

Physics

The Physics standards emphasize a more complex understanding of experimentation, the analysis of data, and the use of reasoning and logic to evaluate evidence. The use of mathematics, including algebra and trigonometry, is important, but conceptual understanding of physical systems remains a primary concern. Students build on basic physical science principles by exploring in depth the nature and characteristics of energy and its dynamic interaction with matter. Key areas covered by the standards include force and motion, energy transformations, wave phenomena and the electromagnetic spectrum, light, electricity, fields, and non-Newtonian physics. The standards stress the practical application of physics in other areas of science and technology and how physics affects our world.

The Physics standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

PH.1 The student will plan and conduct investigations in which

- a) the components of a system are defined;
- b) instruments are selected and used to extend observations and measurements of mass, volume, temperature, heat exchange, energy transformations, motion, fields, and electric charge;
- c) information is recorded and presented in an organized format;
- d) metric units are used in all measurements and calculations;
- e) the limitations of the experimental apparatus and design are recognized;
- f) the limitations of measured quantities are recognized through the appropriate use of significant figures or error ranges;
- g) data gathered from non-SI instruments are incorporated through appropriate conversions; and
- h) appropriate technology including computers, graphing calculators, and probeware, is used for gathering and analyzing data and communicating results.

PH.2 The student will investigate and understand how to analyze and interpret data. Key concepts include

- a) a description of a physical problem is translated into a mathematical statement in order to find a solution;
- b) relationships between physical quantities are determined using the shape of a curve passing through experimentally obtained data;
- c) the slope of a linear relationship is calculated and includes appropriate units;
- d) interpolated, extrapolated, and analyzed trends are used to make predictions; and
- e) analysis of systems employs vector quantities utilizing trigonometric and graphical methods.

- PH.3 The student will investigate and understand how to demonstrate scientific reasoning and logic. Key concepts include
- a) analysis of scientific sources to develop and refine research hypotheses;
 - b) analysis of how science explains and predicts relationships;
 - c) evaluation of evidence for scientific theories;
 - d) examination of how new discoveries result in modification of existing theories or establishment of new paradigms; and
 - e) construction and defense of a scientific viewpoint (the nature of science).
- PH.4 The student will investigate and understand how applications of physics affect the world. Key concepts include
- a) examples from the real world; and
 - b) exploration of the roles and contributions of science and technology.
- PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes. Key concepts include
- a) linear motion;
 - b) uniform circular motion;
 - c) projectile motion;
 - d) Newton's laws of motion;
 - e) gravitation;
 - f) planetary motion; and
 - g) work, power, and energy.
- PH.6 The student will investigate and understand that quantities including mass, energy, momentum, and charge are conserved. Key concepts include
- a) kinetic and potential energy;
 - b) elastic and inelastic collisions; and
 - c) electric power.
- PH.7 The student will investigate and understand properties of fluids. Key concepts include
- a) density and pressure;
 - b) variation of pressure with depth;
 - c) Archimedes' principle of buoyancy;
 - d) Pascal's principle;
 - e) fluids in motion; and
 - f) Bernoulli's principle.
- PH.8 The student will investigate and understand that energy can be transferred and transformed to provide usable work. Key concepts include
- a) transformation of energy among forms including mechanical, thermal, electrical, gravitational, chemical, and nuclear; and
 - b) efficiency of systems.
- PH.9 The student will investigate and understand how to use models of transverse and longitudinal waves to interpret wave phenomena. Key concepts include
- a) wave characteristics (period, wavelength, frequency, amplitude, and phase);
 - b) fundamental wave processes (reflection, refraction, diffraction, interference, polarization, Doppler effect); and
 - c) light and sound in terms of wave models.

- PH.10 The student will investigate and understand that different frequencies and wavelengths in the electromagnetic spectrum are phenomena ranging from radio waves through visible light to gamma radiation. Key concepts include
- a) the properties and behaviors of radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays; and
 - b) current applications based on the wave properties of each band.
- PH.11 The student will investigate and understand, in describing optical systems, how light behaves in the fundamental processes of reflection, refraction, and image formation. Key concepts include
- a) application of the laws of reflection and refraction;
 - b) construction and interpretation of ray diagrams;
 - c) development and use of mirror and lens equations; and
 - d) predictions of type, size, and position of real and virtual images.
- PH.12 The student will investigate and understand how to use the field concept to describe the effects of gravitational, electric, and magnetic forces. Key concepts include
- a) inverse square laws (Newton's law of universal gravitation and Coulomb's law); and
 - b) operating principles of motors, generators, transformers, and cathode ray tubes.
- PH.13 The student will investigate and understand how to diagram and construct basic electrical circuits and explain the function of various circuit components. Key concepts include
- a) Ohm's law;
 - b) series, parallel, and combined circuits; and
 - c) circuit components including resistors, batteries, generators, fuses, switches, and capacitors.
- PH.14 The student will investigate and understand that extremely large and extremely small quantities are not necessarily described by the same laws as those studied in Newtonian physics. Key concepts include
- a) wave/particle duality;
 - b) wave properties of matter;
 - c) matter/energy equivalence;
 - d) quantum mechanics and uncertainty;
 - e) relativity;
 - f) nuclear physics;
 - g) solid state physics;
 - h) superconductivity; and
 - i) radioactivity.