SCIENCE EDUCATION, 8-12
INITIAL PREPARATION PROGRAM FOLIO
UNIVERSITY OF KENTUCKY
September, 1999

I. CONCEPTUAL FRAMEWORK

The secondary science education program was developed, and is monitored by, the Mathematics and Science Education Program Faculty. The science education program has undergone moderate modifications to meet the collapsed certification areas established by the Kentucky Education Professional Standards Board. Certification in science has moved from major and minor certification in biology, chemistry, earth science, and physics to major certification in the **biological sciences** and the **physical sciences**. This change is reflected in the addition of a program option for an individual to teach chemistry, earth science and physics (physical science major). Supporting a strong preparation in the content area, program faculty have maintained options for majors within the specific areas of chemistry, earth science, and physics. In each case, the program requires students to take support work in the other two science disciplines, mathematics, and computer science. As in the past, science education majors are required to complete a major and a supporting minor or equivalent in the remaining sciences or mathematics. Since the new physical science major consists of minors in three areas (chemistry, earth science, and physics), no additional minor is required. Support courses in the other sciences, mathematics, and computer science are required to supplement the three minors (physical science major).

The science education program reflects the reflective decision maker model adopted by the College of Education and the model being implemented by all programs in the MIC Option. The program is accredited by the National Science Teachers Association and the program follows the general guidelines proposed by that organization. NSTA Guidelines general science teachers follow:

1) Understand and develop the major concepts and principles of biology, chemistry, the earth/space sciences and physics.
2) Develop student understanding of the interconnectedness of the sciences, and relate these understandings to the teaching of general science.
3) Apply mathematics, including basic statistics and precalculus, to investigations in general science and the analysis of data.
4) Relate the concepts of general science to contemporary, historical, technological and societal issues.
5) Locate resources, design and conduct inquiry-based, open-ended investigations, interpret findings, communicate results and make judgments based on evidence.

6) Use and care for living organisms in an ethical and appropriate manner.

The attached matrices indicate ways in which the program meets these requirements in the areas of biology, chemistry, earth science, physics and physical science.

The program addresses the content area requirements (Standard 8) of Kentucky's New Teacher Standards. Students are taught to use the Core Content for Science Assessment published by the KDE. Educational reform is endorsed and supported throughout the program. Students study the American Association for the Advancement of Science's Project 2061 and the National Research Council's National Science Education Standards. The program is very consistent with the common philosophy contained in these documents. Specifically, the program encourages the teaching of science through a problem-solving, inquiry-based approach. Future science teachers are taught to select age-appropriate activities, provide hands-on experiences for students, help students relate science concepts and principles to the world of the student, teach less material for greater understanding, interact with students about science concepts and their application, use technology in gathering and analyzing data, and use multiple forms of assessment to evaluate student work and instructional effectiveness.

II. PROGRAM EXPERIENCES

The attached matrices illustrate the selection of courses to address National Science Teachers Association Standards. Content preparation requires several laboratory courses and all science students are required to take introductory calculus and computer science courses. Some science courses (e.g., GLY 220 and BIO 325) provide off-campus field trip experience for students. All science students participate in one stream field trip (science teaching methods class) to study fresh water ecology and raise/discuss issues related to environmental studies.

Students are required to have 100 clock hours of experience with high school age students prior to entering the program. During the fall semester, each student works in the schools four mornings each week. In the afternoons and some evenings, students take university courses. In the spring semester, students teach for approximately fifteen weeks (all day, every day).

In the science teaching methods course, students are involved in the following learning activities (sample):

1) read and discuss science teaching articles and reports (e.g., National Science Education Standards);
2) search for science teaching ideas in professional journals (e.g., The Science Teacher, The Physics Teacher, Journal of Chemical Education, and Journal of Geological Education);
3) apply learning theories to teaching students science;
4) plan appropriate activities for teaching their science discipline(s);

5) evaluate existing science teaching resource materials (i.e., textbooks, reference books, and internet);

6) participate in process-skill-oriented learning activities modeled by the instructor;

7) prepare science lessons and a teaching unit;

8) gather and analyze data using computer interface devices and graphing programs;

9) use the computer (in additional ways) to support instruction;

10) participate in an environmental studies field trip and relate experiences to discipline(s) and science in general;

11) plan a schedule and participate in a professional development meeting (Kentucky Science Teachers Association) for two days;

12) prepare assessment techniques to evaluate student learning in science;

13) discuss ways of dealing with controversial issues (or topics) that may arise within a science class;

14) use scientific equipment to design and conduct experiments; and

15) plan for the safety and health of students in a laboratory science class.

The instructor attempts to model exemplary science teaching and limits presentations and lectures to a small fraction of the allotted class time. Six computers are available in the science education classroom for student use.

Subject Matter Plans for Secondary Science Education

Students will approach secondary science education from a variety of science disciplines. The University of Kentucky secondary science education subject matter plans are designed to ensure that all students seeking a Kentucky science certificate are fully prepared to meet NSTA guidelines and the Kentucky NTS, to be competent to pass required NTE/PRAXIS examinations, to be certifiable as a Kentucky Secondary Life Sciences Teacher or a Kentucky Secondary Physical Sciences, to be qualified for advanced study in a science discipline, and to apply for a more traditional secondary science certificate in another state. Each secondary science education plan includes required university studies/related studies requirements, a rigorous science major, and additional major(s), minor(s) or support areas to meet the intent of Kentucky's new science certificates.

University Studies and Related Studies Requirements

MA 113	Calculus I	4
or		
MA 132	Calculus for the Life sciences	3
or		
MA 123	Elementary Calculus an Its Applications	3

CS 101 Introduction to Computing I 3

Plans for Majors, Minors, and Supporting Subjects

Candidates may choose to be certified in one of two science areas, 1) Biological Science or 2) Physical Science. Biological science candidates must have a Biological Science Major for Secondary Education and follow on of the Biological Science Plans. Physical science candidates must have a Chemistry Major for Secondary Education, Earth Science Major for Secondary Education, Physical Science Major for Secondary Education, or Physics Major for Secondary Education and follow one of the Physical Science Plans.

Plans for Biological Science Candidates

Plan 1. Major (33 hours in **biological science**) plus: (A) a supporting non-certifiable minor of (21 hours) in mathematics, **OR** (B) a supporting non-certifiable minor in one of the other sciences. The science fields from which the minor may be chosen include chemistry, earth science, and physics.

Plan 2. Major (33 hours in **biological science**) with two 12-hour supporting subjects. The 12-hour blocks of support-subjects may be chosen from two of the following fields: chemistry, earth science, physics, or mathematics.

Plan 3. Major (33 hours in **biological science**) and four supporting subjects. Students selecting Plan 3 will complete a major in biology and take a total of 24 semester hours from chemistry, earth science, physics, and mathematics, with a minimum of three semester hours in each field.

Plans for Physical Science Candidates

Plan 1. Major (33 hours in either **chemistry, earth science, or physics**) plus: (A) a supporting non-certifiable minor of (21 hours) in mathematics, **OR** (B) a supporting minor in one of the other sciences. The science fields from which the minor may be chosen include biology (non-certifiable), chemistry, earth science, and physics, and mathematics (non-certifiable).

Plan 2. Major (33 hours in either **chemistry, earth science, or physics**) with two 12-hour supporting subjects. The 12-hour blocks of support-subjects may be chosen from two of the following fields: biology, chemistry, earth science, physics, or mathematics. Courses from the major may not be applied to the support-subjects requirement.

Plan 3. Major (33 hours in either **chemistry, earth science, or physics**) and four supporting subjects. Students selecting Plan 3 will complete a total of 24 semester hours from biology, chemistry, earth science, physics, and mathematics, with a minimum of three semester hours in each field. Courses from the major may not be applied to the support-subjects requirement.

Plan 4. Students will complete a **physical science** for secondary education major. The physical science major consists of 21 hour minors in **chemistry, earth science, and physic**s. Minors from each field must be included in the physical science major.

Matrices showing the relationship between plans, courses, and the NSTA Guidelines.

There are five matrices that follow. They demonstrate the relationship between subject matter plans and NSTA guidelines. Note that in addition to the matrices for Biology/Life Sciences and Physical Sciences, there are matrices for persons wishing to emphasize teaching in Earth Science, Chemistry, and Physics. These matrices accompany the subject matter plans above.

Guidelines and Matrix
FOR THE PREPARATION OF BIOLOGY / LIFE SCIENCE TEACHERS

In addition to the general high school program standards, preparation should enable biology / life science teachers to:

	Guidelines	Courses and/or experiences that fulfill the guidelines
5.1	Understand and develop the major concepts and principles of biology, including concepts in anatomy, physiology, ecology, behavior, evolution, genetics, cell biology, microbiology, diversity, growth, and human biology.	BIO 150, 151, 152, 153, 350, 325, 315, and 351 plus BIO Electives
5.2	Develop student understanding of the interconnectedness of the sciences, and relate the major concepts of chemistry, the earth/space sciences, and physics to the teaching of biology.	CHE 105, 107, 115 PHY 211, 213 (or PHY 231,241, 232, and 242) GLY 220
5.3	Apply mathematics, including statistics and precalculus, to investigations in biology and the analysis of data.	MA 123, 113, or 132 (a calculus course) EDC 634 CS 101
5.4	Relate the concepts of biology to contemporary, historical, technological and societal issues.	BIO 150, 152, 315, 304, 350, and 508 (elective) EDC 634
5.5	Locate resources, design, and conduct inquiry-based, open-ended investigations in biology, interpret findings, communicate results and make judgments based on evidence.	BIO 150,151, 152,153, and 325 EDC 634
5.6	Use and care for living organisms in an ethical and appropriate manner.	BIO 151, 153, and 350 EDC 634

Guidelines and Matrix
FOR THE PREPARATION OF PHYSICAL SCIENCE TEACHERS

In addition to the general high school program standards, preparation should enable physical science teachers to:

	Guidelines	Courses and/or experiences that fulfill the guidelines
9.1	Understand and develop the major concepts and principles of physics, chemistry, and the earth/space sciences.	CHE 105, 107,115, 230, 231, 226, and electives PHY 211 and 213 or (PHY 231, 241, 232, and 242) PHY 361 and electives AST 191 and 192 GLY 220 and electives
9.2	Develop student understanding of the Interconnectedness of the sciences, including biology, and relate these understandings to the teaching of physical science.	BIO 150 and 151 PHY 211 and 213 or (PHY 231,241, 232, and 242) PHY 361 and electives AST 191 and 192 GLY 220 and electives CHE 105, 107,115, 230, 231, 226, and electives
9.3	Apply mathematics, including statistics and precalculus, to investigations in physical science and the analysis of data.	MA 113 and 114 Ma 213 and 214 (recommended) EDC 634 CS 101
9.4	Relate the concepts of physical science to contemporary, historical, technological and societal issues.	CHE 105, 107, 230, and 226 AST 191 and 192 PHY 211 and 213 or (PHY 231, 241, 232, and 242) Gly 220 and electives
9.5	Locate resources, design, and conduct inquiry-based, open-ended investigations in chemistry, interpret findings, communicate results and make judgments based on evidence.	CHE 115, 231, and 226 PHY 241 and 242 or (PHY 211 and 213) GLY 220 and electives EDC 634

Guidelines and Matrix
FOR THE PREPARATION OF EARTH/SPACE SCIENCE TEACHERS

In addition to the general high school program standards, preparation should enable earth/space science teachers to:

	Guidelines	Courses and/or experiences that fulfill the guidelines
7.1	Understand and develop the major concepts and principles of the earth/spaces sciences, including astronomy, geology, meteorology, oceanography and natural resources.	AST 191 and 192 GLY 220, 230, 235, and 401G GEO 130 or 251
7.2	Develop student understanding of the Interconnectedness of the sciences, and relate the major concepts of biology, chemistry, and physics to the teaching of the earth/space sciences.	BIO 150, 151 PHY 211, 213 or (PHY 231,241, 232, and 242) CHE 105, 107, 115 PLS 366
7.3	Apply mathematics, including statistics and precalculus, to investigations in the earth/space sciences and the analysis of data.	MA 123 or 113 EDC 634 CS 101
7.4	Relate the concepts of the earth/space sciences to contemporary, historical, technological and societal issues.	AST 191 and 192 GLY 220, 230, 235, and 401G GEO 130 or 251
7.5	Locate resources, design, and conduct inquiry-based, open-ended investigations in the earth/space sciences, interpret findings, communicate results and make judgments based on evidence.	GLY 220, 230, and 235 EDC 634

Guidelines and Matrix
FOR THE PREPARATION OF CHEMISTRY TEACHERS

In addition to the general high school program standards, preparation should enable chemistry teachers to:

	Guidelines	Courses and/or experiences that fulfill the guidelines
6.1	Understand and develop the major concepts and principles of chemistry, including concepts in inorganic, organic, analytical, physical and biochemistry.	CHE 105, 107,115, 230, 231, 232, 233, CHE 226, CHE 440, and BCH 401G
6.2	Develop student understanding of the interconnectedness of the sciences, and relate the major concepts of biology, the earth/space sciences, and physics to the teaching of chemistry.	BIO 150 and 151 PHY 211 and 213 or (PHY 231,241, 232, and 242) GLY 220 AST 191 (recommended)
6.3	Apply mathematics, including calculus investigations in chemistry and the analysis of data.	MA 113 and 114 (MA 213 recommended) EDC 634 CS 101
6.4	Relate the concepts of chemistry to contemporary, historical, technological and societal issues.	CHE 105, 107, 115, 230, 232, 226, and 440 BCH 401G
6.5	Locate resources, design, and conduct inquiry-based, open-ended investigations in chemistry, interpret findings, communicate results and make judgments based on evidence.	CHE 115, 231, 233, and 226 EDC 634

Guidelines and Matrix
FOR THE PREPARATION OF PHYSICS TEACHERS

In addition to the general high school program standards, preparation should enable physics teachers to:

	Guidelines	Courses and/or experiences that fulfill the guidelines
10.1	Understand and develop the major concepts and principles of physics, including concepts in mechanics, electricity, magnetism thermodynamics, waves, optics, atomic and nuclear physics, radioactivity, relativity and quantum mechanics.	PHY 231, 241, 232, and 242 PHY 361 AST 191 and 192 (or PHY 151 and 152)
10.2	Develop student understanding of the interconnectedness of the sciences, and relate the major concepts of biology, chemistry, and the earth/space sciences to the teaching of physics.	BIO 150 and 151 CHE 105, 107, 115 GLY 220 AST 191 (recommended)
10.3	Apply mathematics, including statistics, calculus, and introductory differential equations to investigations in physics and the analysis of data.	MA 113 and 114 MA 213 and 214 (recommended) EDC 634 CS 101
10.4	Relate the concepts of physics to contemporary, historical, technological and societal issues.	PHY 231, 241, 232, and 242 AST 191 and 192 or (PHY 151 and 152)
10.5	Locate resources, design, and conduct inquiry-based, open-ended investigations in physics, interpret findings, communicate results and make judgments based on evidence.	PHY 241 and 242 EDC 634

III. ASSESSMENT

All candidates must complete a thorough review of their subject matter preparation prior to completing the formal admissions process. During this review, the candidate's course work is compared to the UK undergraduate science education program and the NSTA standards, and any additional required course work is specified. At the time of the formal admissions, the students is required to submit an application packet containing support materials, write an extemporaneous response to a science teaching question, and be interviewed by three representatives of the Mathematics and Science Program Faculty. Program interviewers examine academic performance including 1) grade point average in major, minor, and overall program - 2.5 GPA required in each; 2) ACT and GRE scores; 3) ability to respond to an unfamiliar problem solving situation; 4) ability to discuss significant science concepts with interviewers; 5) oral communication skills; 6) evidence of emotional maturity and stability; and 7) knowledge of, and commitment to, teaching as a profession.

Performance standards are met during the professional year of the masters with initial certification program. Each student must present a portfolio at the end of the year showing how standards have been met. Although students make their own choices of items to show how the have met the standards, specific assignments that are part of the Common Core and Academic Area are usually chosen. Most students have several entries in each component (design and plan instruction, create and maintain learning climate, implement and manage instruction, assess and communicate learning results, reflect on and evaluate teaching and learning, collaborate with colleagues, parents, and other interested stakeholders, engage in professional development, and demonstrate subject matter knowledge and skills) of the standards. By the end of the fall semester, most science education students have multiple entries in several components. For example, participation and planning for professional meeting (KSTA) attendance, science teaching unit, and problem solving activities researched and/or developed in methods class. At this point (end of first semester), the weakest component is "collaborate with colleagues, parents, and other interested stakeholders." In addition to a developing and teaching an interdisciplinary unit through the Common Core, opportunities for this standard are more readily available during the student teaching experience. Common Core and Academic Area faculty can, and do, interact with each other regarding student performance in the various components of the standards.

IV. PROGRAM FACULTY

Chairperson of Mathematics and Science Program Faculty

Doug Jones, Ph.D., Associate Professor of Mathematics Education, Full time IHE, Part Time Program

Science Program Faculty Members

J. Truman Stevens, (Coordinator of Secondary Science Education Program), Ed.D, Associate Professor of Science Education, Full time IHE, Full time Program

Ronald K. Atwood, Ed.D., Professor of Science Education, Full time IHE, Part time Program

J. David Robertson, Ph.D., Department of Chemistry, Associate Professor, Full time IHE, Part time Program (Pending)

Frank R. Ettensohn, Ph.D., Department of Geological Sciences, Professor, Full time IHE, Part time Program (Pending)

James J. Krupa, Ph.D., School of Biological Sciences, Assistant Professor, Full time IHE, Part time Program (Pending)

David A. Taylor, M.S. and Rank I, Science Supervisor, Fayette County Schools, Part time Program

Frank B. Howard, M.S. and Rank I, Science Supervisor (retired), Kentucky Department of Education and Fayette County Schools, Part time IHE, Part time Program

Denis Lester, M.S. and Rank I, Biology Teacher, Fayette County Schools (retired), Part Time Program

Kelly Helton, B.S., Graduate Student Representative, Science Education Program (Pending)

Other Members

Henry P. Cole, Ed.D., Educational Psychology, Professor, Full time IHE, Part time Program

Attachment I: Program Requirements

B.A. in Education with a major in Secondary Education
Option: Science Education

Requirements for Program

This B.A. includes completion of an approved plan in the academic specialty teaching of Physical Science or Biological Science. **The approved majors and minors in the academic specialties for teaching are entitled Physical science major for secondary education or Biological science for secondary education. to distinguish them from the A&S majors and minors. No certification is awarded with the B.A.** Students desiring to go on to Master's with Initial Certification must apply to The Graduate School and apply to the Secondary Science Program Faculty in the spring of their senior year.

To receive the B.A. degree, student must: (1) complete the University Studies Program; and Program Related Studies, (2) complete at least 128 semester hours; (3) complete the major/minor/support area requirements of the chosen academic specialty for teaching; (5) attain an overall grade-point average of at least 2.5 in major, in minor, and in support area; and (6) complete 100 hours of fieldwork with adolescents through the required three hour course, EDC 362 *Field Experiences in Secondary Education.*

The Science Education Program addresses the content area requirements of Kentucky's New Teacher Standards , National Research Council's National Science Education Standards, and the National Science Teachers Association Guidelines. The program encourages the understanding and development of major concepts within a specialty area as well as an understanding of the interconnectedness of the sciences. Students are encouraged to apply mathematics to investigations of science including analyses of data. It is intended that students relate the concepts of science to contemporary, historical, technological and societal issues. As future science teachers, students will need to locate resources, design and conduct inquiry-based and open-ended investigations, interpret findings, communicate results and make judgments based upon evidence. Specifically, the program encourages the teaching of science through a problem-solving, inquiry-based approach.

Continuous Assessment

1. All secondary education majors must be admitted to advanced standing after completing 60 hours. Advanced standing requires (a) 2.50 minimum GPA overall, (b) 2.50 minimum GPA in coursework leading to completion of Plan 1 or Plan 2, (c) review by program faculty advisor for Secondary Science Education.
2. Because certification occurs through the Masters in Education including certification (MIC), students should be aware that they would need to be formally admitted to the MIC program. Admission/Retention/Exit regulations for all teacher certification programs are specified on pp. 110-111 of this bulletin.
3. Oral and written communication skills of applicants for the MIC program in Secondary Science Education will be assessed at the time of the interview, and through the entrance portfolio.
4. Admission to the Masters in Education with certification is competitive.

Statement on Student Teaching

There is no student teaching required for completion of the Secondary Social Studies major. Student teaching occurs as part of the Masters in Education with certification.

University Studies ……..……. 42-53 hours

*See section of UK Bulletin on University Studies Requirements for listing of allowable courses in each area below.

Basic Skills Requirements

A. MA 113 Calculus 1 OR MA 132 Calculus for the Life Sciences
OR MA 123 Elementary Calculus and its Applications 3

B. Two semesters foreign language **OR** two years high school foreign language* 0-8

** Sign language is now an approved language for USP purposes.

Inference and Communication Skills Requirements

A. Calculus **OR** STA 200 **PLUS** PHI 120 or PHI 320 3-6

B. Writing (ENG 101 **and** 102) **OR** ENG 105 6

C. Oral Communication 3

Disciplinary Requirements

A. Natural Sciences 6

B. Social Science . 6

C. Humanities 6

Cross-Disciplinary Requirements 6

Cross-Cultural Requirements 3

Program Related Studies 6

EDC 362 Field Experiences in Secondary Education 3

CS 101 Introduction to Computing 3

Majors and Minors……66-72 hours

Plans for Majors, Minors, and Supporting Subjects

Candidates may choose to be certified in one of two science areas, 1) Biological Science or 2) Physical Science. Biological science candidates must have a Biological Science Major for Secondary Education and follow one of the Biological Science Plans. Physical science candidates must have a Chemistry Major for Secondary Education, Earth Science Major for Secondary Education, Physical Science Major for Secondary Education, or Physics Major for Secondary Education and follow one of the Physical Science Plans.

Plans for Biological Science Candidates

Plan 1. Major (33 hours in **biological science**) plus: (A) a supporting non-certifiable minor of (21 hours) in mathematics, **OR** (B) a supporting non-certifiable minor in one of the other sciences. The science fields from which the minor may be chosen include chemistry, earth science, and physics.

Plan 2. Major (33 hours in **biological science**) with two 12-hour supporting subjects. The 12-hour blocks of support-subjects may be chosen from two of the following fields: chemistry, earth science, physics, or mathematics.

Plan 3. Major (33 hours in **biological science**) and four supporting subjects. Students selecting Plan 3 will complete a major in biology and take a total of 24 semester hours from chemistry, earth science, physics, and mathematics, with a minimum of three semester hours in each field.

Plans for Physical Science Candidates

Plan 1. Major (33 hours in either **chemistry, earth science, or physics**) plus: (A) a supporting non-certifiable minor of (21 hours) in mathematics, **OR** (B) a supporting minor in one of the other sciences. The science fields from which the minor may be chosen include biology (non-certifiable), chemistry, earth science, and physics, and mathematics (non-certifiable).

Plan 2. Major (33 hours in either **chemistry, earth science, or physics**) with two 12-hour supporting subjects. The 12-hour blocks of support-subjects may be chosen from two of the following fields: biology, chemistry, earth science, physics, or mathematics. Courses from the major may not be applied to the support-subjects requirement.

Plan 3. Major (33 hours in either **chemistry, earth science, or physics**) and four supporting subjects. Students selecting Plan 3 will complete a total of 24 semester hours from biology, chemistry, earth science, physics, and mathematics, with a minimum of three semester hours in each field. Courses from the major may not be applied to the support-subjects requirement.

Plan 4. Students will complete a **physical science** for secondary education major. The physical science major consists of 21 hour minors in **chemistry, earth science, and physic**s. Minors from each field must be included in the physical science major.

Major Requirements

Biological Science Major for Secondary Education

Required Support Courses			
CHE 105, 107, 115	General College Chemistry I and II with Laboratory	3,3,3	
[PHY 211, 213]	General Physics		5,5
or			
[PHY 231, 241, PHY 232, 242]	General University Physics with Laboratories		5,5
GLY 220	Principles of Physical Geology	4	
MA 123, **or** 113, **or** 132	Elementary Calculus and Its Applications, **or** Calculus I, **or** Calculus I for the Life Sciences		3-4
Recommended Support Courses			
CHE 230, 231, 232, 233	Organic Chemistry I and II with Laboratories	3,2,3,2	
BCH 401G	Fundamentals of Biochemistry		3
Required for Major			
BIO 150, 151	Principles of Biology I with Laboratory		3,2
BIO 152, 153	Principles of Biology II with Laboratory		3,2
BIO 325	Introductory Ecology		4
BIO 304	Principles of Genetics (or AGR 360)	4	
Upper Level Botany Course	BIO 351, Plant Kingdom or BIO 430G, Plant Physiology		3
Upper Level Zoology Course	BIO 350 Animal Physiology is highly recommended.	4	
BIO electives	(chosen with aid of adviser)		
Recommended for Major			
BIO 315	Introduction to Cell Biology		3

Chemistry Major for Secondary Education

Required Support Courses			
MA 113	Calculus I		4
MA 114	Calculus II		4
[PHY 211, 213]	General Physics		5,5
or			
[PHY 231,241, 232, 242]	General University Physics with Labs		3,2,3,2
GLY 220	Principles of Physical Geology	4	
BIO 150, 151	Principles of Biology I and Laboratory		3,2
Recommended Support Courses			
AST 191	The Solar System	3	
MA 213	Calculus III		4
Required for Major			
CHE 105	General College Chemistry I	3	
CHE 107	General College Chemistry II	3	
CHE 115	General Chemistry Laboratory	3	
CHE 230, 231	Organic Chemistry I with Lab		3,2
CHE 232, 233	Organic Chemistry II with Lab		3,2
CHE 226	Analytical Chemistry	3-4	
BCH 401G	Fundamentals of Biochemistry		3
CHE 440G	Physical Chemistry		3

Recommended Courses in Major

Additional courses selected with aid of adviser.

Earth Science Major for Secondary Education *

Required Support Courses			
[MA 123]	Elementary Calculus and Its Applications		3
or			
[MA 113]	Calculus I		4
CHE 105, 107, 115	General Chemistry I and II with Laboratory	3,3,3	
[PHY 211 and 213]	General Physics		5,5
or			
[PHY 231, 241,	General University Physics with Laboratories		5,5
232, and 242]	General University Physics II with Laboratories		
BIO 150, 151	Principles of Biology I with Laboratory		3,2
Required for Major			
AST 191	The Solar System	3	
GEO 130 **OR** GEO 251	Physical Geography **or** Weather and Climate	3	
[GLY 220**]**	Principles of Physical Geology		4
OR			
[GLY 223]	Introductory Geology in the Rocky Mountains		6
GLY 230	Fundamentals of Geology I	3	
GLY 235	Fundamentals of Geology II	3	
GLY 360 or 401G	Mineralogy **or** Invertebrate Paleobiology	3	
Recommended for Major			
The following list contains courses that are normally applied to the major.			
AST 192	Galactic and Extra-Galactic Astronomy	3	
GLY 360	Mineralogy (if not taken above)	3	
GLY 401G	Invertebrate Paleobiology and Evolution (if not taken above)		3
GLY 341	Landforms	3	
PLS 366	Fundamentals of Soil Science		3
	Oceanography course (if transferred from another university)		3

Earth Science electives to be selected with the aid of advisor.

* Notes:
1) Students should note that earth science is generally taught in Kentucky at the eighth grade level. In many states it is taught at the ninth grade level; therefore, **secondary OR middle school certification could be required.** You must decide the level of certification that fits your needs. If you plan to teach in Kentucky, you may want to follow either of the following options: 1) obtain science certification through the Middle School Program or 2) obtain Earth Science certification through the Secondary Education Program. Currently, the Kentucky Department of Education is allowing secondary science teachers to teach science in the 7th and 8th grades without having middle school certification. The option for secondary certification provides more extensive content preparation in earth science.

Physical Science Major for Secondary Education

Required Support Courses		
MA 113	Calculus I	4
MA 114	Calculus II	4
BIO 150, 151	Principles of Biology I and Prin. of Biology I Laboratory	4,1

Recommended Support Courses for Major

MA 213	Calculus III	4
MA 214	Calculus IV (Note mathematics requirements for upper-level chemistry and physics courses.)	3

Required for Physical Science Major

Chemistry

CHE 105, 107, 115	General College Chemistry I and II and Gen. Chemistry Lab	3,3,3
CHE 230, 231	Organic Chemistry I and Organic Chemis try I Laboratory	3,2
CHE 226	Analytical Chemistry	3-4
CHE electives	(chosen with aid of adviser)	

Physics

AST 191 and 192	The Solar System and Galactic & Extra-Galactic Astronomy	3,3
[PHY 211, 213]	General Physics and General Physics Laboratories	5,5
or		
[PHY 231, 241, 232, 242]	General University Physics, General University Physics Labs	5,5
PHY 361	Principles of Modern Physics	3
PHY electives	(chosen with aid of adviser)	

Earth Science

AST 191, 192	The Solar System and Galactic & Extra-Galactic Astronomy	3,3
[GLY 220**]**	Principles of Physical Geology	4
OR		
[GLY 223]	Introductory Geology in the Rocky Mountains	6
GLY 230	Fundamentals of Geology I	3
GLY 235	Fundamentals of Geology II	3
GLY 360 or 401G	Mineralogy **or** Invertebrate Paleobiology	3
ES electives	(chosen with aid of adviser)	

Recommended Courses for Physical Science Major:

CHE 232, 233	Organic Chemistry II and Organic Chemistry II Laboratory	3,2
BCH 401G	Fundamentals of Biochemistry	3
CHE 440	Physical Chemistry	3
GLY 360 **or** 401G	Mineralogy **or** Invertebrate Paleontology and Evolution	3
GEO 130 **or** 251	Physical Geography **or** Weather and Climate	3
PHY 404G	Mechanics	3
PHY 417G	Electricity and Magnetism	3

Physics Major for Secondary Education

Required Support Courses

CHE 105, 107, and 115	General College Chemistry I and II with Lab	3,3,3
MA 113 and MA 114	Calculus I and II	4,4
GLY 220	Principles of Physical Geology	4
BIO 150 and 151	Principles of Biology I with Laboratory	3,2

Recommended Support Courses

MA 213 and 214	Calculus III	4
MA 214	Calculus IV (Note mathematics requirements for upper-level physics courses.)	3

Required for Major

PHY 231, 241	General University Physics with Lab	3,2

PHY 232, 242	General University Physics with Lab		3,2
PHY 361	Principles of Modern Physics	3	
PHY electives	(chosen with aid of adviser)		

Recommended for Major

AST 191 **or** PHY 151*****	The Solar System **or** Introduction to Physics	3
AST 192 **or** PHY 152*****	Galactic and Extra-Galactic Astronomy **or** Introduction to Physics	**3**

*** Note:**

1) A maximum of nine hours of astronomy may be counted toward the 33 hour physics requirement. A student may not count both the AST 191, 192 **and** PHY 151, 152 sequences toward the physics major for secondary education. If PHY 151 and PHY 152 are applied to the major, they must be completed prior to taking the PHY 231,241,232, 242 sequence.

MINOR REQUIREMENTS

A minor in one of the sciences or mathematics is required for Plans I of the Biological Science and Physical Science certification areas. See plans for details. Students are not certified to teach in a minor area. However, Physical Science for Secondary Education Majors are certified to teach chemistry, earth science, and physics.

Biological Science Minor for Secondary Education

Required Support Courses

CHE 105, 107, 115	General College Chemistry I and II with Laboratory	3,3,3

Required for Minor

BIO 150, 151	Principles of Biology I with Laboratory		3,2
BIO 152, 153	Principles of Biology II with Laboratory		3,2
BIO 325	Introductory Ecology		4
BIO304	Principles of Genetics (or AGR 360)	3-4	

Recommended for Minor
Additional courses selected with aid of adviser.

Chemistry Minor for Secondary Education

Required for Minor

CHE 105	General College Chemistry I	3
CHE 107	General College Chemistry II	3
CHE 115	General Chemistry Laboratory	3

Recommended for Minor

CHE 230, 231	Organic Chemistry I with Lab		3,2
CHE 232, 233	Organic Chemistry II with Lab		3,2
CHE 226	Analytical Chemistry	3-4	
or			
BCH 401G	Fundamentals of Biochemistry		3

Additional courses selected with aid of adviser.

Earth Science Minor for Secondary Education*

Required for Minor

AST 191	The Solar System	3	
GEO 130 **OR** GEO 251	Physical Geography **or** Weather and Climate	3	
[GLY 220**]**	Principles of Physical Geology		4

OR

[GLY 223]	Introductory Geology in the Rocky Mountains		6
GLY 230	Fundamentals of Geology I	3	
GLY 235	Fundamentals of Geology II	3	
GLY 360 or 401G	Mineralogy **or** Invertebrate Paleobiology	3	

Recommended for Minor
The following list contains courses that are normally applied to the minor.

AST 192	Galactic and Extra-Galactic Astronomy	3	
GLY 360	Mineralogy (if not taken above)	3	
GLY 401G	Invertebrate Paleontology and Evolution (if not taken above)		3
GLY 341	Landforms	3	
PLS 366	Fundamentals of Soil Science		3
	Oceanography course (if transferred from another univ.)		3

Electives……..Variable, to meet 128 hrs Total Program Requirement

Mathematics Minor for Secondary Education

Required for Minor

MA 113	Calculus I	4
MA 114	Calculus II	4
MA 213	Calculus III	4

Recommended for Minor
Additional courses chosen with aid of advisor. In most cases courses will be selected from the following list.

MA 341	Topics in Geometry		3
MA 310	Mathematical Problem Solving for Teachers		3
MA 261	Introduction to Number Theory		3
MA 320	Introductory Probability		3
MA 322	Matrix Algebra and Its Applications	3	
MA 330	History of Mathematics		3
MA 214	Calculus IV		3

Physics Minor for Secondary Education

Required Support Courses

MA 113	Calculus 113	4

Recommended Support Courses

CHE 105, 107, and 115	General College Chemistry I and II with Lab	3,3,3	
MA 114	Calculus II		4

Note mathematics requirements for taking upper-level physics courses.

Required for Minor

[PHY 211, 213]	General Physics	5,5

or

[PHY 231, 241	General University Physics with Lab	3,2
232, 242]	General University Physics with Lab	3,2

PHY 361	Principles of Modern Physics	3

Recommended for Minor

AST 191 **or** PHY 151*****	The Solar System **or** Introduction to Physics	3
AST 192 **or** PHY 152*****	Galactic and Extra-Galactic Astronomy **or** Introduction to Physics	3

*** Note:**

1) A maximum of six hours of astronomy may be counted toward the 21 hour physics requirement. A student may **not** count both the AST 191, 192 **and** PHY 151, 152 sequences toward the minor. If PHY 151 and PHY 152 are applied to the major, they must be completed prior to taking the PHY 231,241,232, 242 sequence.

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