

## Course/Grade Level: Physics Curriculum (11th Grade)

### PHY.1 Unifying Concepts: The following three items are incorporated within each individual unit as applicable.

Students will...

PHY.1.1 ▲ understand technology is the application of scientific knowledge for functional purposes. (HS.5.1.1)

Additional Specificity:

- a. Technology is driven by the need to meet human needs and solve human problems.
- b. Engineering is the practical application of science to commerce or industry.
- c. Medicine is a practical application of science to human health.
- d. All technological advances contain a potential for both gains and risks for society.

PHY.1.2 ▲ understand natural resources from the lithosphere and ecosystems are required to sustain human populations. (HS.6.3.1)

Additional Specificity:

- a. These processes of ecosystems include maintenance of the atmosphere, generation of soils, control of the hydrologic cycle, and recycling of nutrients. Humans are altering many of these processes, and the change may be detrimental, beneficial, or both to ecosystem function.
- b. Natural systems can reuse waste, but this capacity is limited. Recycling and environmentally sound decisions improve the quality of human life.

PHY.1.3 develop an understanding that science is a human endeavor that uses models to describe and explain the physical universe. (HS.7.1)

PHY.1.4 develop an understanding of the nature of scientific knowledge. (HS.7.2)

PHY.1.5 understand science from historical perspectives. (HS.7.3)

**PHY.2 Students will use the process of scientific inquiry with the addition of proportional reasoning.**  
Students will...

PHY.2.1 ▲ actively engage in investigations, including developing questions, gathering and analyzing data, and designing and conducting research. (HS.1.1.2)

Additional Specificity: conduct scientific investigations including, when appropriate:

- a. Formulating a testable hypothesis.
- b. Identifying and testing variables (independent, dependent, and variables to be kept constant).
- c. Using methods for gathering data that is observable, measurable, and replicable.
- d. Analyzing and evaluating the results in order to clarify the questions and hypotheses, and to refine methods for further research. The results of which will lead to identifying the type of relationship among the variables (including direct, inverse, square, square root relationships) and translate these into formulas by calculating constants.

PHY.2.2 ▲ actively engage in using technological tools and mathematics in their own scientific investigations. (HS.1.1.3)

Additional Specificity:

- a. Use a variety of technologies, such as hand tools, measuring instruments, calculators, and computers as an integral component of scientific investigations.
- b. Use common mathematical functions to analyze and describe data. These would include the use of scientific notation, the SI units of measure, and proper rounding techniques for the recording of data.
- c. Use statistical and graphing data analysis techniques.
- d. Recognize that the accuracy and precision of the data, and therefore the quality of the investigation, depends on the instruments used.
- e. Use equipment properly and safely.

**PHY.3 ▲ Students will understand Newton's Laws and the variables of time, position, velocity, and acceleration can be used to describe the position and motion of particles. (HS.2B.1.1)**

Students will...

PHY.3.1 identify that the kinematic (motion) variables: position, velocity, and acceleration can most concisely be described as vectors.

PHY.3.2 recognize that velocity describes how position changes and acceleration describes how velocity changes.

PHY.3.3 develop from the definitions of velocity and acceleration, equations that relate the kinematic variables.

PHY. 3.4 appreciate that acceleration occurs when there is either a change in speed or a change in directions.

Additional Specificity:

- a. In the case of uniform circular motion, the acceleration points towards the center of the circle.
- b. The magnitude of this acceleration is a constant, and is related to the speed of the object and the results of the circle.

PHY.3.5 recognize that in the absence of a net force, an object's velocity will not change, which includes Newton's first law as related to the objects inertia.

PHY.3.6 recognize that in the presence of a net force, an object will experience an acceleration which is modeled mathematically by Newton's second law.

PHY.3.7 recognize that the force that one object exerts on a second object has the same magnitude but opposite directions as the force that the second object exerts on the first.

**PHY.4 Students will understand physicists use conservation laws to analyze the motion of objects. (HS.2B.1.2)**

Students will...

PHY.4.1 recognize that mechanical energy is conserved when no non-conservative forces (such as friction) do work.

PHY.4.2 identify that the momentum of an object is a product of its mass and velocity. Momentum is conserved when there are no external forces on our system.

PHY.4.3 recognize that there are situations in which momentum is conserved but mechanical energy is not.

Additional Specificity: Forces internal to a system can cause a loss of mechanical energy, but only external forces can change the system's momentum. This is a result of an impulse acting on the object.

PHY.4.4 recognize that angular momentum is conserved when there is no external torques on the system.

**PHY.5 ▲ Students will understand the first law of thermodynamics states the total internal energy of a substance (the sum of all the kinetic and potential energies of its constituent molecules) will change only if heat is exchanged with the environment or work is done on or by the substance. In any physical interaction, the total energy in the universe is conserved. (HS.2B.2.2)**  
Students will...

PHY.5.1 recognize that there are different manifestations of energy.

Additional Specificity:

- a. Kinetic energy is the energy an object possesses due to its motion.
- b. Gravitational potential energy is the energy due to the separation of masses.
- c. Electric potential energy is the energy due to the separation of charges.
- d. Kinetic and potential energy combined are known as mechanical energy.

PHY.5.2 recognize that heat is an exchange of internal (kinetic and/or potential) energy between systems due to a temperature difference.

Additional Specificity:

- a. Heat flows spontaneously from hot objects to cooler ones.
- b. It does not flow spontaneously in the other direction.
- c. Heat can be made to flow from cooler objects to warmer ones if one does work.
- d. A heat engine can convert heat to work, but some heat will always be lost in the process.
- e. Examples of heat transport include radiation from the sun, convection of hydrosphere/atmosphere/mantle, and conduction between water/land/air.

PHY.5.3 recognize that a force that has a component parallel to the direction of motion of an object is said to do work on that object.

Additional Specificity:

- a. The work done on an object may be positive or negative.
- b. When positive work is done on an object, it increases the object's energy.
- c. Negative work decreases it.

PHY.5.4 recognize that there is a relationship between energy and power.

Additional Specificity: Power is the rate at which work is done, or the rate at which the energy of some system changes.

**PHY.6 Students will appreciate the use of elementary concepts involving the states of matter with reference to the laws and principals that apply.**  
Students will...

- PHY.6.1 appreciate the relationship among density and pressure as it applies to solids, liquids, and gases and identify factors that can cause changes in these.
- PHY.6.2 relate Archimedes' Principle, Flotation Principle, Pascal's Principle, Hooke's Law, Bernoulli's Principle, Boyle's Law, Charles' Law, and Combined Gas Law to the properties of solids, liquids, and gases.
- PHY.6.3 recognize the relationship between area and volume to strength and weight of a material and the affect of changing the scale of a solid structure.

**PHY.7 ▲ Students will understand waves have energy and can transfer energy when they interact with matter. (HS.2B.3.2)**  
Students will...

- PHY.7.1 recognize that waves are traveling disturbances which transport energy without the bulk motion of matter.

Additional Specificity:

- a. In transverse waves, the disturbance is perpendicular to the direction of travel.
- b. In longitudinal waves, the disturbance is parallel to the direction of travel.

- PHY.7.2 recognize that there are many different types of waves.

Additional Specificity:

- a. Examples are water waves, sound waves, and electromagnetic waves.
- b. Visible light, radio waves, and X-rays are all examples of electromagnetic waves.
- c. Periodic waves can also be described in terms of their wavelength, frequency, period, and amplitude.

- PHY.7.3 conclude that all waves can be described in terms of their velocities.

Additional Specificity:

- a. The velocity of most types of waves depends on the medium in which they are traveling.
- b. There is a relationship between the speed, wavelength, and frequency of a periodic wave.
- c. The frequency of sound waves is related to the pitch we perceive.
- d. Different wavelengths of visible light correspond to different colors.

**PHY.8 Students will understand interference - how waves interact with other waves. (HS.2B.3.3)**  
Students will...

PHY.8.1 identify that most common types of waves obey the principle of linear superposition.

Additional Specificity:

- a. When two waves meet, they superimpose.
- b. At points where the crests (or troughs) of two waves meet there is constructive interference.
- c. At points where the crest of one wave meets the **through** of another, there is destructive interference.
- d. Beats are heard when two sound waves with slightly different frequencies interfere.
- e. Two waves traveling in opposite directions can combine to produce a standing wave.

PHY.8.2 recognize that diffraction is the bending of a wave around an obstacle or an edge. When this happens, different intensities of the wave are observed downstream due to the wave interfering with itself.

**PHY.9 Students will understand the principles of reflection and refraction. (HS.2B.3.4)**  
Students will...

**NO COMPONENTS LISTED**

Additional Specificity:

- a. Conclude that when light reflects from a surface; the angle of incidence is equal to the angle of reflection.
- b. When light propagates from one transparent medium to another, it bends (refracts) at the interface in a manner given by Snell's law.
- c. One can trace rays to predict the properties of images produced by mirrors.
- d. One can trace rays to predict the properties of images produced by lenses.

**PHY.10 ▲ Students will understand electromagnetic waves result when a charged particle is accelerated or decelerated. (HS.2B.3.5)**  
Students will...

PHY.10.1 identify that electromagnetic waves include radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays. The energy of electromagnetic waves is carried into packets and had a magnitude that is inversely proportional to the wavelength.

PHY.10.2 recognize that some particles, such as protons and electrons, have physical property known as charge. There are two types of charge, known as positive and negative.

PHY.10.3 recognize that charged particles experience a force given by Coulomb's law.

Additional Specificity:

- a. Coulomb's law indicates that the electric force between two charges is attractive if the charges have opposite sign, and repulsive if they have the same sign.
- b. The force between charges is inversely proportional to the square of the distance between them.

PHY.10.4 conclude that the magnitude of the magnetic force on a particle in a magnetic field is proportional to the particle's charge and speed, and to the magnitude of the magnetic field.

Additional Specificity:

- a. The direction of the force is perpendicular to both the particle's velocity and the magnetic field.
- b. If the particle's velocity is parallel to the magnetic field, the force vanishes.

**PHY.11 Students will understand basic electrostatics and circuits. (HS.2B.3.6)**  
Students will...

PHY.11.1 recognize that there is a potential energy associated with the electric force.

Additional Specificity:

- a. This is the most common dealt with in the related quantity electric potential.
- b. The electric potential energy of a particle is its charge times the electric potential at the particle's location.

PHY.11.2 conclude that knowledge of electric force and potential allows for the analysis of simple DC circuits.

Additional Specificity:

- a. Batteries increase the electric potential energy of electrons. Although it is electrons that flow in a circuit, we analyze circuits as if positive charges are flowing in the other direction.
- b. Current is the rate at which charges are flowing in a circuit.
- c. The electric potential in a conductor has the same value every where in that conductor.
- d. Positive charges flowing through a resistor experience a drop in electric potential given by Ohm's law.
- e. Charges flowing through a resistor lose energy at a rate that depends on the current and on the resistance of the resistor.
- f. The resistance of resistors in series or in parallel can be computed, given the resistance of each individual resistor.