

Physics

[27.190]

In addition to the standards for all science teachers that are set forth in Section 27.140 of this Part, those who specialize in teaching physics shall be required to meet the standards described in this Section.

STANDARD 1

The competent physics teacher understands the essential knowledge and skills needed to practice physics and understands the broad applicability of its principles to real-world situations.

Knowledge Indicators - *The competent physics teacher:*

- 1A. understands scientific processes and principles of experimentation.
- 1B. understands methods and equipment used in scientific measurement.
- 1C. understands the collection and analysis of data and methods used for reporting results.
- 1D. understands how demonstration materials may be used to exhibit and explain a wide variety of physical phenomena.
- 1E. understands safe and proper use of equipment and materials commonly used in physics classrooms and laboratories.
- 1F. understands the growth of physics knowledge from a historical perspective.

Performance Indicators - *The competent physics teacher:*

- 1G. provides examples of the applicability of physics in daily life, including career opportunities and avocations in physics and technology.
- 1H. explains ways in which basic research and the development of new technologies affect society.
- 1I. utilizes basic equipment to demonstrate physical principles and phenomena.
- 1J. incorporates the use of calculator- and computer-based technology, including graphical and statistical procedures, in the collection, analysis, and interpretation of data.
- 1K. uses mathematical concepts, strategies, and procedures up to and including procedures of differential and integral calculus, to derive and manipulate formal relationships between physical quantities.
- 1L. sets up appropriate laboratory investigations addressing the principles and applications of physics.

STANDARD 2

The competent physics teacher understands particle and rigid body motion in its qualitative and quantitative dimensions.

Knowledge Indicators - *The competent physics teacher:*

- 2A. understands translational, rotational, and periodic motion of particles, systems of particles, and rigid bodies.
- 2B. understands inertia and moments of inertia, momentum and angular momentum, and forces and torques as they apply to linear and circular motions, respectively.
- 2C. understands how physical quantities may be represented as vectors, vector sums, and vector products.

- 2D. understands force and friction and their applications to statics, kinematics, and dynamics.
- 2E. understands conservation laws as they apply to momentum and energy in one and two dimensions.

Performance Indicators - *The competent physics teacher:*

- 2F. predicts the position of particles undergoing linear, curvilinear, or periodic motion given initial conditions.
- 2G. applies the concept of gravitational force to problems involving the law of universal gravitation, free fall, and projectile motion.
- 2H. applies Newton's laws of motion to characterize and explain the disposition of forces acting on a given body and its resultant motion.
- 2I. applies conservation principles to analyze motion within a system of particles or rigid bodies when no external forces are applied.
- 2J. uses the relationship between work and energy to analyze the motions of physical systems acted upon by conservative and/or non-conservative forces.

STANDARD 3

The competent physics teacher understands the nature, properties, and behavior of mechanical and electromagnetic waves and how electromagnetic waves interact with matter.

Knowledge Indicators - *The competent physics teacher:*

- 3A. understands types, properties, motions, and interactions of waves.
- 3B. understands characteristics and behavior of sound and the processes by which sound is produced and transmitted.
- 3C. understands the nature and properties of electromagnetic radiation and the processes by which it is produced and transmitted and interacts with matter.
- 3D. understands the basic principles of geometrical and physical optics.

Performance Indicators - *The competent physics teacher:*

- 3E. identifies components and characteristics of the electromagnetic spectrum by both frequency and wavelength.
- 3F. analyzes and predicts interactions of waves with objects and other waves as a function of position and time.
- 3G. analyzes and predicts the behaviors of electromagnetic radiation as it interacts with matter.
- 3H. analyzes and predicts the behavior of light in relation to optical equipment and the human eye.
- 3I. distinguishes between the physical and physiological properties of sound.

STANDARD 4

The competent physics teacher understands heat and matter.

Knowledge Indicators - *The competent physics teacher:*

- 4A. understands basic concepts of heat and temperature as they relate to temperature measurement and temperature-dependent properties of matter.
- 4B. understands the laws of thermodynamics as they relate to temperature, work, energy, and entropy.

- 4C. understands the relationship between heat and work as it pertains to thermodynamic systems.
- 4D. understands kinetic-molecular theory of thermodynamic behavior in gases, solids, and liquids.

Performance Indicators - *The competent physics teacher:*

- 4E. explains the laws of thermodynamics, giving appropriate examples.
- 4F. identifies allowed and disallowed physical processes through application of the laws of thermodynamics.
- 4G. measures and analyzes changes in thermodynamic variables in physical systems for various thermodynamic processes.
- 4H. uses the kinetic-molecular models of thermodynamics to describe the thermal properties and behaviors of solids, liquids, and gases.
- 4I. analyzes the relationship between heat and work in heat engines.

STANDARD 5

The competent physics teacher understands electricity and magnetism and the relationship between them.

Knowledge Indicators - *The competent physics teacher:*

- 5A. understands the characteristics and behavior of electric charges, their fields, and potentials.
- 5B. understands the characteristics and behavior of both AC and DC electrical current in different media.
- 5C. understands the behavior of series and parallel electrical circuits, the symbols used to denote their components, and the methods of diagramming them.
- 5D. understands the effect of magnetic fields on electric charges, including the direction and magnitude of the force on a moving charge or a current-carrying conductor.
- 5E. understands the effect of current-carrying wire, straight and coiled, on the direction of the magnetic field and the effect of current strength on magnetic field.
- 5F. understands electromagnetic induction.

Performance Indicators - *The competent physics teacher:*

- 5G. identifies characteristics and demonstrates applications of magnets and magnetic fields in daily living.
- 5H. identifies principles and applications of electromagnetism in daily living.
- 5I. predicts the influence of static distributions of charges or of electric fields in space on electric charges.
- 5J. designs and sets up DC and AC electrical circuits using basic circuit elements and analysis.
- 5K. illustrates the concepts of charge, fields, potentials and currents using visual demonstrations and/or computer simulations.
- 5L. explains the operation of electric generators and motors.

STANDARD 6

The competent physics teacher understands atomic and nuclear structure.

Knowledge Indicators - *The competent physics teacher:*

- 6A. understands models of atomic structure in both qualitative and quantitative forms.

- 6B. understands the relationship of electron energy level changes to atomic spectra.
- 6C. understands the characteristics of subatomic particles, including basic quark theory.
- 6D. understands the basic principles of radioactive decay.

Performance Indicators - *The competent physics teacher:*

- 6E. balances partial equations on nuclear reactions using the appropriate conservation laws.
- 6F. identifies applications of radioactivity in science and technology.
- 6G. uses the appropriate equipment to detect radioactive decay.
- 6H. analyzes the interaction between atomic radiation and living organisms.

STANDARD 7

The competent physics teacher understands the basic elements and implications of special relativity, quantum mechanics, and solid-state physics.

Knowledge Indicators - *The competent physics teacher:*

- 7A. understands the implications of special relativity as they relate to time, space, and mass.
- 7B. understands the wave-particle duality of radiation and matter.
- 7C. understands the quantum mechanical nature of the interaction between radiation and matter.
- 7D. understands the quantum mechanical nature of matter as it applies to electronic behavior in conductors, semiconductors, and insulators.

Performance Indicators - *The competent physics teacher:*

- 7E. calculates changes in physical parameters related to relativistic motion, and explains their origin.
- 7F. develops and uses simple theoretical models to describe and explain properties of matter and the interaction of matter and energy.
- 7G. describes the importance of energy quantization and how it affects the atomic and electronic behavior of matter.