

# Physics

Adopted 2016

Obtain, evaluate, and communicate information about the relationship between distance, displacement, speed, velocity, and acceleration as functions of time. **SP1**

- a. Plan and carry out an investigation of one-dimensional motion to calculate average and instantaneous speed and velocity.
  - Analyze one-dimensional problems involving changes of direction, using algebraic signs to represent vector direction.
  - Apply one-dimensional kinematic equations to situations with no acceleration, and positive, or negative constant acceleration.**SP1.A**

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- b. Analyze and interpret data using created or obtained motion graphs to illustrate the relationships among position, velocity, and acceleration, as functions of time. **SP1.B**

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- c. Ask questions to compare and contrast scalar and vector quantities. **SP1.C**

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- d. Analyze and interpret data of two-dimensional motion with constant acceleration.
  - Resolve position, velocity, or acceleration vectors into components (x and y, horizontal and vertical).
  - Add vectors graphically and mathematically by adding components.
  - Interpret problems to show that objects moving in two dimensions have independent motions along each coordinate axis.
  - Design an experiment to investigate the projectile motion of an object by collecting and analyzing data using kinematic equations.
  - Predict and describe how changes to initial conditions affect the resulting motion.
  - Calculate range and time in the air for a horizontally launched projectile.
  - Predict and describe how changes to initial conditions affect the resulting motion.
  - Calculate range and time in the air for a horizontally launched projectile.**SP1.D**

Obtain, evaluate, and communicate information about how forces affect the motion of objects. **SP2**

- a. Construct an explanation based on evidence using Newton's Laws of how forces affect the acceleration of a body.
  - Explain and predict the motion of a body in absence of a force and when forces are applied using Newton's 1st Law (principle of inertia).
  - Calculate the acceleration for an object using Newton's 2nd Law, including situations where multiple forces act together.
  - Identify the pair of equal and opposite forces between two interacting bodies and relate their magnitudes and directions using Newton's 3rd Law.**SP2.A**

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- b. Develop and use a model of a Free Body Diagram to represent the forces acting on an object (both equilibrium and non-equilibrium). **SP2.B**

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- c. Use mathematical representations to calculate magnitudes and vector components for typical forces including gravitational force, normal force, friction forces, tension forces, and spring forces. SP2.C
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- d. Plan and carry out an investigation to gather evidence to identify the force or force component responsible for causing an object to move along a circular path.
    - Calculate the magnitude of a centripetal acceleration. SP2.D
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- e. Develop and use a model to describe the mathematical relationship between mass, distance, and force as expressed by Newton's Universal Law of Gravitation. SP2.E
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Obtain, evaluate, and communicate information about the importance of conservation laws for mechanical energy and linear momentum in predicting the behavior of physical systems. SP3

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- a. Ask questions to compare and contrast open and closed systems. SP3.A
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- b. Use mathematics and computational thinking to analyze, evaluate, and apply the principle of conservation of energy and the Work-Kinetic Energy Theorem.
    - Calculate the kinetic energy of an object.
    - Calculate the amount of work performed by a force on an object. SP3.B
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- c. Plan and carry out an investigation demonstrating conservation and rate of transfer of energy (power) to solve problems involving closed systems. SP3.C
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- d. Construct an argument supported by evidence of the use of the principle of conservation of momentum to
    - explain how the brief application of a force creates an impulse.
    - describe and perform calculations involving one dimensional momentum.
    - connect the concepts of Newton's 3rd law and impulse.
    - experimentally compare and contrast inelastic and elastic collisions. SP3.D
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Obtain, evaluate, and communicate information about the properties and applications of waves. SP4

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- a. Develop and use mathematical models to explain mechanical and electromagnetic waves as a propagating disturbance that transfers energy. SP4.A
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- b. Develop and use models to describe and calculate characteristics related to the interference and diffraction of waves (single and double slits). SP4.B
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- c. Construct an argument that analyzes the production and characteristics of sound waves. SP4.C
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- d. Plan and carry out investigations to characterize the properties and behavior of electromagnetic waves. SP4.D
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- e. Plan and carry out investigations to describe common features of light in terms of color, polarization, spectral composition, and wave speed in transparent media.
    - Analyze experimentally and mathematically aspects of reflection and refraction of light waves and describe the results using optical ray diagrams.
    - Perform calculations related to reflections from plane surfaces and focusing using thin lenses. SP4.E
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**f. Plan and carry out investigations to identify the behavior of light using lenses. SP4.F**

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**g. Plan and carry out investigations to describe changes in diffraction patterns associated with geometry and wavelength for mechanical and electromagnetic waves. SP4.G**

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**Obtain, evaluate, and communicate information about electrical and magnetic force interactions. SP5**

**a. Develop and use mathematical models and generate diagrams to compare and contrast the electric and gravitational forces between two charged objects. SP5.A**

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**b. Plan and carry out investigations to demonstrate and qualitatively explain charge transfer by conduction, friction, and induction. SP5.B**

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**c. Construct an explanation based on evidence of the behavior of charges in terms of electric potential energy. SP5.C**

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**d. Plan and carry out an investigation of the relationship between voltage, current, and power for direct current circuits. SP5.D**

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**e. Plan and carry out investigations to clarify the relationship between electric currents and magnetic fields. SP5.E**

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**Obtain, evaluate, and communicate information about nuclear changes of matter and related technological applications. SP6**

**a. Develop and use models to explain, compare, and contrast nuclear processes including radioactive decay, fission, and fusion. SP6.A**

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**b. Construct an argument to compare and contrast mechanisms and characteristics of radioactive decay. SP6.B**

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**c. Develop and use mathematical models and representations to calculate the amount of substance present after a given amount of time based on its half-life and relate this to the law of conservation of mass and energy. SP6.C**