Gustavus Adolphus College

8710.4750 TEACHERS OF SCIENCE: Physics 9-12 FORM I-D GRID

Professional Education Program Evaluation Report (PEPER II)	**FORM I-D** **EVIDENCE OF LEARNING & ASSESSMENT OPPORTUNITIES**	**COMPLETE THIS FORM**

8710.4750 Teachers of Science: Physics 9-12	**Course ID Number**	**Any and all referenced experiences must be verifiable in the course syllabi submitted. Use specific references to activities* in the syllabi that evidence learning opportunities & assessments that align to the standard. (*readings, activities, topics of discussion, assignments, experiences, etc.)**
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.		
A. A teacher of physics must demonstrate a conceptual understanding of physics. The teacher must:		
(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:	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 2-13*
(a) describe, in terms of the known and unknown quantities, a given problem in the appropriate pictorial, graphical, or written form;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 2-13*
(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;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 2-13*
(c) mathematically describe, in terms of the relevant numerical, algebraic, and trigonometric quantities and equations, a given problem;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 2-13*
(d) plan, using words, diagrams, and mathematical relationships, a solution for solving a given problem and verify the solution;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 2-13*
(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	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 2-13*
(f) evaluate, in terms of unit consistency, reasonableness, and completeness of solution, the solution of a given problem;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 2-13*
(2) use computers to display and analyze experimental and theoretical data as evidenced by the ability to:		
(a) graphically describe data using a computer;	Phy 205/206	PHY205 Lecture Notes, PHY206 Laboratory Manual*
(b) design a mathematical model to provide a reasonable fit to a given set of data;	Phy 205/206	PHY205 Lecture Notes, PHY206 Laboratory Manual*
(c) compute and evaluate the statistical significance of mean and standard deviation for a distribution of data;	Phy 205/206	PHY205 Lecture Notes, PHY206 Laboratory Manual*
(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	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 2-13*
(b) compute and evaluate the reasonableness of calculated physical parameters of common objects; and	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 2-13*
(4) develop a plan to ensure a safe environment and practices in all physics learning activities.	EDU 361	Chapters 14 & 17 in the text "Teaching Secondary School Science: Strategies for Developing Scientific Literacy specifically addresses how to create and maintain effective and safe science laboratory environments. Students are required to develop a lab safety policy document that includes the handling and management of all lab materials and specimens, and a list of the equipment and basic materials required to do so.
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;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 2-12*
(b) describe, using words, pictures and diagrams, graphs, vectors, and mathematical relationships, the motion of a given object;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 2-4*
(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;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 5*
(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;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 7-8*
(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;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 10-11*
(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	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 9*
(g) design a strategy for making an object move in a given way;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 2-10*
(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;	Phy 205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 15-16*
(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;	Phy 205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 15*
(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	Phy 205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 15*

the oscillator loses energy to its surroundings;		
(d) design, using words, diagrams or graphs, and mathematical relationships, a system which oscillates at a given frequency or exhibits damped oscillations;	Phy 205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 15*
(e) describe a traveling or standing wave in a given medium;	Phy 205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 16*
(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;	Phy 205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 16*
(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	Phy 205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 16*
(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;	Phy 205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 16-17*
(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;	Phy 215/216	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 27-33*
(b) describe, using words, circuit diagrams, graphs, and mathematical relationships, the current, voltage, resistance, capacitance, or inductance of a given system of circuit elements;	Phy 215	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 27-33*
(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;	Phy 215	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 27*
(d) design a circuit in which the current varies in a given way;	Phy 215/216	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 27*
(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;	Phy 215	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 23,29*
(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;	Phy 215	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 24,30*
(g) predict qualitatively, using Lenz's law and Faraday's Law, the induced currents from a given changing magnetic flux;	Phy 215	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 31*
(h) design, using simple materials, a working electric motor and an air-core electromagnet that produces a field strength; and	Phy 215/216	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 30-31*
(i) explain, in terms of the motion of charges and the electromagnetic nature of light, how electromagnetic radiation is generated in a given situation;	Phy 215	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 34*
(4) understand physical and geometrical optics as evidenced by the ability to:		
(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;	Phy 195	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 35-38*
(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;	Phy 195	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 35-38*
(c) explain and predict qualitatively and quantitatively, in terms of ray diagrams and the	Phy	Physics for Scientists and Engineers, 8th Ed., R. A. Serway &

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;	195	J.W. Jewett: Ch. 35-36*
(d) design a system of lenses and mirrors to produce a real or virtual image of a given magnification;	Phy 195	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 35-36*
(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	Phy 195	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 37-38*
(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;	Phy 195	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 37-38*
(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;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 19-20*
(b) explain qualitatively, using the kinetic-molecular model of matter, a common physical change;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 21*
(c) describe, using words, graphs, and mathematical relationships, changes in pressure, volume, or temperature of an ideal gas;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 21*
(d) predict, using the First Law of Thermodynamics, the final temperature of a given thermally isolated system of interacting objects and materials;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 20*
(e) explain and predict qualitatively and quantitatively, using the First Law of Thermodynamics, the transfer of heat into or out of a given system;	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 20*
(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	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 20,22*
(g) explain, in terms of the second law of thermodynamics, why energy flows from hot to cold objects; and	Phy 195/205	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 22*
(6) understand contemporary physics as evidenced by the ability to:		
(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;	Phy 195/225	Physics for Scientists and Engineers, 8th Ed., R. A. Serway & J.W. Jewett: Ch. 44-45*; Modern Physics for Scientist and Engineers, 2nd Ed., J.A.Taylor, C.D. Zafiratos, M.A. Dubson: Ch. 4,5,11,16,17*
(b) describe, using words, diagrams, and mathematical relationships, the time dilation, length contraction, and momentum and energy of an object of given velocity;	Phy 225	Modern Physics for Scientist and Engineers, 2nd Ed., J.A.Taylor, C.D. Zafiratos, M.A. Dubson: Ch. 1,2*
(c) describe, using words, diagrams, and tables, the basic atomic and subatomic constituents of matter;	Phy 225	Modern Physics for Scientist and Engineers, 2nd Ed., J.A.Taylor, C.D. Zafiratos, M.A. Dubson: Ch. 3,8,10,16-18*
(d) explain qualitatively, in terms of the standard model, the observed interaction between atomic or subatomic particles in a simple situation;	Phy 225	Modern Physics for Scientist and Engineers, 2nd Ed., J.A.Taylor, C.D. Zafiratos, M.A. Dubson: Ch. 10,11,17*
(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;	Phy 225	Modern Physics for Scientist and Engineers, 2nd Ed., J.A.Taylor, C.D. Zafiratos, M.A. Dubson: Ch. 3,4*
(f) explain, using conservation principles, the observed changes in the matter and	Phy	Modern Physics for Scientist and Engineers, 2nd Ed.,

energy of a given nuclear process;	225	J.A.Taylor, C.D. Zafiratos, M.A. Dubson: Ch. 17*
(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	Phy 225	Modern Physics for Scientist and Engineers, 2nd Ed., J.A.Taylor, C.D. Zafiratos, M.A. Dubson: Ch. 6*
(h) describe, in terms of the energy bands and levels in the material, the electrical conductivity of a given conductor, insulator, or semiconductor.	Phy 225	Modern Physics for Scientist and Engineers, 2nd Ed., J.A.Taylor, C.D. Zafiratos, M.A. Dubson: Ch. 13*
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;	Phy 365	Students identify experiment or research project
(2) select an option and complete a research experience that includes conducting a literature search on a problem;	Phy 365	Students perform literature search, etc. to identify research project
(3) design and carry out an investigation;	Phy 365	Students perform experiment and data analysis
(4) identify modes for presenting the research project; and	Phy 365	Students write a formal report on project
(5) present the research project in the selected mode.	Phy 365	Students write a formal report on project

* Any instructor teaching any of the listed courses will meet all of the MN State Standards. For all physics courses, the students will be introduced to the material using a combination of one or more of the following: textbook and other assigned readings, lectures, demonstrations, recitations, and laboratory experiments. The students will be assessed using one or more of the following: written and/or computer graded homework, group problems, quizzes, hour exams, or final examinations. The textbook chapters listed are those used by the instructor for a recent course offering. Any other textbook used for these courses will cover these same standards at essentially the same level as the textbook listed above.