

**8710.4750 TEACHERS OF SCIENCE: Earth and Space 9-12**

**FORM I-C MATRIX**

Professional Education Program Evaluation Report (PEPER II)	MATRIX Form I-C									
8710.4750 Teachers of Science: Earth and Space 9-12	Identify coding used to indicate placement or assignment of standards here: I=introductory level, R = review, A= application, Bold "A" = assessment Insert COURSE NUMBER & ID below									
	GEOL 1110, Physical Geology	GEOL 1120, Historical Geology	GEOL 2110, Min-Pet	ENVR 2000, Intro. Env. Science	SCI 2100, Astronomy	GEOL 3211/ENVR 4050 Hydrogeology/ Geochemistry	GEOL 3500 Topics in Paleontology	GEOL 3600, Stratigraphy & Sedimentation	SCI 2450	GEOL 4970/4980 Internship or Research
Subp. 5. <b>Subject matter standards for teachers of earth and space science.</b> A candidate for licensure as a teacher of earth and space science in grades 9 through 12 must complete a preparation program under subpart 2, item C, that must include the candidate's demonstration of the knowledge and skills in items A to C.										
A. A teacher of earth and space science must demonstrate a conceptual understanding of earth science. The teacher must:										
(1) use sources of information to solve unfamiliar qualitative and quantitative problems and communicate the solution in a logical and organized manner as evidenced by the ability to:										
(a) describe, in terms of the known and unknown quantities, a given problem in appropriate pictorial, graphical, or written forms;	A	A				A	A	A		
(b) translate a given topographical or geological map into a cross-sectional view;	A							R		
(c) describe qualitatively in appropriate terms, using words, stratigraphic columns, flow charts, maps, cross-sectional views, graphs, and drawings as necessary, a given problem situation;	A	A						A		
(d) plan, using words, diagrams, pictures, and simple mathematical relationships, a solution for a given problem in terms of steps necessary to solve the problem and to verify the solution; and	I	I	A			A		A		

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(e) evaluate, in terms of unit consistency, reasonableness, and completeness of solution, the solution of a given problem;	I		I		I	A		A		
(2) use computers to display and analyze experimental and theoretical data as evidenced by the ability to:										
(a) describe data graphically using a computer; and			A		I	A		A		
(b) design a mathematical model to provide a reasonable fit to a given set of data; and			I			A	I	I		
(3) develop a plan to ensure a safe environment and practices in all earth and space science learning activities.									A	
<b>B. A teacher must demonstrate knowledge of earth and space science concepts. The teacher must:</b>										
(1) understand the components that make up the Earth system as evidenced by the ability to:										
(a) perform measurements and statistical analyses to describe the physical properties of a given Earth material;	A	A	A					A		
(b) explain for a given Earth material, in terms of chemical bond strength and chemical composition, how physical properties are related to basic chemical structure;			A							
(c) describe, using words, pictures, diagrams, maps or globes, and satellite images, the component materials, large scale structures, and dominant physical processes of a given Earth subsystem; and	A	A	A							
(d) explain, using seismic evidence, laboratory simulations of Earth-interior conditions, terrestrial and extraterrestrial samples, and models of chemical differentiation, how we know the interior of the Earth is segregated chemically and physically into layers;	A	I	A							
(2) understand energy in the Earth system as evidenced by the ability to:										
(a) describe, using words, pictures, diagrams, and physical or computer models, the radiant, chemical, nuclear, and gravitational energies of a given Earth subsystem or structure;	A					A		A		

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(b) describe, using words, pictures, diagrams, and physical or computer models, the flow of energy within and between given Earth subsystems or structures;	I	I	A			A		A		
(c) describe, using words, pictures, diagrams, mathematical and chemical equations, physical or computer models, and electronic data sets, the transportation of matter within and between given Earth subsystems and structures; and			A			A		A		
(d) explain and predict, in terms of conservation of energy, dynamic equilibrium, and geologic or atmospheric models, changes in behavior of an Earth subsystem or structure due to a given change in energy;	I	I	A			A		I		
(3) understand geochemical cycling as evidenced by the ability to:										
(a) explain, in terms of reaction equilibrium and disequilibrium and mass balance, how chemical elements and compounds in a given simple Earth system are distributed;	I	I	A			A				
(b) explain and predict quantitatively and qualitatively, using related experimental data and the principles of mass balance and chemical equilibrium, how the concentration of an element or compound will change in a given reservoir interacting with another given reservoir;	I	I	A			A				
(c) describe, using words, pictures, and diagrams, the concentration and depletion of given elements or compounds in a given reservoir; and	I	I	A			A		R		
(d) explain, using mass balance, advection, convection, and chemical equilibrium, the process by which a given depletion or concentration of elements or compounds could have occurred in a given reservoir;	I	I	A			A		R		
(4) understand the origin and evolution of the universe as evidenced by the ability to:										
(a) describe, using words, drawings, and graphs, the properties of a given galaxy;					A					

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(b) explain, using the observed distribution of structural types, the relationship between astronomical distances and age, and the Big Bang theory, how differences in the composition and types of galaxies and the organization of galaxies into systems lead us to conclude that the universe is continuously changing;					A					
(c) perform measurements to describe the spectral distribution of light from a given star;					A					
(d) explain and predict, using the Hertzsprung-Russell Diagram, distance to the star, and stellar models, the changes in mass, luminosity, and size of a given star as it evolves from birth to death;					A					
(e) explain, using models of stellar evolution, how stars die and become neutron stars and black holes;					A					
(f) explain, using theories for nuclear stabilities and nuclear reactions, how elements can be formed in stars and novae;					A					
(g) describe, using words, pictures, diagrams, and mathematical relationships, the distance over which a given astronomical distance scale is accurate; and					A					
(h) explain, using blackbody radiation and quantization of energy levels, how to determine the temperature and elemental composition of a stellar object from its spectral signature;					A					
(5) understand the Earth in the solar system as evidenced by the ability to:										
(a) describe, with words, chemical formulas, drawings, scaled diagrams, and numerical orders of magnitude, the mass, size, and composition for a given solar system object;					A					
(b) explain and predict, using geologic and climatic stability, availability of nutrients, and atmospheric parameters, the suitability for life for a given planetary description;					A					
(c) explain and predict quantitatively and qualitatively, using Newton's laws of motions and gravitation and conservation of momentum, the motion of the bodies of a given solar system;					A					

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(d) explain, with words, diagrams, and models using orbital paths and relative sizes of solar system objects, the locationally dependent observation of solar and lunar eclipses and phases of the moon for a given simple solar system;					A					
(e) explain, using Newton's laws of motion and gravitation and relative orbital positions, the origin of oceanic tides on the Earth; and					A					
(f) design a physical solar-planetary model to demonstrate eclipses and lunar phases;					A					
(6) understand the evolution of the Earth as evidenced by the ability to:										
(a) perform measurements to describe the physical properties of a given rock sequence;								A		
(b) describe, using words, pictures, and diagrams, the composition, textures, spatial relationships, and fossil content of a given rock sequence;	I	I						A		
(c) explain, in terms of type and quantity of fossils, isotopic concentrations, unconformities, rock types, and rock sequences, the connection between a given major biospheric change and the rock and fossil record and a given major lithospheric change and the rock and fossil record;		A					A	A		
(d) explain, using the principle of actualism, the relationship between features seen in the rock record and processes observable in the Earth today;	I	A						A		
(e) predict, in terms of known rock sequences and the principle of actualism, how a given geologic or biologic event might be recorded in a rock sequence; and		A						A		
(f) explain, using the fossil record and decay rates of radioactive isotopes, how the age of a given rock is determined; and	A	A					A	A		
(7) understand human interactions with the Earth system as evidenced by the ability to:										

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(a) describe, using words, charts, figures, and maps or globes, the present distribution of a given natural resource;	I			A						
(b) explain, using words, charts, figures, illustrations, and maps, how the distribution of a given resource has affected the distribution and history of human society;				A						
(c) predict, in terms of present trends, possible alternative resources, and changes in technology or social structure, the plausible impacts on human society of future changes in the availability of a given natural resource;				A						
(d) describe, using words, charts, figures, and maps or globes, a given occurrence of an environmental hazard;	I			A		I				
(e) predict, in terms of direct and indirect, short-term and long-term effects, the probable impacts of a given environmental hazard on human society;	I			A		I				
(f) explain, in terms of chemical changes, physical modifications, and changes in energy, how human activity impacts a given Earth system;	I			A		I				
(g) predict, in terms of direct and indirect, short-term and long-term effects, the probable effects of a given human activity on an Earth system;	I			A		I				
(h) explain, using words, diagrams, graphs, and maps, how it is known that there have been long-term changes in climate and sea level during the course of human existence;	I	A		A				A		
(i) explain, using words, diagrams, pictures, and maps, how observed changes in climate and sea level may have impacted the history of human development; and		A		A						
(j) predict, in terms of changes in resource availability, production, population size and distribution, and current social structures, the probable impacts of future changes in climate or sea level on human society.				A						

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C. A teacher of earth and space science must demonstrate an advanced conceptual understanding of earth and space science and the ability to apply its fundamental principles, laws, and concepts by completing a full research experience. The teacher must:										
(1) identify various options for a research experience including independent study projects, participation in research with an academic or industry scientist, directed study, internship, or field study;										A
(2) select an option and complete a research experience that includes conducting a literature search on a problem;										A
(3) design and carry out an investigation;										A
(4) identify modes for presenting the research project; and										A
(5) present the research project in the selected mode.										A

**Standards that integrate knowledge of science with knowledge of pedagogy, students, learning environments, and professional development were articulated in subpart 3 E of rule 8710.4750. These pedagogy standards need to be evidenced in addition to the specific content science standards.**

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E. A teacher of science must have a broad-based knowledge of teaching science that integrates knowledge of science with knowledge of pedagogy, students, learning environments, and professional development. A teacher of science must understand:										

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(1) curriculum and instruction in science as evidence by the ability to:										
(a) select, using local, state, and national science standards, appropriate science learning goals and content;									A	
(b) plan a coordinated sequence of lessons and instructional strategies that support the development of students' understanding and nurture a community of science learners including appropriate inquiry into authentic questions generated from students' experiences; strategies for eliciting students' alternative ideas; strategies to help students' understanding of scientific concepts and theories; and strategies to help students use their scientific knowledge to describe real-world objects, systems, or events;									A	
(c) plan assessments to monitor and evaluate learning of science concepts and methods of scientific inquiry; and									A	
(d) justify and defend, using knowledge of student learning, research in science education, and national science education standards, a given instructional model or curriculum;									A	
(2) safe environments for learning science as evidenced by the ability to:										
(a) use required safety equipment correctly in classroom, field, and laboratory settings;									A	
(b) describe, using knowledge of ethics and state and national safety guidelines and restrictions, how to make and maintain a given collection of scientific specimens and data;									A	
(c) describe, using knowledge of ethics and state and national safety guidelines and restrictions, how to acquire, care for, handle, and dispose of live organisms;									A	
(d) describe, using state and national guidelines, how to acquire, care for, store, use, and dispose of given chemicals and equipment used to teach science;									A	
(e) implement safe procedures during supervised science learning experiences in the public schools; and									A	
(f) develop a list of materials needed in an elementary science safety kit;									A	
(3) how to apply educational principles relevant to the physical, social, emotional, moral, and cognitive development of preadolescents and adolescents;									<b>ED 3110, ED 3350</b>	
(4) how to apply the research base for and the best practices of middle level and high school education;									<b>ED 3350</b>	
(5) how to develop curriculum goals and purposes based on the central concepts of science and how to apply instructional strategies and materials for achieving student understanding of the discipline;									A	
(6) the role and alignment of district, school, and department mission and goals in program planning;									<b>ED 4830</b>	
(7) the need for and how to connect students' schooling experiences									<b>ED</b>	

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with everyday life, the workplace, and further educational opportunities;										<b>4830</b>	
(8) how to involve representatives of business, industry, and community organizations as active partners in creating educational opportunities;										<b>ED 4830</b>	
(9) the role and purpose of cocurricular and extracurricular activities in the teaching and learning process;										<b>ED 4830</b>	
(10) the impact of reading ability on student achievement in science, recognize the varying reading comprehension and fluency levels represented by students, and possess the strategies to assist students to read science content more effectively; and										<b>ED 3780 ED 3350 ED 4830</b>	
(11) how to apply the standards of effective practice in teaching through a variety of early and ongoing clinical experiences with middle level and high school students within a range of educational programming models.										<b>ED 3100 ED 4830 SCI 3450</b>	