

Physics

Physics is a physical science course that provides high school students with foundational content regarding the properties of physical matter, physical quantities, and their interactions. The course provides the required science background preparation for students pursuing postsecondary studies and careers in science, technology, engineering, and mathematics (STEM) fields.

In Physics, students learn through investigation, experimentation, and analysis of data. The academic language of physics is used in context to communicate claims, evidence, and reasoning for phenomena and to engage in arguments from evidence to justify and defend claims. Students take part in active learning involving authentic investigations and engineering design processes. The course provides a rich learning context for acquiring knowledge of the practices, core ideas, and crosscutting concepts that develop scientific literacy and critical thinking, problem-solving, and information literacy skills. External resources, including evidence-based literature in scientific journals, research, and other sources, should be utilized to provide students with science experiences that will adequately prepare them for college, career, and citizenship.

Content standards within this course are organized according to three of the disciplinary core ideas for physical science. The first core idea, “Motion and Stability: Forces and Interactions,” concentrates on forces and motion, types of interactions, and stability and instability in physical systems. The second core idea, “Energy,” investigates energy conservation, transformations, and applications to everyday life. The final core idea, “Waves and Their Applications in Technologies for Information Transfer,” examines wave properties, electromagnetic radiation, information technologies, and instrumentation.

Embedded in the content standards are the disciplinary core ideas of the Engineering, Technology, and Applications of Science (ETS) domain, which require students to use design strategies in conjunction with knowledge and understanding of science and technology to solve practical problems. Engineering standards are denoted with a gear icon . Through participation in the engineering design process, students design solutions to determine the magnitude and direction of the buoyant force acting on an object and the force’s effects on the object's motion.

This course is designed to provide students with a deep exploration of kinematics, dynamics, and conservation, while also surveying circular motion, waves, fluids, and electricity.

Although not included as discrete standards, these scientific practices should be embedded throughout the course:

- Measurement - Choose appropriate measurement tools and record measurements with the correct number of significant figures to show measured and estimated digits and units.
- Significant figures - Record the correct number of significant figures after performing mathematical calculations with the data.
- Dimensional analysis - Perform unit conversions using dimensional analysis, including conversions of derived units such as km/hr; N/m², kg/m³.

- Scientific notation - Use scientific notation to report very large or small quantities with the correct number of significant figures and carry out multiplication, division, addition, and subtraction calculations with scientific notation.
- Graphing - Create graphs to determine and communicate relationships between variables, and analyze graphs to make predictions about unknown data points.

Each content standard completes the stem “*Students will...*”

Motion and Stability: Forces and Interactions		
Kinematics	1. Obtain, evaluate, and communicate ideas about kinematics, including scalar quantities (distance and speed) and vector quantities (position, displacement, velocity, and acceleration).	Scale, Proportion, and Quantity
	a. Analyze data to create and interpret graphs of position, velocity, and acceleration versus time for one-dimensional motion.	Patterns
	b. Analyze free fall motion using one-dimensional kinematics to determine the acceleration due to gravity (g). c. Analyze and interpret data to explain changes in the vector quantities of position, velocity, and acceleration in two-dimensional projectile motion, including projectiles launched horizontally and at an angle.	Cause and Effect
	d. Use mathematics and computational thinking to solve problems, using kinematics equations in both one- and two-dimensional motion.	Patterns
Dynamics	2. Construct explanations of dynamics from evidence, using Newton’s laws of motion. a. Evaluate the effects of balanced and unbalanced forces on an object’s motion. b. Use mathematical, graphical, and narrative methods to explain the relationships among net force, mass, and acceleration of a single object.	Cause and Effect

	<ul style="list-style-type: none"> c. Create free and fixed body diagrams to model all the forces acting on a single object. d. Create an explanation of the nature of forces and the interactions among them, including tension, friction, gravitation, and normal forces, using free-body diagrams. 	Systems and System Models
	<ul style="list-style-type: none"> e. Analyze data to identify the pair of equal and opposite forces between two interacting bodies and relate their magnitudes and directions using Newton's third law. 	Cause and Effect
Energy		
Conservation	<ul style="list-style-type: none"> 3. Design and carry out experiments to verify that energy and momentum are conserved in closed systems. 	Energy and Matter
	<ul style="list-style-type: none"> a. Use mathematical and computational thinking to explain the relationships among work, power, and time. 	Scale, Proportion, and Quantity
	<ul style="list-style-type: none"> b. Create mathematical and graphical representations to depict the transformation of energy from one form to another, including kinetic energy, gravitational potential energy, elastic potential energy, and work due to friction. c. Use models to illustrate the relationship between the work performed on an object and the object's total mechanical energy. <i>Example: energy bar chart</i> 	Energy and Matter
	<ul style="list-style-type: none"> d. Qualitatively and quantitatively evaluate the relationship among the force acting on an object, the time of interaction, and the change in linear momentum (impulse) of the object. 	Scale, Proportion, and Quantity
	<ul style="list-style-type: none"> e. Obtain, evaluate, and interpret data related to collisions (both elastic and inelastic) and their effects on both linear momentum and energy conservation. 	Cause and Effect

Motion and Stability: Forces and Interactions

Fluids	4. Use mathematics and computational thinking to analyze the effects of pressure changes and buoyant forces in fluid systems.	Cause and Effect
	a. Plan and carry out experiments to determine the density of objects. b. Use and solve algebraic formulas to determine the relationships between pressure, force, area, and density. <i>Examples: $P=F/A$; $P=\rho gh$</i>	Scale, Proportion, and Quantity
	c. ⚙️ Design solutions to determine the magnitude and direction of the buoyant force acting on an object and the effects of the buoyant forces on the object's motion.	Systems and System Models
	d. Use the buoyant force acting on an object and free body diagrams to determine the acceleration of submerged objects.	Scale, Proportion, and Quantity
Circular Motion	5. Develop and use models to analyze the circular motion of objects.	Systems and System Models
	a. Use mathematics and free-body diagrams to relate the tangential velocity, the radius of orbit, the centripetal acceleration, and force to each other for an object moving in a circle.	Scale, Proportion, and Quantity
	b. Develop and use a model to describe the mathematical relationship between mass, distance, and force as expressed by Newton's law of universal gravitation.	Systems and System Models

Energy

Electricity	6. Obtain, evaluate, and communicate information concerning static and current electricity.	Scale, Proportion, and Quantity
	a. Develop and use a model to describe the mathematical relationship among charge, distance, and force as expressed by Coulomb's law.	Systems and System Models
	b. Obtain, evaluate, and communicate information regarding the relationship among voltage, current, and power for direct current circuits.	Scale, Proportion, and Quantity
	c. Create models of series, parallel, and mixed direct current circuits.	Systems and System Models
	d. Use mathematics and computational thinking to determine the voltage, current, and resistance for an entire circuit and at each resistor or load. <i>Examples: use measurement devices and Ohm's law</i>	Scale, Proportion, and Quantity
Waves and Their Applications in Technologies for Information Transfer		
Waves	7. Obtain, evaluate, and communicate information regarding the propagation, properties, and applications of waves. a. Use mathematics and computational thinking to describe the relationships among the velocity, frequency, and wavelength of a propagating wave.	Scale, Proportion, and Quantity

	<p>b. Use results of investigations to explain the production and characteristics of sound waves including interferences, the Doppler effect, and standing waves. <i>Examples: the relationship between amplitude and wave energy, the relationship between frequency and pitch</i></p>	<p>Energy and Matter</p>
	<p>c. Obtain, evaluate, and communicate information to explain the properties and behavior of electromagnetic waves.</p>	