

PHYSICS I: COURSE OVERVIEW

The Physics 1 academic standards were written to establish the core content and practices for all schools in the state of Tennessee. The core and component ideas in the Physical Sciences section in *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* were used to subdivide the Physics course content into four sections:

Physics I (PHYS1)
Physical Sciences (PS)
Matter and Its Interactions
Motion and Stability: Forces and Interactions <ul style="list-style-type: none">• Forces and motion• Types of interactions• Stability and instability in physical systems
Energy <ul style="list-style-type: none">• Definitions of energy• Conservation of energy and energy transfer• Relationship between energy and forces
Waves and Their Applications in Technologies for Information Transfer

PS2: Motion and Stability: Forces and Interactions

An understanding of the forces and interactions between objects is important for describing an object's motion and determining the stability in a system. Students should understand that forces between objects arise from four types of interactions (gravitational, electromagnetism, and strong and weak nuclear interactions) and that some physical systems are more stable than others.

PS3: Energy

The concept of the transfer of energy in or out of a system can be explained and predicted. Students should understand the conservation of energy, how it is stored and transferred, the relationship between forces and how they are related to energy, and how we use energy in our everyday life.

Throughout the Physics course, the seven crosscutting concepts should be reinforced in the appropriate context both in the classroom and hands-on experimentation. These standards also incorporate the core and component ideas in engineering, technology, and applications of science (cited throughout the standards) and should be implemented in this course.

Although science is a body of content knowledge consisting of theories that explain data, science is also a set of practices that use analysis and argumentation to establish, extend, and refine knowledge. The science and engineering practices are used as a means to learn science by doing science, thus combining content knowledge with skill. These practices are not intended to be a sequence of steps nor are they intended to be taught as a separate, introductory unit for the course. By combining content knowledge with skill, students discover how scientific knowledge is acquired and applied to solve problems or advance scientific knowledge further. In addition, there are seven crosscutting concepts that are fundamental to the nature of science and thus stretch across all science disciplines. The Physics standards have been constructed by explicitly integrating practices and crosscutting concepts, iteratively and in combination, within each core idea to provide students with a well-rounded education in science.

These standards were written to allow students to engage in scientific reasoning, critique, creative thinking, and applied learning through hands-on investigations.

These academic standards should be used in order to develop classroom and course-level assessments.

PHYSICS I: ACADEMIC STANDARDS

PHYS1.PS2: Motion and Stability: Forces and Interactions

- 1) Investigate and evaluate the graphical and mathematical relationship (using either manual graphing or computers) of one-dimensional kinematic parameters (distance, displacement, speed, velocity, acceleration) with respect to an object's position, direction of motion, and time.
- 2) Algebraically solve problems involving constant velocity and constant acceleration in one-dimension.
- 3) Algebraically solve problems involving arc length, angular velocity, and angular acceleration. Relate quantities to tangential magnitudes of translational motion.
- 4) Use free-body diagrams to illustrate the contact and non-contact forces acting on an object. Use the diagrams in combination with graphical or component-based vector analysis and with Newton's first and second laws to predict the position of the object on which the forces act in a constant net force scenario.
- 5) Gather evidence to defend the claim of Newton's first law of motion by explaining the effect that balanced forces have upon objects that are stationary or are moving at constant velocity.
- 6) Using experimental evidence and investigations, determine that Newton's second law of motion defines force as a change in momentum, $F = \Delta p / \Delta t$.
- 7) Plan, conduct, and analyze the results of a controlled investigation to explore the validity of Newton's second law of motion in a system subject to a net unbalanced force, $F_{\text{net}} = ma$ or $F_{\text{net}} = \Delta p / \Delta t$.
- 8) Use examples of forces between pairs of objects involving gravitation, electrostatic, friction, and normal forces to explain Newton's third law.
- 9) Use Newton's law of universal gravitation, $F = G \frac{m_1 m_2}{r^2}$, to calculate the gravitational forces, mass, or distance separating two objects with mass, given the information about the other quantities.
- 10) Develop and apply the impulse-momentum theorem along with scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on an object during a collision (e.g., helmet, seatbelt, parachute).
- 11) Use experimental evidence to demonstrate that air resistance is a velocity dependent drag force that leads to terminal velocity.

- 12) Develop a model to predict the range of a two-dimensional projectile based upon its starting height, initial velocity, and angle at which it was launched.
- 13) Plan and conduct an investigation to provide evidence that a constant force perpendicular to an object's motion is required for uniform circular motion ($F = m v^2 / r$).

PHYS1.PS3: Energy

- 1) Investigate conduction, convection, and radiation as a mechanism for the transfer of thermal energy.
- 2) Use the principle of energy conservation and mathematical representations to quantify the change in energy of one component of a system when the energy that flows in and out of the system and the change in energy of the other components is known.
- 3) Assess the validity of the law of conservation of linear momentum ($p=mv$) by planning and constructing a controlled scientific investigation involving two objects moving in one-dimension.
- 4) Construct an argument based on qualitative and quantitative evidence that relates the change in temperature of a substance to its mass and heat energy added or removed from a system.
- 5) Define power and solve problems involving the rate of energy production or consumption ($P = \Delta E / \Delta t$). Explain and predict changes in power consumption based on changes in energy demand or elapsed time. Investigate power consumption and power production systems in common use.
- 6) Recognize and communicate information about energy efficiency and/or inefficiency of machines used in everyday life.
- 7) Compare and contrast the process, design, and performance of numerous next-generation energy sources (hydropower, wind power, solar power, geothermal power, biomass power, etc.).