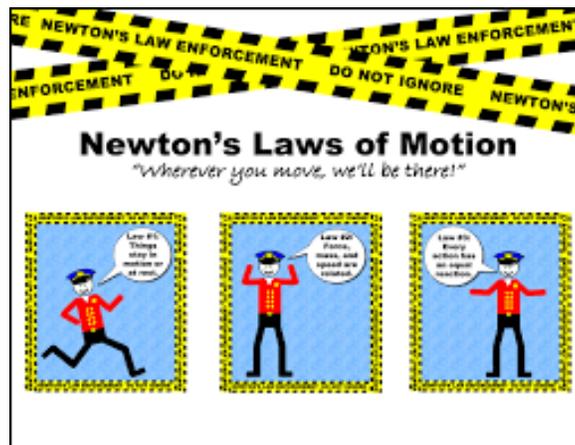


Physics Curriculum Guide for High School SDP Science Teachers



Please note: Pennsylvania & Next Generation Science Standards as well as Instructional Resources are found on the SDP Curriculum Engine

Physics: Term 1 Unit 1

Topic: Scientific Processes

Duration: 10 Days

Eligible Content

S11.A.1.1.1 Compare and contrast scientific theories, scientific laws, and beliefs

S11.A.1.1.2 Analyze and explain the accuracy of scientific facts, principles, theories, and laws.

S11.A.1.1.3 Evaluate the appropriateness of research questions

S11.A.1.1.4 Explain how specific scientific knowledge or technological design concepts solve practical problems

S11.A.1.1.5 Analyze or compare the use of both direct and indirect observation as means to study the world and the universe

S11.A.2.2.1 Evaluate appropriate methods, instruments, and scale for precise quantitative and qualitative observations

Performance Objectives

SWBAT: *These are examples, created by SDP teachers, of how you may translate the eligible content into learning goals for your classroom.*

- **SWBAT** carry out experimental procedures **IOT** use scientific equipment correctly, make measurements, evaluate their uncertainty and display data.
- **SWBAT** analyze problems **IOT** discuss methods used by scientists to identify and solve them.
- **SWBAT** make estimates **IOT** develop familiarity with relative sizes, relative precision and orders of magnitude.
- **SWBAT** graph data sets and find lines of best fit and areas under curves **IOT** understand relationships between variables.

Key Terms and Definitions

1. **Observation** - The process by which scientists learn about their world. Includes looking, noticing and measuring, as well as designing and carrying out experiments and creatively reevaluating previous observations
2. **Qualitative Observation** - An observation that is expressed in terms of a verbal description
3. **Quantitative Observation** - An observation that is expressed numerically
4. **Theory** - a testable explanation for a set of observations

5. **Law** - a concise quantitative statement or equation that proves valid for a wide variety of phenomena
6. **Measurement** - the process of making a quantitative observation for the purpose of comparison
7. **Uncertainty** - A quantitative expression of how imperfect a measurement is
8. **Precision** - The repeatability of a measurement given a particular instrument. Higher precision means more significant figures.
9. **Accuracy** - How close a measurement is to the true, correct value

Physics: Term 1 Unit 2

Topic: Linear Model

Duration: 20 Days

Eligible Content

S11.C.3.1.2 Design or evaluate simple technological or natural systems that incorporate the principles of force and motion (e.g., simple machines, compound machines).

S11.C.3.1.3 Describe the motion of an object using variables (i.e., acceleration, velocity, displacement).

Performance Objectives

SWBAT: *These are examples, created by SDP teachers, of how you may translate the eligible content into learning goals for your classroom.*

- **SWBAT** collect and analyze data **IoT** analyze, calculate and represent the motion of objects.
- **SWBAT** observe and investigate physical systems **IoT** distinguish the components of motion.
- **SWBAT** construct and analyze graphs **IoT** compare and contrast different types of motion.
- **SWBAT** investigate kinematics equations and quantities **IoT** solve a variety of accelerated motion problems.

Key Terms and Definitions

1. **Kinematics** - the description of how objects move
2. **Reference Frame** - the specified point of view (and the associated biases) from which an observation is made
3. **Time** - what a clock measures. Measured in seconds [s]
4. **Distance** - a scalar quantity representing the amount of space between two locations. Measured in meters [m]

5. **Displacement** - a vector quantity specifying the change in position of an object. Requires a direction to be specified. Measured in meters [m]
6. **Speed** - distance divided by time. a scalar quantity measured in meters per second [m/s]
7. **Velocity** - the vector version of speed. defined as time rate change of displacement (change in displacement divided by change in time) - measured in meters per second [m/s]
8. **Acceleration** - the time rate change of velocity (change in velocity divided by change in time) - measured in meters per second squared [m/s/s]

Physics: Term 1 Unit 3

Topic: Vectors and Two-Dimensional Motion

Duration: 20 Days

Eligible Content

S11.C.3.1.2 Design or evaluate simple technological or natural systems that incorporate the principles of force and motion (e.g., simple machines, compound machines).

S11.C.3.1.3 Describe the motion of an object using variables (i.e., acceleration, velocity, displacement).

Performance Objectives

SWBAT: *These are examples, created by SDP teachers, of how you may translate the eligible content into learning goals for your classroom.*

- **SWBAT** perform vector addition **IOT** combine quantities that point in different directions
- **SWBAT** represent 2D motion as separate instances of 1D motion **IOT** simplify and solve problems
- **SWBAT** design and conduct investigations **IOT** measure kinematic quantities and predict motion
- **SWBAT** analyze physical situations and equations **IOT** solve problems using kinematics in two dimensions

Key Terms and Definitions

1. **Scalar** - A quantity defined by only a magnitude (or number)
2. **Vector** - A quantity defined by a magnitude and a direction
3. **Component Vector** - The piece of a vector that points along the x or y axis
4. **Resultant Vector** - The sum of two or more other vectors
5. **Projectile Motion** - The two-dimensional motion of an object accelerated only by gravity near the Earth's surface.

Physics: Term 2 Unit 4

Topic: Newton's Law

Duration: Approximately 17 Days

Eligible Content

S11.C.3.1.2 Design or evaluate simple technological or natural systems that incorporate the principles of force and motion (e.g., simple machines, compound machines).

S11.C.3.1.3 Describe the motion of an object using variables (i.e., acceleration, velocity, displacement).

Performance Objectives

SWBAT: *These are examples, created by SDP teachers, of how you may translate the eligible content into learning goals for your classroom.*

- **SWBAT** understand Newton's Laws of Motion **IOT** qualitatively describe situations involving forces.
- **SWBAT** analyze free body diagrams and use vector addition **IOT** determine the net force on an object.
- **SWBAT** design and conduct investigations **IOT** analyze and calculate forces such as friction and gravity.
- **SWBAT** analyze physical situations and equations **IOT** solve problems using net force, mass and acceleration.

Key Terms and Definitions

1. **Force** - A push or pull on an object - measured in Newtons [N]
2. **Inertia** - an object's resistance to changes in its motion
3. **Mass** - the measure of the inertia of an object - measured in kilograms [kg]
4. **Weight** - The force of gravity on an object
5. **Gravity** - An attractive force between two massive bodies
6. **Friction** - A force that acts to resist sliding between two surfaces. Can be kinetic (if the objects move relative to one another) or static (if the objects are at rest relative to one another).
7. **Net Force** - The vector sum of all the forces acting on an object
8. **Normal Force** - The force exerted on an object perpendicular to a surface it is in contact with
9. **Free-Body Diagram** - a diagram used to depict the relative magnitudes and directions of the forces acting on a single object

Physics: Term 2 Unit 5

Topic: Linear Momentum

Duration: Approximately 13 Days

Eligible Content

S11.C.3.1.1 Explain common phenomena (e.g., a rock in a landslide, an astronaut during a space walk, a car hitting a patch of ice on the road) using an understanding of conservation of momentum.

S11.C.3.1.2 Design or evaluate simple technological or natural systems that incorporate the principles of force and motion (e.g., simple machines, compound machines).

S11.C.3.1.3 Describe the motion of an object using variables (i.e., acceleration, velocity, displacement).

Performance Objectives

SWBAT: *These are examples, created by SDP teachers, of how you may translate the eligible content into learning goals for your classroom.*

- **SWBAT** design and conduct investigations **IOT** examine momentum transfers within a system
- **SWBAT** quantify momentum transfers within a system **IOT** predict motion and solve problems
- **SWBAT** analyze data from collisions **IOT** differentiate between elastic and inelastic collisions
- **SWBAT** apply the concept of impulse **IOT** qualitatively explain phenomena

Key Terms and Definitions

1. **Isolated System** – A system where the net external force on it is zero.
2. **Momentum** – The product of an object's mass and its velocity. Measured in kilogram-meters per second [kg m/s].
3. **Impulse** – The product of a force and the time interval for which it acts. The impulse on an object is equal to the object's change in momentum.
4. **Collision** – A situation where two or more objects interact with (typically) large forces over (typically) small time intervals.
5. **Elastic Collision** – A collision where both momentum and kinetic energy is conserved.
6. **Inelastic Collision** – A collision where kinetic energy is not conserved. Note that momentum and total energy will still always be conserved.

Physics: Term 2 Unit 6

Topic: Work and Energy

Duration: Approximately 15 Days

Eligible Content

S11.C.2.1.3 Apply the knowledge of conservation of energy to explain common systems (e.g., refrigeration, rocket propulsion, heat pump).

S11.C.3.1.2 Design or evaluate simple technological or natural systems that incorporate the principles of force and motion (e.g., simple machines, compound machines).

S11.C.3.1.3 Describe the motion of an object using variables (i.e., acceleration, velocity, displacement).

Performance Objectives

SWBAT: *These are examples, created by SDP teachers, of how you may translate the eligible content into learning goals for your classroom.*

- **SWBAT** determine the work done on an object and its change in energy **IOT** deduce and verify that energy is conserved
- **SWBAT** keep track of energy transformations within a system **IOT** predict motion and solve problems
- **SWBAT** design and conduct investigations **IOT** examine energy transfers within a system
- **SWBAT** apply the principles of conservation of energy **IOT** engineer a solution to real world problems

Key Terms and Definitions

1. **Work** – Occurs when a force changes the motion of an object. The amount of work done is the product of the parallel component of that force and the resulting displacement. Measured in Joules [J], where $[J] = [N\ m]$
2. **Energy** – The ability to do work. Measured in Joules [J].
3. **Kinetic Energy** – The energy associated with an object in motion. Measured in Joules [J].
4. **Potential Energy** – The energy associated with forces that depend on the position or configuration of objects relative to their surroundings. Measured in Joules [J].
5. **Gravitational Potential Energy** – Potential energy associated with an object's position in a gravitational field. Measured in Joules [J].
6. **Elastic Potential Energy** – Potential energy associated with the stretching or compression of a spring. Measured in Joules [J].

7. **Conservative Force** – A force where the work done is independent of the path taken and only depends on the initial and final positions (such as the gravitational force). Potential energies can only be defined for conservative forces.
8. **Nonconservative Force** – A force where the work done depends on the path taken (such as friction). Potential energies cannot be defined for nonconservative forces.
9. **Power** – The time rate at which work is done. Measured in Watts [W], where [W] = [J/s].
10. **Efficiency** - A ratio of the work or energy output of a system to the work or energy input.

Physics: Term 3 Unit 7

Topic: Circular Motion

Duration: Approximately 14 Days

Eligible Content

S11.C.3.1.2 Design or evaluate simple technological or natural systems that incorporate the principles of force and motion (e.g., simple machines, compound machines).

S11.C.3.1.3 Describe the motion of an object using variables (i.e., acceleration, velocity, displacement).

Performance Objectives

SWBAT: *These are examples, created by SDP teachers, of how you may translate the eligible content into learning goals for your classroom.*

- **SWBAT** make measurements **IOT** verify an object is undergoing uniform circular motion.
- **SWBAT** apply their understanding of uniform circular motion **IOT** make engineering design choices.
- **SWBAT** apply their understanding of uniform circular motion **IOT** understand non-uniform motion along a curved path.

Key Terms and Definitions

1. **Uniform Circular Motion** – Motion along a circular path with constant tangential speed.
2. **Tangential Velocity** – The component of an object's velocity that is tangent to its path.
3. **Centripetal Acceleration** – The acceleration that points toward the center of a circular path that constantly changes the direction of the tangential velocity.
4. **Period** – The time it takes for an object to finish one complete cycle.
5. **Frequency** – The rate at which an object completes cycles. Measured in Hertz, where [1 Hz] = [1 s⁻¹]

Physics: Term 3 Unit 8

Topic: Gravitation

Duration: Approximately 14 Days

Eligible Content

S11.C.3.1.2 Design or evaluate simple technological or natural systems that incorporate the principles of force and motion (e.g., simple machines, compound machines).

S11.C.3.1.3 Describe the motion of an object using variables (i.e., acceleration, velocity, displacement).

Performance Objectives

SWBAT: *These are examples, created by SDP teachers, of how you may translate the eligible content into learning goals for your classroom.*

- **SWBAT** calculate the gravitational force between bodies **IOT** reconcile observations
- **SWBAT** use the gravitational force and circular motion **IOT** approximate planetary motion
- **SWBAT** use observations of orbital motion **IOT** verify Kepler's Laws.
- **SWBAT** apply understanding of size and speeds in space **IOT** discuss the feasibility of interplanetary and interstellar missions.

Key Terms and Definitions

1. **Period** – The time it takes for an object to finish one complete cycle.
2. **Frequency** – The rate at which an object completes cycles. Measured in Hertz, where $[1 \text{ Hz}] = [1 \text{ s}^{-1}]$
3. **Gravity** – An attractive force between all massive bodies
4. **Ellipse** - an ellipse is a curve in a plane surrounding two focal points such that the sum of the distances to the two focal points is constant for every point on the curve
5. **Semi-Major Axis** - The semi-major axis is one half of the major axis, and thus runs from the centre, through a focus, and to the perimeter

Physics: Term 3 Unit 9

Topic: Rotational Motion

Duration: Approximately 18 Days

Eligible Content

S11.C.3.1.2 Design or evaluate simple technological or natural systems that incorporate the principles of force and motion (e.g., simple machines, compound machines).

S11.C.3.1.3 Describe the motion of an object using variables (i.e., acceleration, velocity, displacement).

Performance Objectives

SWBAT: *These are examples, created by SDP teachers, of how you may translate the eligible content into learning goals for your classroom.*

- **SWBAT** use rotational kinematics and torque **IOT** describe rotational motion quantitatively and solve problems.
- **SWBAT** apply the principles of net force and net torque **IOT** engineer structures in equilibrium.
- **SWBAT** keep track of energy transformations within a system **IOT** predict motion and solve problems.
- **SWBAT** apply the principles of conservation of angular momentum **IOT** explain observations.

Key Terms and Definitions

1. **Axis of Rotation** – The imaginary line that objects rotate around
2. **Radian** – A unit of angular measure. One radian is the angle subtended by an arc whose length is equal to its radius. 2π radians are equal to 360° .
3. **Angular Displacement** – The angle subtended by an arc drawn from an object's initial position to its final position. Analogous to displacement in kinematics. Typically measured in radians.
4. **Angular Velocity** – The time rate of change of angular position. Analogous to translational velocity. Measured in radians per second.
5. **Angular Acceleration** – The time rate of change of angular velocity. Analogous to translational acceleration. Measured in radians per second.
6. **Torque** – The product of an applied force times the lever arm. Analogous to force. Measured in $\text{N}\cdot\text{m}$.
7. **Lever Arm** – The distance between a force's point of application and the axis of rotation.
8. **Moment of Inertia** – An object's resistance to changes in rotational motion. Depends on the mass of the object and how that mass is distributed around the axis of rotation. Analogous to mass. Measured in $\text{kg}\cdot\text{m}^2$
9. **Rotational Kinetic Energy** – The kinetic energy associated with rotation. Objects can have both rotational and translation kinetic energy and its total kinetic energy is the sum of both. Measured in Joules.

10. **Angular Momentum** – The product of an object’s moment of inertia and angular velocity. Also equal to the cross product of an object’s translational velocity and its distance from the axis of rotation. Angular momentum is a conserved quantity. Analogous to linear momentum. Measured in $\text{kg}\cdot\text{m}^2/\text{s}$.

Physics: Term 4 Unit 10

Topic: Simple Harmonic Motion

Duration: 10 Days

Eligible Content

S11.C.3.1.2 Design or evaluate simple technological or natural systems that incorporate the principles of force and motion (e.g., simple machines, compound machines).

S11.C.3.1.3 Describe the motion of an object using variables (i.e., acceleration, velocity, displacement).

Performance Objectives

SWBAT: *These are examples, created by SDP teachers, of how you may translate the eligible content into learning goals for your classroom.*

- **SWBAT** make measurements **IOT** verify an object is undergoing simple harmonic motion.
- **SWBAT** apply their understanding of simple harmonic motion **IOT** make engineering design choices.
- **SWBAT** apply their understanding of conservation of energy **IOT** understand simple harmonic motion.
- **SWBAT** draw position, velocity and acceleration graphs **IOT** analyze simple harmonic motion.

Key Terms and Definitions

1. **Simple Harmonic Motion** – periodic motion where the restoring force is proportional to the displacement of the oscillator
2. **Amplitude** – the maximum displacement of an oscillator
3. **Period** – The time it takes for an object to finish one complete cycle.
4. **Frequency** – The rate at which an object completes cycles. Measured in Hertz, where $[1 \text{ Hz}] = [1 \text{ s}^{-1}]$
5. **Resonance** - a phenomenon where an applied force to an oscillator matches the natural frequency of the oscillator, resulting in oscillations of increasing amplitude

Physics: Term 4 Unit 11

Topic: Waves and Sound

Duration: 15 Days

Eligible Content

S11.A.3.3.3 Analyze physical patterns of motion to make predictions or draw conclusions (e.g., solar system, tectonic plates, weather systems, atomic motion, waves).

Performance Objectives

SWBAT: *These are examples, created by SDP teachers, of how you may translate the eligible content into learning goals for your classroom.*

- **SWBAT** apply their understanding of conservation of energy **IOT** describe transmission of energy in a wave.
- **SWBAT** apply their understanding of waves, interference and the Doppler Effect **IOT** explain and understand wave phenomena.
- **SWBAT** apply their understanding of sound **IOT** make engineering design choices.

Key Terms and Definitions

1. **Wavelength** – the distance between two successive crests on a wave
2. **Amplitude** – the maximum height of a crest on a wave
3. **Period** – the time delay between crests on a wave
4. **Frequency** – the number of wavelengths (or crests) that pass a reference point per unit time
5. **Wave velocity** – how fast a crest moves through space
6. **Transverse Wave** – a wave where the oscillations are perpendicular to the direction the wave travels
7. **Longitudinal Wave** – a wave where the oscillations are parallel to the direction the wave travels
8. **Intensity** – the energy per unit time carried across a unit area of a wave. Measured in W/m^2
9. **Interference** – a phenomenon where two waves in the same region of space combine to have either a higher or lower resultant displacement
10. **Standing Wave** – an interference phenomenon where reflected waves interfere with generated waves, giving the appearance of a wave that is standing still
11. **Pitch** – the frequency of a sound wave. The higher the frequency, the higher the pitch.
12. **Loudness** – the intensity of a sound wave.
13. **Sound Level** – a logarithmic scale used to measure loudness, measured in decibels.
14. **Doppler Effect** – a shift in perceived frequency due to relative motion between a wave source and an observer

