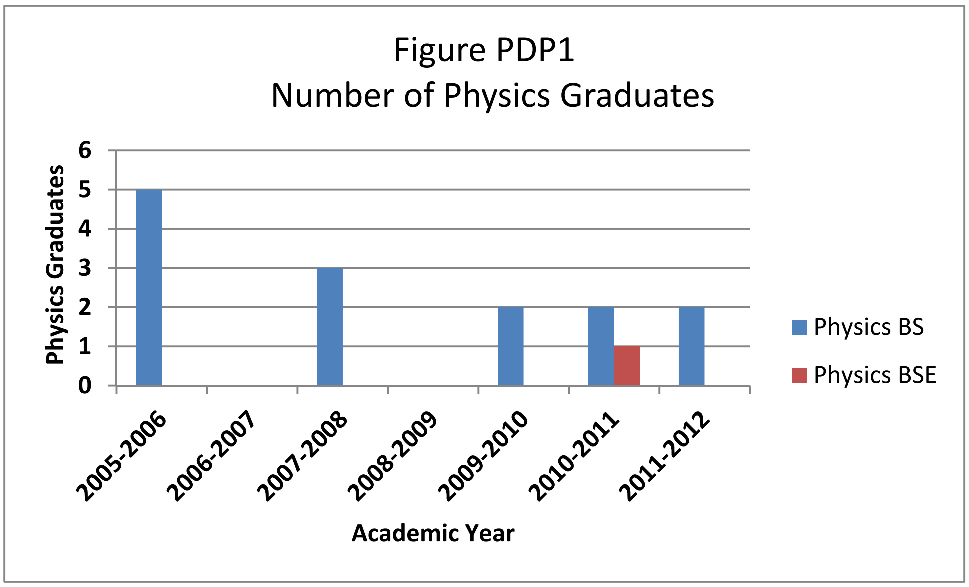
Year 1					**Year 1**			
Fall Semester					**Spring Semester**			
Course No.	**Course Name**	**Hrs**	**Gen Ed**		**Course No.**	**Course Name**	**Hrs**	**Gen Ed**
PHSC 1003	First Year Experience Course	**3**			**CS 2114**	Structured Programming I	**4**	
ENG 1003	Composition I	**3**	X		**ENG 1013**	Composition II	**3**	X
MATH 2204	Calculus I	**4**	X		**PHYS 2044**	University Physics II	**4**	
PHYS 2034	University Physics I	**4**	X		**MATH 2214**	Calculus II	**4**	
elective	elective	**1**						
Total Hours		**15**			**Total Hours**		**15**	
Year 2					**Year 2**			
Fall Semester					**Spring Semester**			
Course No.	**Course Name**	**Hrs**	**Gen Ed**		**Course No.**	**Course Name**	**Hrs**	**Gen Ed**
Gen Educ	General education required course	**3**	X		**elective**	elective	**2**	
Gen Educ	General education required course	**3**	X		**CHEM 1013**	Chemistry I	**3**	
PHYS 3153	Mechanics	**3**			**CHEM 1011**	Chemistry I Lab	**1**	
PHYS 3303	Modern Physics	**3**			**PHYS 3203**	Electromagnetic Theory	**3**	
MATH 3254	Calculus III	**4**			**MATH 4403**	Differential Equations	**3**	
					Gen Educ	General education required course	**3**	X
Total Hours		**16**			**Total Hours**		**15**	
Total Hours		**15**			**Total Hours**		**15**	

Table PDP7, continued BS Physics 4-Year Degree Plan 2012-2013								
Year 3					**Year 3**			
Fall Semester					**Spring Semester**			
Course No.	**Course Name**	**Hrs**	**Gen Ed**		**Course No.**	**Course Name**	**Hrs**	**Gen Ed**
BIOL 2013	Biology of the Cell	**3**	X		**PHYS 4353**	Mathematical Physics	**3**	
BIOL 2011	Biology of the Cell Lab	**1**	X		**PHYS 3253**	Optics	**3**	
Gen Educ	General education required course	**3**	X		**SCOM 1203**	Oral Communication	**3**	X
CHEM 1023	Chemistry II	**3**			**PHYS 3282 OR PHYS 4442**	Physical Instrumentation II OR Advanced Physics Laboratory II	**2**	
CHEM 1021	Chemistry II Lab	**1**			**Elective**	elective	**3**	
PHYS 3272 OR PHYS 4432	Physical Instrumentation I OR Advanced Physics Laboratory I	**2**						
Elective	elective	**2**						
Total Hours		**15**			**Total Hours**		**14**	
Year 4					**Year 4**			
Fall Semester					**Spring Semester**			
Course No.	**Course Name**	**Hrs**	**Gen Ed**		**Course No.**	**Course Name**	**Hrs**	**Gen Ed**
Elective	elective	**3**			**PHYS 4693**	Research in Physics - Capstone	**3**	
Elective	elective	**3**			**PHYS 3103**	Thermal Physics	**3**	
Elective	elective	**3**			**PHYS 4553**	Quantum Mechanics	**3**	
Elective	elective	**3**			**Elective**	elective	**3**	
Gen Educ	General education required course	**3**	X		**Elective**	elective	**3**	
Total Hours		**15**			**Total Hours**		**15**	
						Total Degree Hours	**120**	

Table PDP8 BSE Physics 4-Year Degree Plan 2012-2013								
Year 1					**Year 1**			
Fall Semester					**Spring Semester**			
Course No.	**Course Name**	**Hrs**	**Gen Ed**		**Course No.**	**Course Name**	**Hrs**	**Gen Ed**
PHYS 1003	First Year Experience for Chemistry & Physics	**3**			**ENG 1013**	Composition II	**3**	X
MATH 2204	Calculus I	**4**	X		**CS 2114**	Structured Programming I	**4**	
ENG 1003	Composition I	**3**	X		**PHYS 2044**	University Physics II	**4**	
PHYS 2034	University Physics I	**4**	X		**MATH 2214**	Calculus II	**4**	
elective	elective	**1**						
Total Hours		**15**			**Total Hours**		**15**	
Year 2					**Year 2**			
Fall Semester					**Spring Semester**			
Course No.	**Course Name**	**Hrs**	**Gen Ed**		**Course No.**	**Course Name**	**Hrs**	**Gen Ed**
MATH 3254	Calculus III	**4**			**Gen Educ**	General education required course	**3**	x
CHEM 1013	Chemistry I	**3**			**SCOM 1203**	Oral Communication	**3**	X
CHEM 1011	Chemistry I Lab	**1**			**MATH 4403**	Differential Equations	**3**	
PHYS 3153	Mechanics	**3**			**CHEM 1023**	Chemistry II	**3**	
SCED 2513	Introduction to Secondary Teaching	**3**			**CHEM 1021**	Chemistry II Lab	**1**	
					PHYS 3043	Atmospheric Dynamics	**3**	
Total Hours		**14**			**Total Hours**		**16**	

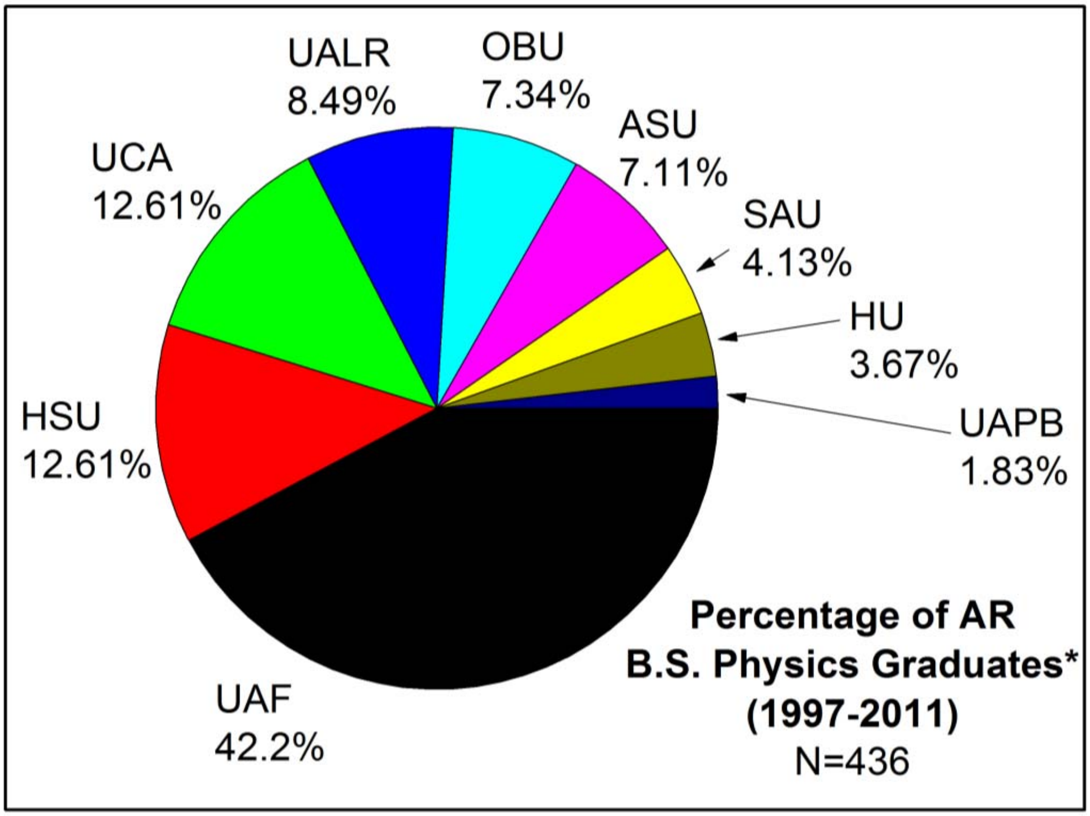
Table PDP8 continued BSE Physics 4-Year Degree Plan 2012-2013								
Year 3					**Year 3**			
Fall Semester					**Spring Semester**			
Course No.	**Course Name**	**Hrs**	**Gen Ed**		**Course No.**	**Course Name**	**Hrs**	**Gen Ed**
HIST 2763 OR 2773	US history to 1876 or US History since 1876	**3**	X		**POSC 2103**	Intro to US Government	**3**	X
POSC 2103	Introduction to Psychology	**3**	X		**PHYS 3203**	Electromagnetic Theory	**3**	
SCED 3515	Performance Based Inst. Design	**5**			**HLTH 2513**	Principles of Personal Health	**3**	
PHYS 1103	Intro. To Space Science	**3**			**ELSE 3643**	Exceptional Student in the Regular Classroom	**3**	
PHYS 3303	Modern Physics	**3**			**BIO or BIOL**	Biology general education lecture requirement	**3**	X
					BIO or BIOL	Biology general education laboratory requirement	**1**	X
Total Hours		**17**			**Total Hours**		**16**	
Year 4					**Year 4**			
Fall Semester					**Spring Semester**			
Course No.	**Course Name**	**Hrs**	**Gen Ed**		**Course No.**	**Course Name**	**Hrs**	**Gen Ed**
Gen Educ	General education required course	**3**	x		**TIPH 4826**	Teaching Internship in the Secondary School	**12**	
EDSC 4593	Methods & Materials in the Secondary School	**3**						
SCED 4713	Educational Measurement with Computer App.	**3**						
PSY 3703	Educational Psychology	**3**						
GEOG 3723	Intro. To Physical Geography	**3**						
Total Hours		**15**			**Total Hours**		**12**	
					Total Degree Hours		**120**	

Graduation Rate Figure PDP1 provides BS and BSE graduation rates for the last seven academic years. A total of 15 degrees were conferred, corresponding to an average of two graduates per year. It is worth noting four of these graduates were female, which corresponds to nearly 27% of the graduates. This is noteworthy as the American Institute of Physics (AIP) September 2012 report *Physics Bachelor's Degrees Results from the 2010 Survey of Enrollments and Degrees* indicates, "The representation of women among new physics bachelor's degrees has remained relatively unchanged in recent years at around 21%. This is slightly below a high seen in the early 2000's where the representation of women reached 23%." (Mulvey, P. J.; Nicholson, S. AIP, *Focus on Physics Bachelor's Degrees, Results from the 2010 Survey of Enrollments and Degrees*, September 2012)



Interestingly, the same AIP report indicates 68 percent of the 503 bachelor's only granting physics departments in the United States averaged five or fewer degrees per year between 2008 and 2010. Moreover, during the same time period more than 170 of these departments averaged no more than two graduates per year. Similar graduation rates exist in Arkansas; six of the nine Arkansas BS physics programs averaged three or fewer graduates per year between 1997 and 2011(see Figure PDP2).

Figure PDP2
1997-2011 Percent of BS Physics Gradates at Arkansas Institutions



Future Need for Physicists

The current edition of the Bureau of Labor Statistics (BLS) Occupational Outlook Handbook indicates 1,037,600 secondary school teachers were employed in 2010. It is projected an additional 71,900 teachers will be needed by 2020, and 283,700 of the currently filled positions will become available due to retirement or leaving the occupation. The shortage of secondary math and science teachers is well documented, and the need for highly-qualified physics teachers at the high school level is fairly ubiquitous in the United States. According to the 2010 American Association for Employment in Education (AAEE) *Report on Education Supply and Demand in the United States*, physics scored a 4.26 on the 5 point scale for teaching demand. A score of 4.21-5 is classified as an area of "considerable shortage." In fact, less than half of all high school physics teachers have a degree (major or minor) in physics or physics education. While formal high school physics teacher preparation at ASU is a small component of the current program effort, the single BSE physics degree conferred in 2010-2011 (see Figure PDP1) is the only such degree conferred in Arkansas between 2006 and 2011.
According to the BLS there were 18,300 physicists employed in 2010 and it is projected an additional 2,600 physicists will be needed by 2020. In addition to this growth, 5,400 of the existing physics

positions will become available due to retirement or leaving the occupation. During this same time period it is expected 900 astronomer , 13,400 biochemist and biophysicist, 3,700 material scientists, and 2,700 atmospheric and space scientists positions will become available as a result of growth and replacement needs in these fields. The typical entry level education for employment as a physicist, astronomer, or biochemist or biophysicist is a Ph.D. or a professional degree, and thus the BLS data indicates a clear, ongoing, national need for BS physics majors that also are motivated to pursue post baccalaureate physics training. The AIP report *Physics Bachelor's Degrees Results from the 2010 Survey of Enrollments and Degrees* indicates, "Physics departments that only award a bachelor's degree are generally rather small." Approximately 2,500 of the 6,000 physics bachelor degrees conferred in 2010 where awarded by exclusively baccalaureate programs. ASU is one of these typical small programs, that taken as a group, make a significant and essential contribution to fulfilling the national demand for physicists.

Personnel

Staff Table P1 provides a summary of current budgeted Department of Chemistry and Physics personnel. Staff provides support for both the physics and chemistry programs. Prior to the 2009-2010 academic year the department had a full time, 12 month research assistant that provided teaching laboratory support in addition to fulfilling other needs of both physics and chemistry. In 2009 this position was converted to an instructor line with significant teaching duties within the chemistry program. This precluded any meaningful participation in general teaching lab support and several essential department needs.

Table P1
Department of Chemistry and Physics Current Budgeted Personnel

Title	Number of Positions	Notes
Faculty	16 [a]	10 chemistry, 5 physics, 1 science education
Instructor	2	chemistry, physical science
Staff	2	Administrative Specialist II, Fiscal Support Specialist
Graduate Assistant	1	

[a] A tenure track chemistry faculty search has successfully concluded during spring 2013, and thus an additional faculty will join the department in August 2013.

Faculty Table P2 provides a summary description of current (Fall 2012) active physics faculty. John Pratte (Dean of College of Sciences and Mathematics; Full Professor), and Andy Sustich (Vice Provost for Research and Graduate Studies; Full Professor), have been omitted as they are not currently active in teaching or research. The Temporary Assistant Professor position filled by Michael Guenther has been renewed annually since August 2007. During much of this time financial support for the position has resulted from physics and chemistry faculty buying out teaching duties to participate in government contracted research. As seen below, there is a significant physics teaching load associated with this position.

Salary Average ASU academic year salaries of tenure-track and tenured faculty are compared to various national and regional values in Table P3. While ASU average salaries lag behind other supplied averages, in the last three years ASU administration has made an effort to ameliorate existing internal salary inequities. Additionally, funds resulting from College of Sciences and Mathematics differential tuition are mandated to be used to address faculty salary issues. Accordingly, over the last three years $7,900 has been utilized to address internal salary inequities of two physicists.

Table P2
Physics Faculty Rank and Salary*

Faculty	Current Rank	Base appointment description	Year of initial tenure track appointment	Year current rank was earned	Salary
Biswas, Koushik	Assistant Professor tenure track	75% teaching 25% research	2012	2012	52,000
Carroll, Ross	Assistant Professor tenure track	75% teaching 25% research	2011	2011	53,560
Zhang, Liangmin	Assistant Professor tenure track	25% teaching 75% research	2008	2008	55,631
Zhang, Bin	Associate Professor tenured	100% teaching	2000	2005	59,210
Johnson, Bruce	Associate Professor tenured	100% teaching	1994	1999	61,587
Guenther, Michael	Temporary Assistant Professor Nontenured (off-budget	100% teaching			39,735

* Excludes 1) Andy Sustich, Vice Provost for Research and Graduate Studies, Professor; 2) John Pratte, Dean of the College of Sciences and Mathematics, Professor

Table P3
Average Salary of Tenure-Track and Tenured Physics Faculty

Rank	ASU Average Salary	Chronicle of Higher Education Average Salary [a]	Aspirational Peer Institutions Average Salary [b]	AIP Typical 9-10 Month Salary [c]
Assistant Professor	53,730	57,447	67,796	54,000-69,000
Associate Professor	60,399	67,590	77,493	64,000-85,000
Full Professor		89,280	98,301	80,000-120,000

[a] Average physical sciences faculty salaries at 4-Year Colleges and Universities, 2010-11; http://chronicle.com/article/Average-Faculty-Salaries-by/126586/ accessed 12-3-12.
[b] Cost of living adjusted. Self-identified aspirational peers include Mississippi State University, North Dakota State University, University of North Carolina-Charlotte, University of North Carolina-Greensboro, University of Memphis, University of North Texas, University of Southern Mississippi, and University of Wyoming. Data collected in 2011.
[c] Chu, R; AIP Report *Salaries of PhD Physicists and Related Scientists during Spring 2006: Summary Report,* November 2007.

Teaching Load The base appointment description provided in Table P2 is taken from faculty letters of appointment. Prior to 2008 these letters included a 100% teaching appointment, which corresponded to a 12 credit hour per semester teaching load. In an effort to promote research activity, faculty appointments within the department subsequent to this time have included both teaching and research components. Most new appointments subsequent to 2008 have been described as 75% teaching (9 credit hours per semester) and 25% research.

Chair assigned teaching loads for the last five academic year terms are supplied in Tables P4 (credit hour load) and P5 (weekly contact hour load). Chair assigned teaching loads of all tenure track/tenured physics faculty have been less than 9 credit hours, regardless of the base appointment description.

Table P4
2010-2012 Chair Assigned Physics Faculty Teaching Loads (credit hours)

Faculty	Current rank	Fall 2010	Spring 2011	Fall 2011	Spring 2012	Fall 2012	Average
Biswas, Koushik	Assistant Professor					7	7.0
Carroll, Ross	Assistant Professor	7	7	7	8	6	7.0
Zhang, Liangmin	Assistant Professor	4	4	4	3	4	3.8
Johnson, Bruce	Associate Professor	6	3	8	3	6	5.2
Zhang, Bin	Associate Professor	6	7	6	8	8	7.0
Guenther, Michael	Temporary Assistant Professor	20	16	16	19	13	16.8

Table P5
2010-2012 Chair Assigned Physics Faculty Weekly Contact Load (hours)

Faculty	Current rank	Fall 2010	Spring 2011	Fall 2011	Spring 2012	Fall 2012	Average
Biswas, Koushik	Assistant Professor					6.83	6.83
Carroll, Ross	Assistant Professor	8.17	8.17	8.17	6.17	6.50	7.43
Zhang, Liangmin	Assistant Professor	5.50	4.33	5.50	2.50	2.50	4.07
Johnson, Bruce	Associate Professor	9.33	2.50	8.67	2.50	5.00	5.60
Zhang, Bin	Associate Professor	5.00	8.17	5.00	10.00	8.67	7.37
Guenther, Michael	Temporary Assistant Professor	21.67	17.33	18.67	19.83	14.83	18.47

In addition to chair assigned teaching load, faculty can assume additional teaching load, which often takes the form of a special topics course (PHYS 2393 or 4393) or a research course (PHYS 459V or PHYS 4693). Additional assumed load is provided in Table P6. In many cases, faculty assuming this additional load have benefitted as students conduct research in their lab.

Table P6 2010-2012 Additional Physics Faculty Load (credit hours)							
Faculty	**Current rank**	**Fall 2010**	**Spring 2011**	**Fall 2011**	**Spring 2012**	**Fall 2012**	**Total**
Biswas, Koushik	Assistant Professor of Physics						
Carroll, Ross	Assistant Professor of Physics					3	3
Zhang, Liangmin	Assistant Professor of Physics					3	3
Johnson, Bruce	Associate Professor of Physics		6		6		12
Zhang, Bin	Associate Professor of Physics				6		6
Guenther, Michael	Temporary Assistant Professor of Physics						

Table P7 is a summary of faculty scholarly activity between Fall 2005 and Fall 2012. There is some "double " counting in all four activity areas, as faculty do collaborate with one another, and a given student is often a coauthor/presenter on more than one publication or presentation. Additional detail regarding faculty productivity may be found in the faculty curriculum vitae of Appendix II.

Table P7 Summary of Faculty Scholarly Activity: Fall 2005-Fall 2012*				
Faculty	**Number of Grants submitted as Pi or Co-PI**	**Number Journal or Proceedings Publications**	**Number of Oral or Poster Presentations**	**Number of Students included as Publication Coauthor or Presentation Coauthor/Presenter**
Biswas, Koushik		1		
Carroll, Ross	2	5	4	
Zhang, Liangmin	8	7	10	4
Johnson, Bruce	8	8	21	50
Zhang, Bin	7	23	16	5
Total	25	44	51	
* Data compiled from Faculty180, 2-23-13				

Resources

Fiscal Table R1 provides a snapshot of current and past financial resources. Additional unbudgeted resources which can become available are not included. Current fiscal year laboratory course fees are provided in Table R2. This laboratory fee structure was initiated in fall 2008, and has provided the department with needed teaching related monies. Collected funds are deposited in the Revenue account, and are designated for teaching laboratory consumables and equipment. These funds are in addition to those annually deposited in the Lab Supply account.

Table R1 Department of Chemistry and Physics Financial Resources					
Account	**FY2013**	**FY2012**	**FY2011**	**FY2010**	**FY2009**
Department	53,463	53,463	53,463	53,463	68,048
Lab Supply	45,793	44,173	41,568	39,099	38,824
Revenue	82,157	75,798	78,397	80,401	82,233
Infrastructure	27,288	20,259	15,120	13,875	8,640
Technology		15,397	7,755	15,600	2,584
Carry Forward	114,848[a]	52,430	15,135		
Part-Time Labor	20,997	20,997	20,997	20,997	
Graduate Assistant	10,610	10,610	10,610	10,610	
Chemistry Foundation balance[b]	44,342				
Physics Foundation balance[b]	14,114				
Undergraduate Student Travel balance[b]	14,950				
Northeast Arkansas Science Fair balance[b]	1,100				
John Woodside Science Fair balance[b]	1,300				

Fiscal year (FY): July 1 – June 30

[a] Last allocation received: 4th quarter FY2012

[b] December 2012 balance

Table R2 Department of Chemistry and Physics Fiscal Year 2013 Laboratory Course Fees			
Subject	**Course Number**	**Course Title**	**Fee**
CHEM	1011	General Chemistry I Lab	$50.00
CHEM	1021	General Chemistry II Lab	$50.00
CHEM	1041	Fund Concepts Of Chemistry Lab	$50.00
CHEM	2004	Descriptive Inorganic	$50.00
CHEM	3054	Quantitative Analysis	$50.00
CHEM	3101	Organic Chemistry I Lab	$50.00
CHEM	3111	Organic Chemistry II Lab	$50.00
CHEM	3124	Physical Chemistry I	$50.00
CHEM	3134	Physical Chemistry II	$50.00
CHEM	3154	Survey Of Physical Chemistry	$50.00
CHEM	4204/5204	Inorganic Chemistry	$20.00
CHEM	4224/5224	Instrumentation	$50.00
PHSC	1201	Physical Science Lab	$10.00
PHYS	1101	Introduction to Space Science	$5.00
PHYS	2034	University Physics I	$20.00
PHYS	2044	University Physics II	$20.00
PHYS	2054	General Physics I	$20.00
PHYS	2064	General Physics II	$20.00

Each year students within the College of Science and Mathematics (units include Environmental Sciences, Molecular Biosciences, and the Departments of Chemistry and Physics, Biology, Mathematics and Statistics, Computer Science) make and prioritize requests for infrastructure needs. These requests are usually related to laboratory or classroom needs, and often include scientific and laboratory equipment, and computers.
The carry forward account offers flexibility by not requiring associated funds to be spent by the end of a fiscal year. Use of departmental carry forward accounts started in fiscal year 2011, and these funds are currently being used to honor faculty start-up obligations, (physics, Ross Carroll, year 2 of 2 allocation; physics, Koushik Biswas, year 1 of 2 allocation; chemistry, Anahita Izadyar, year 1 of 2 allocation; chemistry, Jonathan Merten, year 1 of 2 allocation).
Technology funds are used to update faculty and staff computers. Starting in fiscal year 2013, the administration of these funds changed and thus will not be directly deposited in department accounts. While the administration of the funds has changed, faculty and staff computers will continue to be updated on a three year cycle.
Part-time labor funds are used to hire qualified students to assist with departmental office obligations and undergraduate laboratory assistance. The department budget also includes funds for a graduate assistant. An additional four graduate assistantships have historically provided by the Graduate School.
Foundation account funds have the fewest spending restrictions and are primarily due to alumni, faculty, and corporate donations.

Facilities Use details of the 44,000 square feet of space currently allocated to the Department of Chemistry and Physics are provided in Table R3. Department activities are carried out primarily in Lab Science East (27,156 square feet allocated), and Lab Science West (12,463 square feet), but additional research and office space is located in the attached Agriculture building (4,442 square feet). While nearly 16,000 square feet are shared by the chemistry and physics programs, 6,838 square feet are currently dedicated to physics (2,604 square feet teaching; 378 square feet service; 934 square feet office 2,620 square feet research; 302 square feet miscellaneous).

Table R3
Department of Chemistry and Physics Space Distribution

Room Use	Area (sq ft)
Teaching-classroom	7,351
Teaching-classroom/lab	2,604
Teaching-lab	7,675
Teaching subtotal	**17,630**
Service-teaching lab stockroom	1,277
Service-dishwasher	110
Service-department stockroom	1,250
Service subtotal	**2,637**
Office	**5,960**
Research lab	**12,843**
instrumentation facility	**1,408**
Miscellaneous-conference room	374
Miscellaneous-machine shop	450

Table R3 Department of Chemistry and Physics Space Distribution	
Room Use	**Area (sq ft)**
Miscellaneous-storage	2,759
Miscellaneous subtotal	**3,583**
Total	**44,061**

Equipment Department maintained equipment available for both research and teaching is provided in Table R4. Table R5 lists additional equipment available to physics faculty that is maintained by other units on campus. There is a significant amount of equipment used by physics and chemistry faculty in on-going research contracts and grants, which is described in Table R6. Much of this equipment is associated with a federal government contract, and thus is not owned by ASU, nor can it be used for non-contract research. It is hoped this equipment will be abandoned in place once the contract ends.

Table R4
Department of Chemistry and Physics Major Equipment

Description	Model	Manufacturer	Year acquired
300 Megahertz superconducting nuclear magnetic resonance spectrometer	Avance 300	Bruker	2009
Scanning ultraviolet-visible spectrometer	8453	Agilent	2007
Gas chromatograph	GC2014	Shimadzu	2011
Inductively coupled plasma optical emission spectrometer	ICPE 9000	Shimadzu	2010
Graphite furnace atomic absorption spectrometer	AA240	Varian	2009
Thermal gravimetric analyzer	TG-DTA 320	Seiko	1993 (updated 2010)
Gas chromatograph-mass spectrometer	CP3380 GC-Saturn 2000MS	Varian	2002
Glove box	HE-553-2	Vacuum Atmospheres Company	1991
Time of flight mass spectrometer	QTOF2	Micromass	2100
Fluorescence spectrometer	F2700	Hitachi	2011
Fourier transform infrared spectrometer 0.125 cm^{-1} resolution	Nicolet 8700	Thermo Scientific	2010
Mass spectrometer auto sampler	CP8400	Varian	2005
Nitrogen gas generator	Nitroflowlab	Parker	2011
Fourier transform infrared spectrometer 0.5 cm^{-1} resolution	iS10	Thermo Scientific	2012

Table R4 Department of Chemistry and Physics Major Equipment			
Description	**Model**	**Manufacturer**	**Year acquired**
Bomb calorimeter	6200, A1290DDEB	Parr	2012
High performance liquid chromatograph	LPG3400SD pump, TCC-3000SD column compartment, DAD-3000 diode array detector, SR-3000 solvent rack	Dionex (Thermo Scientific)	2012
Power conditioner	5BGX-10K-7-A	Controlled Power Company	2012
Laboratory glassware washer (2 units)	610	Steelco	2011
Reverse osmosis water purification system	Medica-R200	Elga (Siemens)	2011

Table R5 Additional Equipment	
Equipment	**Responsible Unit**
Computer cluster with one front node (computer) and four compute nodes. Each computer node has two 4-core CPUs, two NVIDIA M2050 GPUs (896 CUDA cores each), and 48 GB memory. The cluster uses a Linux operating system and is ideal for GPU computing with CUDA.	Computer Science/Information Technology Services
Shimadzu UV-3600 spectrophotometer (UV-VIS-NIR) with transmission & diffuse reflectance capabilities	Engineering
MBruan thermal/e-beam evaporator capable of evaporating six separate targets	Engineering
Rigaku Geigerflex powder x-ray diffractometer	Engineering
Veeco Dektak 6M mechanical profilometer	Engineering
TESCAN Vega TS-5236 XM scanning electron microscope with an Oxford Instruments INCA energy-dispersive x-ray spectrometer detector	Biology
JEOL 100CXII Tunneling electron microscope	Biology

Table R6 Equipment Allocated to Ongoing Physics Related Research Contracts and Grants
Fourier-transform-limited, three-color, independently tunable OPO/OPA-based picosecond laser system with tenability from 210 nm to 10 microns
Hamamatsu C7700 streak camera
Angstrom/High Finesse wavelength meters (WSU-30, WS-5.5, WS-5)
(3) digital delay generators (SRS DG 645, DG 535)

Table R6 **Equipment Allocated to Ongoing Physics Related Research Contracts and Grants**
(4) boxcar integrators (SRS SR250) with power supply and computer interface (SR245)
(3) tunable Fabry-Perot interferometers with interchangeable mirrors for coverage from the ultraviolet at 200 nm through the visible range of the spectrum
Infrared Fabry-Perot etalons for coverage from the near infrared region to 10 microns
Injection-seeded Nd:YAG (Continuum Powerlite) with 1.2 J at 1064 nm, 600 mJ at 532 nm, and 300 mJ at 355 nm
Tunable external cavity diode lasers (Toptica TA pro, DL pro) with coverage from 875 - 945 nm (100 mW) and from 910 - 985 nm (500 mW)
Optics for two injection seeded nanosecond OPOs (pumped with the SHG of the Nd:YAG, and seeded with the diode lasers) together with piezoelectric elements and electronics for cavity stabilization, several mirrors, filters, beam splitters, optical isolators, and nonlinear crystals for amplification, SHG, THG, FHG, and DFG of the output from the nanosecond OPOs to provide tunable Fourier-transform-limited light (100 MHz line width) for portions of the ultraviolet, visible, and most of the infrared regions of the spectrum.
Various vacuum systems including a turbo-pump, various roughing pumps, vacuum gauges, flow controllers (MKS 647C)
SRS RGA 300
Modul 200 vacuum leak detector
liquid nitrogen generator
300 mm imaging spectrograph (Acton/PI SpectraPro 2300i) with photomultiplier and ICCD camera (Andor iStar)
Various oscilloscopes (LeCroy, Tektronics)
Several optical tables
Laser laboratory that is temperature stabilized (to within ~0.1 degrees C), and air filtered to remove 95% of particles of dimension 300 nm.
Nanosecond pulsed Laser system: Continuum Surelite II
Furnace: Lindberg Sola Basic
Spin-Coater: MTI VTC-100
Electronics characterization suite including a master workstation with LabVIEW 2012, OriginPro 8.6, Mathematica 8, GPIB connectivity, and an NI PCIe-6361 X Series Multifunction DAQ
NI BNC-2120 shielded BNC connector block with frequency generator,
Boonton 7200 capacitance meter
Agilent U2722A modular source-measure unit

Table R7 is the current inventory of equipment dedicated to physics teaching laboratories, including General Physics I and II, University Physics I and II, Physical Instrumentation I and II, and Advanced Physics Laboratory I and II. Items marked with an asterisk (*) need to be replaced or repaired. Recall, the department level revenue, infrastructure, and lab supply accounts (Table R1) are used to address such needs.

Table R7 Teaching Laboratory Equipment
Vernier
LabQuest -16 units with charging stations
LabPro - 15 units
Ultrasonic motion detectors -15 units
Photo gate - 15 units
Dual-channel amplifiers
Voltage probes
Current probes
Dual-range force sensors
Microphones
Pasco
Dynamics and collision carts
Fans to propel carts
Tracks for collision and dynamics carts
Pulleys and additional masses (2 kg/cart) for tracks and carts
Optics (Pasco)
Optics bench
Viewing screens
100 mm lenses
200 mm lenses
Basic Optics Diode Laser
Single Slit Sets
Multiple Slit Sets
Basic Optics Light Source
Basic Optics Ray Optics sets
Thermodynamics
Linear expansion apparatuses *
Digital thermometers (thermocouple)
Steam generators
Calorimeters *
Waves
Apparatus to create standing waves in a column of air *
120 Hz vibrators to generate standing waves on strings
Equipotential lab apparatus *
Sine wave generator with cord vibrator - 1 unit
Electricity and Magnetism
Galvanometers *
Decade resistance boxes *
Electrostatics laboratory equipment *
Atomic emission hydrogen tubes and power supplies
Fluke digital multi-meters
AC circuits series LRC resonance laboratory apparatus *
Basics
Digital calipers

Table R7 Teaching Laboratory Equipment
Micrometers *
Force tables *
Balances
Young's modulus apparatus *
* Replacement or repair needed

Library The Department of Chemistry and Physics 2012-2013 library allocation is $136,786 of which $121,424 is allocated to journal and database subscriptions (see Table R8). While the department allocation includes access to SciFinder Scholar and Science Direct databases, additional library resources are used to subscribe to a growing list of service providers including EBSCO, JSTOR, IOP, and Web of Science. These and others provide electronic access to many additional journal titles, including *Applied Physics Letters, Biomicrofluidics, Chaos, Journal of Applied Physics, Journal of Mathematical Physics, Journal of Renewable and Sustainable Energy, Low Temperature Physics, Physics of Fluids, Physics of Plasmas,* and *Review of Scientific Instruments* (each with a one-year embargo on the most recent issues). The library also provides access to the rising number of open-access journals of which there are eighty-five journals in the field of physics and another twenty in astronomy. In those cases where ASU does not have paper or electronic journal access, the Interlibrary Loan Department is very supportive, and are able to get digital copies of articles within about a day.

Table R8
Department of Chemistry and Physics Journal Subscriptions

Journal	Format
American Physical Society News	Online
Bulletin of the American Physical Society	Online
Journal of Chemical Physics	Online
Physical Review A, Atomic, Molecular, and Optical Physics	Online
Physical Review and Physical Review Letters Index	Online
Physical Review B, Condensed Matter and Materials Physics	Online
Physical Review C , Nuclear Physics	Online
Physical Review D, Particles, Fields, Gravitation, and Cosmology	Online
Physical Review E, Statistical, Nonlinear, and Soft Matter Physics	Online
Physical Review Online Archive (PROLA)	Online
Physical Review Special Topics - Accelerators & Beams	Online
Physical Review Special Topics - Physics Education Research	Online
Accounts of Chemical Research	Online
ACS Applied Materials & Interfaces	Online
ACS Catalysis	Online
ACS Chemical Biology	Online
ACS Chemical Neuroscience	Online
ACS Macro Letters	Online
ACS Medicinal Chemistry Letters	Online
ACS Nano	Online
ACS Synthetic Biology	Online
Analytical Chemistry	Online

Table R8 **Department of Chemistry and Physics Journal Subscriptions**	
Journal	**Format**
Biochemistry	Online
Bioconjugate Chemistry	Online
Biomacromolecules	Online
Chemical Communications	Print + Online
Chemical Research in Toxicology	Online
Chemical Reviews	Online
Chemical Science	Print + Online
Chemistry of Materials	Online
Chinese Journal of Geophysics	Online
Crystal Growth and Design	Online
Dalton Transactions	Print + Online
Earth Interactions	Online
Energy & Fuels	Online
Environmental Science & Technology	Online
Geochemistry Geophysics Geosystems	Online
Geophysical Research Letters	Online
Global Biogeochemical Cycles	Online
Ground Water	Online
Industrial & Engineering Chemistry Research	Online
Inorganic Chemistry	Online
Journal of Agricultural and Food Chemistry	Online
Journal of Analytical Atomic Spectrometry	Print + Online
Journal of Chemical & Engineering Data	Online
Journal of Chemical Information and Modeling	Online
Journal of Chemical Theory and Computation	Online
Journal of Combinatorial Chemistry	Online
Journal of Environmental Quality	Online
Journal of Geophysical Research - All sections	Online
Journal of Inorganic Biochemistry	Online
Journal of Materials Chemistry	Print + Online
Journal of Medicinal Chemistry	Online
Journal of Natural Products	Online
Journal of Organic Chemistry	Online
Journal of Physical Chemistry	Online
Journal of Physical Chemistry A,	Online
Journal of Physical Chemistry B,	Online
Journal of Physical Chemistry C,	Online
Journal of Proteome Research	Online
Journal of the American Chemical Society	Online
Langmuir	Online
Macromolecules	Online
Molecular Pharmaceutics	Online
Nano Letters	Online

Table R8 Department of Chemistry and Physics Journal Subscriptions	
Journal	**Format**
New Journal of Chemistry	Print + Online
Nonlinear Processes in Geophysics	Online
Organic & Biomolecular Chemistry	Print + Online
Organic Letters	Online
Organic Process Research and Development	Online
Organometallics	Online
Paleoceanography	Online
Physical Chemistry Chemical Physics	Print + Online
Radio Science	Online
Reviews of Geophysics	Online
Space Weather	Online
Spectrochimica Acta Part B: Atomic Spectroscopy	Online
Tectonics	Online
Water Resources Research	Online

Scholarships The Department of Chemistry and Physics awards six private scholarships per year, including three available to physics majors and one that is restricted to physics majors. Scholarship award amounts are typically at least $1000, and the specific amount depends on the interest earned from individual endowments.

Additional Resources

Compensated Faculty Leave is designed to provide opportunities for eligible faculty members to engage in professional activities that enhance their tenure at Arkansas State University while receiving regular salary. Instructional staff and academic administrators holding faculty status may apply for sabbatical after six academic years. A full academic year may be granted at half salary or one semester of leave at full salary may be substituted.

The ASU **Faculty Research Fund** provides financial seed money for faculty to conduct pilot or feasibility studies to support application to state, federal, foundation, or other larger funding opportunities. Applicants must hold full-time faculty appointments, and preferential consideration is given to first time and non-tenured applicants and those who have not received this award for at least 10 years. Typical award are $3,000-$5,000.

The **Office of Research and Technology Transfer** (ORTT) has full time staff dedicated to providing grant writing assistance. ORTT has also sponsored the **Research Development Institute** (RDI), which focuses on assisting selected faculty with creating and submitting grant proposals while learning the intricacies of the grant-making process. Program components include research and evaluation design, grant writing, budgeting and planning, compliance responsibilities. ORTT also has competitively awarded **undergraduate research travel funds** (up to $400 per student) to support presentation of research at professional meetings. Similar **graduate research travel funds** are available through the Graduate School.

A recent example of additional resources becoming available occurred during fall 2012. The Dean of the College of Sciences and Mathematics announced three faculty development opportunities to support the writing of a federal, state, or private foundation STEM research or STEM education grants, or support faculty in redesigning the classroom experience so as to provide ASU students with a superior learning experience. $55,000 was allocated to these opportunities, and faculty could request up to $5,000 for equipment, supplies, or salary.

Assessment Efforts

Formalized and systematic assessment efforts are in their infancy for both the department and university. However, program assessment has assumed a more prominent role as the University prepares for the upcoming fall 2013 Higher Learning Commission site visit. As part of this preparation, during the spring 2011 term, the physics curriculum maps provided in Tables AE1 and AE2 were prepared (see Tables PDP1 and PPP2 for the corresponding degree program objectives).

Table AE1
BS Physics Degree Program Objectives Curriculum Map

	Program Objectives					
Course	**Communication**	**Ethics**	**Instrumentation**	**Literature**	**Phenomena**	**Post degree**
CHEM 1011			I		I	
CHEM 1013					I	
CHEM 1021			I		I	
CHEM 1023					I	
CS 2114					I	
MATH 2204					I	
MATH 2214					R	
MATH 3254					M	
MATH 4403					M	
PHYS 2034			I		I	
PHYS 2044			I		I	
PHYS 3103					R	
PHYS 3153					R	
PHYS 3203					R	
PHYS 3253					R	
PHYS 3272			MX			
PHYS 3282			MX			
PHYS 4432			MX			
PHYS 4442			MX			
PHYS 3303					I	
PHYS 4353					M	
PHYS 4553					R	
PHYS 4693	MX	MX	MX	MX	MX	I
I: introduced, R: reinforced, M: mastered, X: outcome assessed						

Table AE2
BSE Physics Degree Program Objectives Curriculum Map

	Program Objectives								
Course	**Assessment**	**Communication**	**NSTA**	**Pedagogy 1**	**Pedagogy 2**	**Phenomena**	**Post degree**	**Safety**	**Understanding of Science**
CHEM 1011 & 1013				I		I		I	I
CHEM 1021 & 1023				I		I		I	I
CS 2114						I			
MATH 2204						I			
MATH 2214						R			
MATH 3254						M			
MATH 4403						M			
PHSC 1003								I	
PHYS 2034						IX		I	IR
PHYS 2044						IX		I	IR
PHYS 3153						RMX			RM
PHYS 3203						RMX			RM
PHYS 3303						MX			M
GEOG 3723						I			
GEOL 1003						I			
PHYS 1103						I			
PHYS 3043						I			
EDSC 4593	R	I	R	R	R			R	
ELSE 3643			R	I	R				
PSY 3703	R				R				
SCED 2513	I		I	I	I				
SCED 3515	R	R	R	R	R				
SCED 4713	R								
TIPH 4826	M	M	M	M	M	MRX	MRX	M	M

I: introduced, R: reinforced, M: mastered, X: outcome assessed

Course/Instructor evaluations are conducted both fall and spring terms. The electronic evaluation solicits student input regarding instructor strong/weak points, factors contributing to current level of student performance, time devoted to course studying, and perception of course difficulty and utility. Although this instrument does not assess course content knowledge, it does provide significant assessment data used for faculty evaluation. The current course/instructor evaluation instrument is included in Appendix III.

As part of this self-study an electronic alumni survey was created (Appendix IV), and sent to all physics alumni graduating between 1990 and spring 2012. 51 alumni received announcement of the survey via the U.S. Postal Service, as available postal addresses were deemed more reliable than the limited number of available email addresses. Eight physics alumni responded during the 29 day collection period, corresponding to a 15.6% return rate. Respondents graduated between 1990 and 2004, and six subsequently earned higher degrees; two completed law school, two pursued health related careers (physician and occupational therapy), one earned a physics Ph.D. and another earned a MS education degree. Alumni were asked to provide feedback regarding how the program contributed to their development of program objective related skills, and this information is summarized in Table AE3. Analysis indicates additional emphasis should initially focus on the development of ethical standards and oral communication skills. The data also indicates a greater variability in response to computer skills, abilities to use common instruments, and work as team. Although the response rate is low, it may be prudent to consider these as also requiring additional attention.

Table AE3
Alumni Survey Response Summary

How much did your ASU degree(s) contribute to your current state of....	Average Response *	Response Standard Deviation
Physics knowledge	6.00	1.07
Oral communication skills	4.63	1.51
Written communication skills	5.13	0.83
Ethical standards	3.75	2.12
Laboratory skills	5.75	0.71
Laboratory safety skills/awareness	5.75	0.71
Ability to use common laboratory instruments	5.25	1.83
Computer skills	5.00	1.77
Problem-solving skills	5.88	1.36
Ability to work as a member of a team	5.13	1.96

* response scale runs from 1 (not at all) to 7 (a great amount)

Alumni were asked to identify aspects of the program that were most beneficial (six responses) and most in need of change (five responses). Half indicated the most beneficial aspect was the focus on the development of problem solving skills. Suggested changes included a broader range of faculty research interests, and additional structure to aid students in upper division courses.

Response to External Reviewer Recommendations from the 1996-1997 Self-Study

Provided below (in bold) are reviewer recommendations from the 1996-1997 physics self-study. Immediately following each recommendation is a status update.

- **More spacious accommodations should be provided for the large lecture sections in introductory courses and laboratories.** In 1996 introductory physics courses (General Physics I and II and University Physics I and II) transitioned to a six hour per week (four credit hour) unified lecture and laboratory format utilizing multimedia computers at each student station, which allowed lab and lecture experiences to be intermingled during a given class meeting. As a result of existing classroom configurations, this format limited enrollment to 36 students per section. In turn, this has contributed to the challenge of balancing faculty research expectations and student course enrollment needs. Recently this has been overcome by transitioning back to the traditional lecture- laboratory format, in which a single lecture can accommodate 90-120 students. This is possible because of the recent availability of existing large classrooms, and the conversion of a department laboratory into a 90 seat classroom. While the laboratory sections are currently still limited to 36 students, we are discussing renovation of existing laboratory space to increase student capacity, and training physics majors to assist with these labs. Both of these measures should allow us to accommodate the expected growth in these courses while providing faculty appropriate time to fulfill research expectations.

- **Financial resources for the purchase of new equipment should be allocated on a consistent basis.** As outlined in the Revenue section of this self-study, the laboratory fee structure initiated in fall 2008 has provided the department with much needed funds to support the extensive laboratory teaching component of the physics and chemistry programs. The amount of funds is directly tied to student enrollment and has averaged approximately $80,000 per academic year.

- **Additional clerical and technical help should be provided to accommodate the needs of a large department.** During summer 2002 the request for a second full time, staff position in the Department of Chemistry and Physics budget was granted. This allowed fiscal and student/faculty support activities to be split, and the current positions are designated as Fiscal Support Specialist and Administrative Specialist II, respectively. The split of duties has been essential as both sponsored research and student enrollment continue to grow.
  Prior to summer 2009 the department budget included a 12 month research assistant position, which was held by Ben Rougeau. Ben's duties were extensive, and included maintenance of teaching lab equipment, departmental instrumentation, computers, and audio visual equipment. He also coordinated chemical waste processing, ordering of research/teaching supplies and chemicals, and managed the stockroom facilities. With the start of the 2009-2010 academic year, Ben Rougeau's position was changed to 12 month instructor. This resulted in more clearly defined duties and expectations for Ben, and benefited the chemistry program, as the primary duty involved coordination of all sections of general chemistry laboratories. However, this position change also left the department without a full time research assistant dedicated to performing the duties described above.

- **A senior capstone course should be implemented to help students get a better picture of the unity of physics and prepare them for the highly competitive job market or graduate school.** In response to this recommendation, PHYS 4693, Research in Physics-Capstone, was created and became a required course of the BS physics degree program in 2002. The course provides for direct interaction between physics students and faculty, and requires students to, "conduct research with a physics faculty member, write a paper and present a talk on their research, and take an exit exam." The course has a prerequisite of 20 hours of physics courses, is taken during the senior year, and includes a nine hour per week research expectation.

- **An exit level assessment plan (in addition to graduate placement) should be developed to help the department determine how the program compares with other programs across the nation.** Although the Research in Physics-Capstone course is supposed to include an exit exam there is no record of a formal exam being given.

Additional Program Changes

Faculty Turnover Since the last self-study in 1996-1997, there has been a nearly complete turnover of faculty (see Table P2). This was initiated in 1998 with the retirement of a full professor (Hal McCloud), which was followed by a second retirement in 2000 (Larry Mink), and a third physicist assuming university level administrative positions in 2002 (Andy Sustich). In the intervening period, these vacancies have been filled by several colleagues that are no longer at ASU (Bao-An Li, Texas A&M University, Commerce; Derek Teaney, SUNY Stony Brook; Magdalena and Marko Djordjevic, University of Belgrade).

The physics program historically has consisted of four tenure track faculty. In 2002 negotiations to recruit a vice chancellor included a commitment to support this incoming administrator's research activities with the creation of an additional tenure track faculty. This resulted in the current fifth tenure-track physicist, Liangmin Zhang. While his appointment is research focused, Liangmin typically teaches 8 credit hours per academic year and participates in department service.

University Research Focus Over the last ten years university administration has made a concerted effort to grow research productivity and external funding. Faculty expectations to actively contribute to this goal, and the University financial and administrative support of this goal are <u>significantly</u> greater than what existed at the time of the last self-study. These ongoing efforts have resulted in some success ($17.69 million in university wide external funding as of January 2013). Physics and chemistry faculty continue to make significant contributions to this growth. Specifically, all tenure-track/tenured physics faculty have active research labs, and either current external funding or grants being reviewed. As a result of this research growth, there has been a need to modify lecture course size and delivery methods in order to accommodate student course demands (see External Reviewer Recommendations from the 1996-1997 Self-Study).

Chemistry/Physics and Engineering/Physics Course Equivalencies In an effort to increase the number of physics degree awarded, the physics faculty and department chair are in the process of formalizing upper division chemistry and engineering courses that will be accepted as substitutions for upper division required physics courses. This will encourage chemistry and engineering majors to pursue a double major in physics. In the past year, two chemistry majors have utilized these developing course equivalencies to also earn a physics degree. In these cases, Physical Chemistry I (CHEM 3124), Physical Chemistry II (CHEM 3134), and Instrumentation (CHEM 4224) were substituted for Principles of Quantum Mechanics (PHYS 4553), Thermal Physics (PHYS 3103), and Physical Instrumentation I (PHYS 3272), respectively. In one instance Research in Chemistry (CHEM 427V) was also substituted for Research in Physics (PHYS 459V).

Course Offerings In addition to Research in Physics-Capstone, in spring 2008 PHYS 3043, Atmospheric Dynamics, was introduced as upper level physics elective. This multi-disciplinary course supports the

BalloonSAT program which focuses on atmospheric research carried out predominantly via high altitude (approximately 85,000 feet) weather balloon launch/recoveries.

Introduction to Space Science (PHYS 1103) and the corresponding lab, Introduction to Space Science Laboratory (PHYS 1101), were created in the mid-1990s to provide students with an additional course option to fulfill the university general education physical science requirement. These courses continue to be popular among students, and in spring 2009 the lab was transitioned to a web based course. This was possible because of available web based material, for example, WorldWide Telescope, http://www.worldwidetelescope.org/Home.aspx and Stellarium, http://www.stellarium.org/. In summer 2011 PHYS 1103 was transitioned to a web format. These courses are offered both fall and spring terms and enrollments have averaged over 100 students since fall 2011.

Future Program Needs

It is reasonable to envision improvement and growth of the physics degree programs will depend on multiple factors. Moreover, it would not be unexpected for different people to weight the significance of these factors in various manners. It is expected the lack of appropriate support staff would be a factor commonly identified by multiple people. The addition of the second Department of Chemistry and Physics office staff in 2002 allowed office duties to be split between the resulting Fiscal Support Specialist and Administrative Specialist II positions. While this level of office staffing has proved to be adequate for the current levels of department activity, the same cannot be said for teaching and department maintenance related staffing levels.

Prior to summer 2009 Ben Rougeau was the only "research assistant" within the Department of Chemistry and Physics. He had a multitude of responsibilities, including, but not limited to, the following: maintenance of 1) teaching lab equipment, 2) departmental instrumentation, 3) computers, 4) audio visual equipment, coordination of chemical waste processing, ordering of research/teaching supplies and chemicals, managing the stockroom facilities, and preparing/maintaining reagents and supplies for laboratory courses. During the 2008-2009 academic year there was over 2,000 students enrolled in chemistry, physics, and physical science laboratory courses. It is unreasonable to assign all these responsibilities to single person. With the start of the 2009-2010 academic year, Ben Rougeau's position was changed from research assistant to 12 month instructor, with a primary teaching duty of coordinating the 15 sections of general chemistry I and II laboratory offered each year. This position change left the department without a full time research assistant responsible for the duties described above. It should be noted the fall 2012spring 2013 enrollment in chemistry, physics, and physical science labs still exceeds 2,000 students. If there are expectations that students will be provided with high quality laboratory experiences, and faculty research productivity will grow, additional support staff is essential.

As Indicated in Table P3, the College of Sciences and Mathematics has identified eight institutions as aspirational peers: Mississippi State University, North Dakota State University, University of North Carolina-Charlotte, University of North Carolina-Greensboro, University of Memphis, University of North Texas, University of Southern Mississippi, and University of Wyoming. Using data from departmental websites, the median number of non-clerical support staff in the chemistry and physics departments of these peer institutions (each institution has separate chemistry and physics departments) is seven. In addition to teaching laboratory support staff, this does include managers of departmental facilities such as an electronic shop, instrumentation facility, or chemical stockroom. Although this level of support staff is not necessary for the current level of Department of Chemistry and Physics activity, neither is the current zero dedicated support staff. Additional staff positions and the associated funding have been on-going requests for many years, and the requests are being included in this self-study as essential if departmental faculty productivity and student enrollment are expected to increase.