

8710.4750 TEACHERS OF SCIENCE: Physics 9-12

FORM I-C MATRIX

Professional Education Program Evaluation Report (PEPER II)	MATRIX Form I-C					
<p align="center">8710.4750 Teachers of Science: Physics 9-12</p>	<p>Identify coding used to indicate placement or assignment of standards here: (example: K=knowledge, A= assessed). Bold= primary assessment</p> <p>Insert COURSE NUMBER & ID below</p>					
	Physics I Phys. 2101	Physics II Phys 2102	Modern Physics PHYS 3600	Optics PHYS 4580	Research PHYS 4980	Electronics PHYS 2500
<p>Subp. 7. Subject matter standards for teachers of physics. A candidate for licensure as a teacher of physics 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.</p>						
<p>A. A teacher of physics must demonstrate a conceptual understanding of physics. The teacher must:</p>						
<p>(1) use sources of information to solve unfamiliar quantitative problems and communicate the solution in a logical and organized manner as evidenced by the ability to:</p>	A	A			A	
<p>(a) describe, in terms of the known and unknown quantities, a given problem in the appropriate pictorial, graphical, or written form;</p>	A	A			A	
<p>(b) qualitatively describe, in appropriate physics terms using motion diagrams, vector force diagrams, energy or momentum diagrams, ray diagrams, or field diagrams as necessary, a given problem situation;</p>	A	K				
<p>(c) mathematically describe, in terms of the relevant numerical, algebraic, and trigonometric quantities and equations, a given problem;</p>	A	A				
<p>(d) plan, using words, diagrams, and mathematical relationships, a solution for solving a given problem and verify the solution;</p>	A	A				
<p>(e) implement, using algebra and manipulation and solution of coupled sets of linear equations, quadratic equations, simple differential equations, and simple integrals as necessary, a solution to a given problem; and</p>	K	K	A	A		A
<p>(f) evaluate, in terms of unit consistency, reasonableness, and completeness of solution, the solution of a given problem;</p>	A	A	A	A		
<p>(2) use computers to display and analyze experimental and theoretical data as evidenced by the ability to:</p>						
<p>(a) graphically describe data using a computer;</p>	A	A				
<p>(b) design a mathematical model to provide a reasonable fit to a given set of data;</p>	A	A			A	
<p>(c) compute and evaluate the statistical significance of mean and standard deviation for a distribution of data;</p>	A	A			A	

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(3) estimate common physical properties as evidenced by the ability to:						
(a) describe numerically, using reasonable physical estimates, the physical properties of common objects; and	A				A	
(b) compute and evaluate the reasonableness of calculated physical parameters of common objects; and	A				A	
(4) develop a plan to ensure a safe environment and practices in all physics learning activities.	A	A			A	
B. A teacher of physics must demonstrate a knowledge of physics concepts. The teacher must:						
(1) understand linear and rotational motion as evidenced by the ability to:						
(a) perform measurements and calculations to describe the linear and angular position, velocity, and acceleration of a given object; the forces and torques acting on an object; and the energy, momentum, and angular momentum of a system before and after an interaction;	A					
(b) describe, using words, pictures and diagrams, graphs, vectors, and mathematical relationships, the motion of a given object;	A					
(c) describe, using words, free-body vector diagrams, and mathematical relationships, the forces acting on each object in a given system of interacting objects and explain, using Newton's Second and Third Laws, the relationships between all the forces;	A					
(d) describe, using words, energy diagrams or graphs, and mathematical relationships, the change of energy of a system and any transfer of energy into or out of a given system of interacting objects;	A					
(e) describe, using words, vector diagrams, and mathematical relationships, the change of linear or angular momentum of a given system and any transfer of momentum into or out of the system of interacting objects;	A					
(f) explain and predict qualitatively and quantitatively, in terms of Newton's Laws, the conservation of energy, and the conservation of momentum, the motion of objects in a given system of interacting objects; and	A					
(g) design a strategy for making an object move in a given way;	A					
(2) understand simple harmonic and wave motion as evidenced by the ability to:						
(a) perform measurements and calculations to describe the wavelength, amplitude, period, frequency, and energy of a traveling wave or an object in simple harmonic motion;	A					
(b) describe, using words, force diagrams, energy diagrams or graphs, motion graphs, and mathematical relationships, simple or damped harmonic motion or resonance of a given oscillating system;	A					

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(c) explain and predict qualitatively and quantitatively, using the equation of motion, changes in motion of an oscillator in a given system when the intrinsic characteristics of the oscillator change, when a given external force is applied to the oscillator, and when the oscillator loses energy to its surroundings;	A					
(d) design, using words, diagrams or graphs, and mathematical relationships, a system which oscillates at a given frequency or exhibits damped oscillations;	A					
(e) describe a traveling or standing wave in a given medium;	A					
(f) explain and predict qualitatively and quantitatively, using the wave equation of motion and the superposition principle, changes in wave motion when a given traveling wave interacts with a given object or boundary;	A	K		A		
(g) explain and predict qualitatively and quantitatively, using the wave equation of motion and the superposition principle, changes in wave motion when a given traveling wave interacts with a second wave; and	A	K		A		
(h) explain and predict qualitatively and quantitatively, using the wave equation of motion and the superposition principle, changes in the wave when the source and detector are moving relative to each other;	A	K		A		
(3) understand electricity and magnetism as evidenced by the ability to:						
(a) perform measurements and calculations to describe time varying or constant values of current, voltage, and power in electric circuits and in magnetic fields;		A				A
(b) describe, using words, circuit diagrams, graphs, and mathematical relationships, the current, voltage, resistance, capacitance, or inductance of a given system of circuit elements;		A				A
(c) explain and predict qualitatively and quantitatively, using the conservation of charge and the conservation of energy, the current through or the voltage across each element in a given circuit when changes are made to the circuit;		A				A
(d) design a circuit in which the current varies in a given way;		A				A
(e) explain and predict qualitatively and quantitatively, in terms of Newton's laws and the Lorentz Force, the motion of charges in given electric and magnetic fields;		A	A			
(f) predict qualitatively and quantitatively, using Gauss's law or Ampere's law, the electric field around a given simple geometric distribution of charges and the magnetic field around a given simple geometric system of current-carrying wires;		A				
(g) predict qualitatively, using Lenz's law and Faraday's Law, the induced currents from a given changing magnetic flux;		A				
(h) design, using simple materials, a working electric motor and an air-core electromagnet that produces a field strength; and		A				A
(i) explain, in terms of the motion of charges and the electromagnetic nature of light, how electromagnetic radiation is generated in a given situation;		A	K			
(4) understand physical and geometrical optics as evidenced by the ability to:						

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(a) perform measurements and calculations to describe light intensity and polarization of a given light source, the location of images formed by a simple mirror and lens system, and the focal length and magnification of a curved mirror or thin lens;		A		A		
(b) describe, using words, ray diagrams, graphs, and mathematical relationships, the reflection, refraction, transmission, and absorption of light when it encounters a given macroscopic object, a plane or curved mirror, a boundary between mediums of different indices of refraction, a linear polarizer, a prism, and thin concave and convex lenses;		A		A		
(c) explain and predict qualitatively and quantitatively, in terms of ray diagrams and the laws of reflection and refraction of light, the location and magnification of a real or virtual image for a given system of mirrors or lenses;		A		A		
(d) design a system of lenses and mirrors to produce a real or virtual image of a given magnification;		A		A		
(e) describe, using words, diagrams, and graphs, the interaction of monochromatic light with a given single or pair of parallel slits and with thin films; and		K		A		
(f) explain and predict qualitatively and quantitatively, using the behavior of waves and the principle of superposition, the change in the resulting light pattern with given changes in slit width, separation, and the wavelength of the incident light on a system of slits;		A	K	A		
(5) understand the kinetic-molecular model of matter and thermodynamics as evidenced by the ability to:						
(a) perform measurements and calculations to describe the mass, volume, density, temperature, and heat capacity of a solid, liquid, or gas at constant pressure and the pressure in a gas;		A				
(b) explain qualitatively, using the kinetic-molecular model of matter, a common physical change;		A				
(c) describe, using words, graphs, and mathematical relationships, changes in pressure, volume, or temperature of an ideal gas;		A				
(d) predict, using the First Law of Thermodynamics, the final temperature of a given thermally isolated system of interacting objects and materials;		A				
(e) explain and predict qualitatively and quantitatively, using the First Law of Thermodynamics, the transfer of heat into or out of a given system;		A				
(f) explain, using the First Law of Thermodynamics, the changes of pressure, temperature, and volume for a monatomic ideal gas operating in a Carnot cycle between given states, and describe quantitatively, using words, graphs, and mathematical relationships, the thermal efficiency of the system; and		A				
(g) explain, in terms of the second law of thermodynamics, why energy flows from hot to cold objects; and		A				
(6) understand contemporary physics as evidenced by the ability to:						

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(a) perform measurements and calculations to detect nuclear radiation in the environment, and determine wavelengths and energy of the emission spectrum of a given gas;		A	A			
(b) describe, using words, diagrams, and mathematical relationships, the time dilation, length contraction, and momentum and energy of an object of given velocity;			A			
(c) describe, using words, diagrams, and tables, the basic atomic and subatomic constituents of matter;			A			
(d) explain qualitatively, in terms of the standard model, the observed interaction between atomic or subatomic particles in a simple situation;			A			
(e) explain qualitatively, using the quantum nature of light and matter, and the conservation of energy and momentum, the observed interaction between photons and matter in a given situation;			A			
(f) explain, using conservation principles, the observed changes in the matter and energy of a given nuclear process;			A			
(g) predict, using the Heisenberg Uncertainty Principle, the lower limit of size, momentum, energy, or time that could be expected in a given atomic or subatomic measurement or situation; and		K	A			
(h) describe, in terms of the energy bands and levels in the material, the electrical conductivity of a given conductor, insulator, or semiconductor.			A			A
C. A teacher of physics must demonstrate an advanced conceptual understanding of physics 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.

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:						Sci. 3450
(1) curriculum and instruction in science as evidence by the ability to:						A
(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
(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;						ED 3110, ED 3350
(4) how to apply the research base for and the best practices of middle level and high school education;						ED 3350
(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;						ED 4830
(7) the need for and how to connect students' schooling experiences with everyday life, the workplace, and further educational opportunities;						ED 4830

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(8) how to involve representatives of business, industry, and community organizations as active partners in creating educational opportunities;						ED 4830
(9) the role and purpose of cocurricular and extracurricular activities in the teaching and learning process;						ED 4830
(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						ED 3780 ED 3350 ED 4830
(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.						ED 3100 ED 4830 SCI 3450