Field 047: Science—Physics
REPA Educator Standards

Standard 1: The Nature and Processes of Science
Physics teachers have a broad and comprehensive understanding of the nature of science and the processes of scientific inquiry, including:

1.1 the characteristics, assumptions, and goals of science

1.2 the tentative nature of scientific knowledge, which is subject to change as new evidence, new tools, or new ways of thinking become available

1.3 the formulation of testable hypotheses and the principles and procedures for designing and conducting scientific investigations

1.4 common tools, materials, and technology used in physics investigations

1.5 the collection, organization, analysis, interpretation, and communication of scientific data, including the use of technology

1.6 the safe execution of laboratory exercises and the safe storage and disposal of materials

1.7 the role and applications of mathematics in science

1.8 the characteristics and uses of various sources of scientific information and the evaluation of scientific information, claims, and arguments

1.9 the role of peer review and critical evaluation of the results of scientific investigations, models, and explanations

Standard 2: Central Concepts and Connections in Science
Physics teachers have a broad and comprehensive understanding of the core ideas in other science disciplines and of the relationships between science, engineering, technology, and society, including:

2.1 the unifying concepts and processes that cut across the sciences and engineering

2.2 the basic concepts and major principles of chemistry

2.3 the basic concepts and major principles of Earth and space science

2.4 the basic concepts and major principles of life science

2.5 the basic characteristics, principles, and goals of the engineering, or technological, design process

2.6 the interconnections between the various disciplines of science

2.7 the interrelationships between science and technology

2.8 the social, cultural, and ethical aspects of science and technology

2.9 the historical development of important ideas in science from different periods and cultures

Standard 3: Motion and Forces

Physics teachers have a broad and comprehensive understanding of motion, forces, and Newton's laws in one and two dimensions, including:

3.1 the representation of motion using graphs, motion maps, algebra, trigonometry, and calculus

3.2 the vector nature of force and motion in two dimensions

3.3 characteristics of the gravitational force, frictional forces, and elastic forces

3.4 applications of Newton's laws to a variety of situations on Earth and in space

3.5 torque and its application to static and dynamic systems

3.6 properties of fluids and applications of the principles of Archimedes, Pascal, and Bernoulli

Standard 4: Energy and Momentum

Physics teachers have a broad and comprehensive understanding of the conservation of energy and momentum, including:

4.1 the interrelationships between force, work, energy, and power

4.2 conservation of energy and the work-energy theorem

4.3 the interrelationships between force, impulse, and momentum

4.4 the conservation of momentum in one and two dimensions

4.5 the conservation of rotational energy and angular momentum

Standard 5: Thermodynamics and Kinetic Theory

Physics teachers have a broad and comprehensive understanding of the laws of thermodynamics and the kinetic theory of matter, including:

5.1 heat and temperature, specific heat, phase changes, thermal expansion, and methods of heat transfer

5.2 the mechanical equivalence of heat, thermodynamic work, and the first law of thermodynamics

5.3 the kinetic theory of matter and the description of macroscopic quantities in terms of molecular interactions

5.4 heat engines, entropy, energy conversions and efficiency, and the second law of thermodynamics

Standard 6: Electricity and Magnetism

Physics teachers have a broad and comprehensive understanding of electricity and magnetism, including:

6.1 electric charge, electrostatics, the electric force, and Coulomb's law

6.2 the electric field and the motion of charged particles in an electric field

6.3 conservative fields, electrostatic potential energy, and electric potential

6.4 properties of the magnetic field, the motion of charged particles in magnetic fields, and magnetism in matter

6.5 Faraday's law of induction, Lenz's law, and induced electric fields and electromotive force

6.6 Ohm's law, capacitance, resistivity and resistance, and the analysis of electric circuits using Kirchhoff's laws

6.7 qualitative aspects of the generation of electromagnetic waves and characteristics of the electromagnetic spectrum

6.8 basic characteristics of alternating current and the operation of devices such as electric motors, generators, and transformers

Standard 7: Vibrations and Waves

Physics teachers have a broad and comprehensive understanding of vibrations and waves and the application of wave properties to sound and light, including:

7.1 the application of force and energy principles to simple harmonic motion and oscillating systems

7.2 the properties of waves and the transfer of energy and momentum by transverse and longitudinal waves

7.3 the production, propagation, and properties of sound waves

7.4 the superposition principle, resonance, and the production of standing waves for various boundary conditions

7.5 the production, propagation, reflection, and refraction of light waves

7.6 geometric optics and image formation in thin lenses and mirrors

7.7 physical optics and the interference, diffraction, and polarization of light waves

Standard 8: Modern Physics

Physics teachers have a broad and comprehensive understanding of the fundamental ideas of modern physics, including:

8.1 energy of light quanta and the photoelectric effect

8.2 historic and contemporary models of the atom

8.3 the wave-particle duality, the uncertainty principle, and interactions between light and matter

8.4 fundamentals of the special theory of relativity

8.5 the structure of the nucleus, binding energy, stability, and nuclear reactions

Standard 9: Science Instruction and Assessment

Physics teachers have a broad and comprehensive understanding of content-specific instruction and assessment in science, including:

9.1 the Indiana Revised Academic Standards for Science

9.2 the National Science Education Standards, the NCATE/NSTA Standards for Science Teacher Preparation, the Common Core State Standards for English Language Arts & Literacy in Science and Technical Subjects, and the ISTE National Educational Technology Standards for Teachers

9.3 instructional strategies and resources for promoting students' development of conceptual understanding, inquiry skills, and scientific habits of mind

9.4 strategies and skills for planning and designing science instruction, including the use of techniques and approaches that meet the needs of diverse learners

9.5 instructional strategies and communication methods that encourage active inquiry, supportive interaction, and collaboration in the science classroom

9.6 strategies and resources for promoting students' reading, writing, and mathematics skills in science

9.7 strategies and skills for selecting, adapting, and using technological resources to enhance teaching and learning in science

9.8 procedures, resources, and guidelines for maintaining a safe science learning environment

9.9 strategies and skills for effectively assessing student understanding and mastery of essential science concepts and skills