

Proficiency Level Descriptors – Physics

Policy

Students who are designated Below Proficient (Level 1) will be able to perform up to the level described by the Proficiency Level Descriptor (PLD). Level 1 is the lowest reported proficiency designation; some student may perform below the provided description.

- Below Proficient – The Level 1 Student is below proficient in applying the science knowledge/skills as specified in the Utah Core State Standards. The Student generally performs significantly below the standard for his or her grade level, is likely able to partially access grade-level content and engage with higher-order thinking skills with extensive support.
- Approaching Proficient – The Level 2 Student is approaching proficient in applying the science knowledge/skills as specified in the Utah Core State Standards. The Student generally performs slightly below the standard for his or her grade level, is likely able to access grade-level content and engage in higher-order thinking skills with some independence and support.
- Proficient - The Level 3 Student is proficient in applying the science knowledge/skills as specified in the Utah Core State Standards. The Student generally performs at the standard for his or her grade level, is able to access grade level content, and engage in higher order thinking skills with some independence and minimal support.
- Highly Proficient - The Level 4 Student is highly proficient in applying the science knowledge/skills as specified in the Utah Core State Standards. The Student generally performs significantly above the standard for his or her grade level, is able to access above grade level content, and engage in higher order thinking skills independently.

Motion and Newton's First Law

Objective I.1 – Describe the motion of an object in terms of position, time, and velocity.

- Below Proficient – The Level 1 Student - Describes and calculates distance and speed. Compares magnitude of average and instantaneous velocity given explicit values. Compares velocities from position vs. time graphs for objects with constant velocity.
- Approaching Proficient – The Level 2 Student - Describes and calculates the magnitude of displacement and velocity. Creates a

position vs. time graph for an object with constant velocity and identifies position at different times.

- Proficient – The Level 3 Student - Distinguishes between distance vs. displacement and speed vs. velocity. Describes and calculates the magnitude and direction of displacement and velocity. Determines and compares average and instantaneous velocities using position vs. time graphs. Creates a position vs. time graph for an object with non-constant velocity using experimental data. Interprets motion of an object from a position vs. time graph.
- Highly Proficient – The Level 4 Student - Calculates velocity from data, complex graphs, and charts. Infers from data the average and instantaneous velocity for any time interval. Collects and analyzes data graphically or mathematically.

Objective I.2 – Analyze the motion of an object in terms of velocity, time, and acceleration.

- Below Proficient – The Level 1 Student – Calculates acceleration given explicit data. Recognizes that an object at rest has zero acceleration. Recognizes that an increase of positive velocity is positive acceleration.
- Approaching Proficient – The Level 2 Student – Recognizes that an object with constant velocity has zero acceleration. Creates a velocity vs. time graph for an object with constant acceleration and identifies velocity at different times. Recognizes that a change in direction results in a nonzero acceleration.
- Proficient – The Level 3 Student – Calculates average acceleration from data. Describes the conditions at which acceleration is zero. Creates a velocity vs. time graph for an object with non-constant acceleration using experimental data. Interprets the motion of the object from a velocity vs. time graph. Describes that circular motion or any change in direction results in a nonzero acceleration.
- Highly Proficient – The Level 4 Student – Calculates average acceleration from self-generated data. Infers the motion of real world objects when the object is either accelerating or not. Collects data and analyzes it graphically or mathematically.

Objective I.3 - Relate the motion of objects to a frame of reference.

- Below Proficient – The Level 1 Student – Relates the motion of an object to the student's own frame of reference.
- Approaching Proficient – The Level 2 Student – Recognizes that the motion of an object would seem different in a different frame of reference.

- Proficient – The Level 3 Student – Compares and predicts the motion of an object relative to two frames of reference and chooses an appropriate frame of reference to describe an object's motion.
- Highly Proficient – The Level 4 Student - Compares and predicts the two-dimensional motion of an object from multiple frames of reference and recognizes the relationship between various frames of reference.

Objective I.4 - Use Newton's first law to explain the motion of an object.

- Below Proficient – The Level 1 Student – Identifies balanced forces in a diagram.
- Approaching Proficient – The Level 2 Student – Identifies the balanced forces in a diagram and recognizes that the object may be at rest.
- Proficient – The Level 3 Student – Describes and states the direction of balanced forces. Recognizes that an object experiencing balanced forces may be at rest or moving with a constant velocity.
- Highly Proficient – The Level 4 Student - Describes and states the direction of the balanced forces and describes the motion of an object in real world or abstract situations.

Forces and Newton's Second and Third Laws

Objective II.1 – Analyze forces acting on an object.

- Below Proficient – The Level 1 Student – Describes and observes some forces given a labeled vector diagram. Measures and calculates net force when given detailed instructions and group guidance.
- Approaching Proficient – The Level 2 Student – Describes, observes, and states the direction of everyday forces and labels the forces in a provided vector diagram. Uses data to calculate the net force acting on an object, provided with instructions.
- Proficient – The Level 3 Student – Describes, observes, and states the direction of everyday forces and represents the forces in a vector diagram. Measures forces and uses the data to calculate the net force acting on an object.
- Highly Proficient – The Level 4 Student – Describes, observes, and states the direction of a wide range of forces and represents the forces in a vector diagram. Designs and conducts an experiment to measure forces and uses the data to calculate the net force acting on an object.

Objective II.2 – Use Newton's second law, relate the force, mass, and acceleration of an object.

- Below Proficient – The Level 1 Student – Recognizes that changing either a force or mass can affect the acceleration. Measures force, mass, and acceleration given appropriate tools.
- Approaching Proficient – The Level 2 Student – Recognizes the relationship between net force, mass, and acceleration. Calculates the net force on an object given the mass and acceleration.
- Proficient – The Level 3 Student – Explains the relationship between net force, mass, and acceleration on an object with unbalanced forces. Calculates the net force on an object and predicts the change on the object's motion due to unbalanced forces.
- Highly Proficient – The Level 4 Student – Applies the relationship between net force, mass, and acceleration on an object with unbalanced forces to unfamiliar situations. Designs and conducts an experiment to measure net force, mass and/or acceleration and compares the results to Newton's second law.

Objective II.3 - Explain that forces act in pairs as described by Newton's third law.

- Below Proficient – The Level 1 Student – Identifies the directions of two forces in force pairs. Recognizes Newton's development of the laws of motion.
- Approaching Proficient – The Level 2 Student – Identifies magnitude and direction of contact force pairs. Realizes that Newton's laws of motion still have applications today.
- Proficient – The Level 3 Student – Identifies magnitude and direction of force pairs, including contact and long-range forces. Makes connections between Newton's laws of motion to current understanding. Distinguishes between force pairs and balanced forces.
- Highly Proficient – The Level 4 Student - Identifies magnitude and direction of force pairs with multiple sets of force pairs in a system. Makes connections between Newton's laws and modern systems.

Gravitational and Electrostatic Forces

Objective III.1 – Relate the strength of the gravitational force to the distance between two objects and the mass of the objects (i.e., Newton's law of universal gravitation).

- Below Proficient – The Level 1 Student – Recognizes that there is a connection between mass and weight. Recognizes that gravity affects everyday life.

- Approaching Proficient – The Level 2 Student – Investigates and describes qualitatively how the amount of mass and the distance between two objects affect the gravitational force. Describes common gravitational interactions on Earth.
- Proficient – The Level 3 Student – Distinguishes between mass and weight. Investigates and describes quantitatively how the amount of mass and the distance between two objects affect the gravitational force. Describes evidence and makes inferences of gravitational forces on objects in nature.
- Highly Proficient – The Level 4 Student – Creates a visual representation that shows relationships between amount of mass and distance between objects and the gravitational force between these objects. Describes modern day applications of gravitational force.

Objective III.2 - Describe the factors that affect the electric force (i.e., Coulomb's law).

- Below Proficient – The Level 1 Student – Relates the type of charge to the effect on electric force (i.e., like charges repel, unlike charges attract). Recognizes electric forces found in nature and technology.
- Approaching Proficient – The Level 2 Student – Investigates and describes qualitatively how the amount of charge, type of charge, and distance between charged objects affects the electric force. Cites evidence that electric forces occur in nature and technology.
- Proficient – The Level 3 Student – Investigates and describes quantitatively how the amount of charge, type of charge, and distance between charged objects affects the strength of the electric force. Summarizes how electric forces affect everyday life.
- Highly Proficient – The Level 4 Student – Creates a visual representation that shows relationships between amount of charge, type of charge, and distance between charged objects and the force between these objects. Makes inferences about how electric forces impact everyday life.

Energy

Objective IV.1 - Determine kinetic and potential energy in a system.

- Below Proficient – The Level 1 Student – Identifies gravitational potential energy, elastic potential energy, and kinetic energy in a system.

- Approaching Proficient – The Level 2 Student – Identifies types of potential energy (i.e., gravitational, elastic, chemical, electrostatic, and nuclear), kinetic, and heat energy in a system.
- Proficient – The Level 3 Student – Describes many types of energy in a system. Calculates the kinetic energy of an object given the velocity and mass of an object.
- Highly Proficient – The Level 4 Student – Develops generalizations about types of energy. Uses kinetic and potential energies to quantitatively describe real world situations.

Objective IV.2 – Describe conservation of energy in terms of systems.

- Below Proficient – The Level 1 Student – Describes a closed system in terms of its total energy. Recognizes the transformations between kinetic and potential energy. Calculates gravitational potential energy and kinetic energy of an object. Recognizes social, economic, and environmental issues related to the production of electrical energy.
- Approaching Proficient – The Level 2 Student – Specifies transformations between kinetic and potential energy in a system and shows that total energy remains constant. Uses data to calculate gravitational potential energy and kinetic energy of an object. Cites evidence for social, economic, and environmental issues related to the production of electrical energy based on provided information.
- Proficient – The Level 3 Student – Analyzes and draws qualitative conclusions from data, explaining the transformations between kinetic energy and various types of potential energy in a system. Gathers data and calculates the gravitational potential energy and kinetic energy of an object and relates this to conservation of energy. Summarizes the social, economic, and environmental issues related to the production of electrical energy based on provided information.
- Highly Proficient – The Level 4 Student – Draws quantitative conclusions explaining the transformations between kinetic and various types of potential energy in a system. Designs an investigation and collects data to show the relationship between kinetic and potential energies of a system. Evaluates the social, economic, and environmental issues related to the production of electric energy.

Objective IV.3 – Describe common energy transformations and the effect on availability of energy.

- Below Proficient – The Level 1 Student – Identifies that when energy is transferred, useful energy is lost. Recognize radiation, conduction, and

convection. Recognizes that mechanical energy can transform into electrical energy.

- Approaching Proficient – The Level 2 Student – Identifies that when energy is transferred, useful energy is lost to a variety of energy forms. Classifies examples of radiation, conduction, and convection. Identifies where/when energy transformations (between mechanical and electrical) have occurred in a given situation. Given evidence, identifies energy transformations in electrical generation plants.
- Proficient – The Level 3 Student – Explains that when energy is transferred, useful energy is lost to a variety of energy forms. Draws conclusions about the type of heat transfer (radiation, conduction, or convection) from evidence. Describes the transformation of mechanical energy to electrical energy. Gathers and analyzes information to report on the energy transformations in electrical generation plants.
- Highly Proficient – The Level 4 Student - Shows the relationship between the amount of initial energy and final energy of a system. Draws conclusions and cites evidence about the type of heat transfer. Gathers, analyzes, and evaluates information about the energy transformations in a variety of electrical generation plants.

Waves

Objective V.1 – Demonstrate an understanding of mechanical waves in terms of general wave properties.

- Below Proficient – The Level 1 Student – Identifies amplitude and wavelength of a wave. Identifies examples of reflection and refraction, from a diagram. Identifies examples of waves commonly found in nature.
- Approaching Proficient – The Level 2 Student – Differentiates between period, frequency, wavelength, and amplitude. Recognizes examples of reflection, refraction, and diffraction. Provides examples of waves found in nature. Identifies relationships between wavelength and frequency. Determines direction of relative motion given changes in frequency. Recognizes that energy can move through a medium.
- Proficient – The Level 3 Student – Compares reflection, refraction, and diffraction. Identifies and uses relationships between speed, wavelength, and frequency of a wave. Predicts changes in frequency based on relative motion of an object. Recognizes that energy moves through an object, rather than matter moving.

- Highly Proficient – The Level 4 Student – Investigates reflection, refraction, and diffraction and provides models to describe each. Designs models and interprets data (for stationary or moving objects) and makes inferences on the changes to frequency, wavelength, and speed of the waves created. Explains and models how energy moves through an object.

Objective V.2 - Describe the nature of electromagnetic radiation and visible light.

- Below Proficient – The Level 1 Student – Given a diagram of the EM spectrum showing frequency or wavelength, orders waves by energy. Provides examples of EM radiation in everyday life.
- Approaching Proficient – The Level 2 Student – Recognizes that all EM waves travel the same speed in a vacuum. Distinguishes and orders EM waves by frequency, wavelength, or energy. Recognizes relationships between energy and frequency. Determines direction of relative motion given changes in frequency.
- Proficient – The Level 3 Student – Compares and diagrams parts of the EM spectrum, including color, use of the waves' energies, frequencies, wavelengths, and speeds. Identifies relationships between wavelength, frequency, and energy. Predicts changes in frequency based on relative motion of objects and distinguishes between red and blue shift.
- Highly Proficient – The Level 4 Student – Creates a graph of energy vs. frequency and/or wavelength. Justifies relationship differences in frequency, wavelength, or energy. Designs models and interprets data for stationary or moving objects and makes inferences on changes to frequency, wavelength, and speed.