

# Proficiency Level Descriptors – Earth Science

## 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.

## Earth, Solar System, and Universe

Objective I.1 – Describe both the big bang theory of universe formation and the nebular theory of solar system formation and evidence supporting them.

- Below Proficient – The Level 1 Student - Recognizes the big bang theory and recalls that heavy elements on Earth came from stars. Provides an example of how technology has helped scientists investigate the universe.
- Approaching Proficient – The Level 2 Student - Recognizes evidence and theories for the age and formation of the solar system. Describes

the big bang theory in simple terms. Simply describes the nebular theory of solar system formation.

- Proficient – The Level 3 Student - Explains how scientists determine the age of the solar system. Describes and gives evidences for the big bang and nebular theories. Describes how heavy elements on Earth were formed. From a given text, relates past scientific findings to current understanding of the universe composition and origin. Distinguishes how scientists form and support theories.
- Highly Proficient – The Level 4 Student - Describes the evidence for the big bang and how scientists use the evidence to infer past events. Generalizes the nebular theory to the formation of other solar systems. Reports on the development of theories for the formation of the universe.

Objective I.2 – Analyze Earth as part of the solar system, which is part of the Milky Way galaxy.

- Below Proficient – The Level 1 Student – Recalls that the distance from the sun is a predictor for the composition of objects in the solar system. Identifies conditions necessary for life. Recognizes that the solar system is much larger than Earth and that the Milky Way is much larger than the solar system.
- Approaching Proficient – The Level 2 Student – Given a table, organizes objects in the solar system by size, composition, or distance from the sun. Produces a list of the conditions necessary for life. Draws a diagram comparing the sizes of the solar system and the Milky Way.
- Proficient – The Level 3 Student – Relates the composition of objects in the solar system to their distance from the sun. Models the size of the solar system compared to the Milky Way Galaxy. Compares the size and scale of objects within the solar system. Evaluates the conditions that currently support life on Earth and compares them to the conditions that exist on other planets and moons in the solar system.
- Highly Proficient – The Level 4 Student – Constructs a model using conditions of the lithosphere, atmosphere, and hydrosphere that affect the biosphere. Uses this model to compare conditions on Earth that support life compared to other planets and moons in the solar system.

## Earth's Internal Heat and Structure

Objective II.1 – Evaluate the source of Earth's internal heat and the evidence of Earth's internal structure.

- Below Proficient – The Level 1 Student – Recognizes Earth's internal heat is a source of energy on Earth. Labels a diagram of Earth's physical layers. Given a diagram recognizes convection currents that help distribute heat within the mantle.
- Approaching Proficient – The Level 2 Student – Recognizes radioactive decay of elements and heat of formation as sources of Earth's internal heat. Recognizes and labels Earth's interior layers when given a diagram. Recognizes that Earth's layers are separated based on physical properties. Given a model, describes how convection currents within the mantle distribute heat.
- Proficient – The Level 3 Student – Describes how radioactive decay of elements and heat of formation are the sources of Earth's internal heat. Identifies the scientific evidence that supports the claim that separation of Earth's core, mantle, and crust are based on composition. Summarizes the scientific evidence leading to the inference that the lithosphere, asthenosphere, mesosphere, outer core and inner core are separated based on physical properties. Explains the results of convection currents within the mantle.
- Highly Proficient – The Level 4 Student – Analyzes the physical properties and composition of Earth's interior. Describes how seismic activity and wave behavior distinguishes between the physical properties of each layer in Earth's interior. Creates a model demonstrating how convection currents distribute heat within the mantle.

Objective II.2 – Describe the development of the current theory of plate tectonics and the evidence that supports this theory.

- Below Proficient – The Level 1 Student – Given an illustration, recognizes evidence that supports the theory of plate tectonics, specifically mid-ocean ridges, oceanic trenches, and magnetic striping. Recalls evidence of Alfred Wegener's continental drift theory. Illustrates tectonic plate motion.
- Approaching Proficient – The Level 2 Student – Identifies evidence supporting the current theory of plate tectonics. Identifies hot spots and mantle plumes from a model. Identifies examples of evidence of past change preserved in the geological record. Identifies evidence of mantle plumes. Recognizes evidence for the rate and direction of tectonic plate motion.
- Proficient – The Level 3 Student – Explains Alfred Wegener's continental drift hypothesis and why evidence for it was not accepted in his time. Explains and analyzes how the past is inferred from the

geologic record. Explains how mantle plumes provide evidence for the rate and direction of tectonic plate motion.

- Highly Proficient – The Level 4 Student – Analyzes the evidence for the current theory of plate tectonics: sea floor spreading, age of sea floor, distribution of earthquakes and volcanoes. Compares and contrasts the discovery of mid-ocean ridges, oceanic trenches, and magnetic striping of the sea floor to the development of the modern theory of plate tectonics.

Objective II.3 - Demonstrate how motion of tectonic plates affects Earth and living things.

- Below Proficient – The Level 1 Student – Recognizes that the Earth's crust is made of major plates. Given a model identifies convergent, divergent, transform plate boundaries. Recalls that earthquakes and volcanoes transfer energy.
- Approaching Proficient – The Level 2 Student – Describes convergent, divergent, and transform boundaries, and draws a diagram of each boundary. From a graphic, identifies Earth's major plates. Recognizes that many factors cause plate tectonic movement. Identifies geologic processes and their possible effects on human-made structures.
- Proficient – The Level 3 Student – Describes a lithospheric plate. Describes how earthquakes and volcanoes transfer energy from Earth's interior to the surface. Constructs a model demonstrating factors that cause tectonic plates to move. Labels types of boundaries and the resulting formation of mountains, volcanoes, trenches, mid-oceanic ridges and earthquakes. From a news source or reference, analyzes how geologic processes may affect human-engineered structures.
- Highly Proficient – The Level 4 Student - Designs, builds, and tests a model that investigates local geologic processes and the possible effects on human-engineered structures. Explains complex plate interactions and the energy sources that produce them. Constructs a model demonstrating factors that cause plate tectonics and analyzes the effect of these factors on plate movement and changes to Earth's surface.

## Atmospheric Processes, Weather, and Climate

Objective III.1 – Relate how energy from the sun drives atmospheric processes and how atmospheric currents transport matter and transfer energy.

- Below Proficient – The Level 1 Student – On a diagram, labels energy transfer between the sun, ocean, atmosphere and land masses. Recalls that there are factors that cause uneven heating of the Earth's surface. Recognizes the greenhouse effect from a diagram.
- Approaching Proficient – The Level 2 Student – On a diagram, identifies energy from the sun that is reflected, absorbed or scattered by the atmosphere, oceans, and land masses. Defines Coriolis effect, Hadley cells, trade winds, and prevailing westerlies. Using a diagram, explains that the greenhouse effect maintains higher atmospheric temperatures. Observes effects of Hadley cells, trade winds, prevailing westerlies, Coriolis effect and the tilt of the Earth on the distribution of heat and sunlight on Earth's surface.
- Proficient – The Level 3 Student – Given a model demonstrates energy transfer from the sun by the atmosphere, oceans, and land masses and determines the effects of greenhouse gasses on that model. Designs and conducts an experiment on how the tilt of Earth's axis causes variations in the intensity and duration of sunlight striking Earth. Describes how Coriolis effect, Hadley cells, trade winds, and prevailing westerlies affect Earth's atmosphere. Identify locations in the atmosphere in which ozone is beneficial to life and locations in which ozone is a pollutant.
- Highly Proficient – The Level 4 Student – Designs a demonstration to show movement and uneven distribution of heat energy in the Earth's atmosphere from various factors. Compares the effects of ozone in the troposphere and stratosphere. Models Earth's energy budget.

Objective III.2 - Describe elements of weather and the factors that cause them to vary from day to day.

- Below Proficient – The Level 1 Student – Identifies the instruments used to measure weather. Recognizes conditions that give rise to severe weather phenomena. Given a weather map, identifies low pressure and high pressure zones.
- Approaching Proficient – The Level 2 Student – Identifies the elements of weather and matches them with the instruments used to measure them. Identifies conditions that give rise to severe weather phenomena. Using a map, identifies a low pressure system and its weather and a high pressure system and its weather.
- Proficient – The Level 3 Student – Describes conditions that give rise to severe weather phenomena. Explains the difference between a low pressure system and a high pressure system, including the weather

associated with them. Given a map, identifies the location of a cold front, a warm front, occluded and stationary boundaries.

- Highly Proficient – The Level 4 Student – Diagrams and describes cold, warm, occluded, and stationary boundaries between air masses. Designs and conducts a weather investigation, uses appropriate weather tools, uses an appropriate display of the data, and interprets the combined observations and data.

Objective III.3 – Examine the natural and human-caused processes that cause Earth's climate to change over intervals of time ranging from decades to millennia.

- Below Proficient – The Level 1 Student – Identifies the difference between weather and climate. Recognizes that Earth's climate has changed over time. Given a picture, identifies parts of the carbon cycle. Recognizes that use of fossil fuels produces pollutants. Identifies that climate change could have an ecological consequence.
- Approaching Proficient – The Level 2 Student – Identifies the methods used to investigate evidence for changes in climate. Given textual information, cites evidence of how Earth's climate has changed over time. Given a diagram, identifies where human activities affect the carbon cycle. Defines the differences between air pollution and climate change. Cites examples of how pollution is related to the use of fossil fuels. Cites evidence from given information about the current and potential consequences of climate change on ecosystems.
- Proficient – The Level 3 Student – Given diagrams, explains how Earth's climate has changed over time and describes the natural causes for these changes. Describes how human activity influences the carbon cycle and may contribute to climate change. Explains the differences between air pollution and climate change and how these are related to society's use of fossil fuels. Draws conclusions from given evidence about the current and potential consequences of climate change on ecosystems, including human communities.
- Highly Proficient – The Level 4 Student - Applies differences between weather and climate and the methods used to investigate evidence for changes in climate to real life situations. Compares and contrasts opposing views on how Earth's climate has changed over time and describes the natural causes for these changes. Analyzes multiple sources documenting how human activity influences the carbon cycle and may contribute to climate change. Synthesizes information across multiple texts to compare the differences between air pollution

and climate change and how these are related to society's use of fossil fuels.

## Hydrosphere

Objective IV.1 - Characterize the water cycle in terms of its reservoirs, water movement among reservoirs, and how water has been recycled throughout time.

- Below Proficient – The Level 1 Student – Identifies bodies of water as the reservoirs within Earth's water cycle. Identifies evaporation, condensation, precipitation, and surface runoff.
- Approaching Proficient – The Level 2 Student – Identifies oceans, lakes, running water, frozen water, ground water, and atmospheric moisture as the reservoirs of Earth's water cycle. Describes the processes of evaporation, condensation, precipitation, surface runoff, ground infiltration, and transpiration. Identifies that natural purification of water occurs through those processes.
- Proficient – The Level 3 Student – Interprets a graph or chart of the relative amounts of water in each reservoir of the water cycle. Describes how the processes of evaporation, condensation, precipitation, surface runoff, ground infiltration, and transpiration contribute to the cycling of water through Earth's reservoirs. Interprets a diagram of the natural purification of water as it moves through the water cycle.
- Highly Proficient – The Level 4 Student – Creates a chart or graph identifying the relative amount of water in each of Earth's hydrologic reservoirs. Creates a diagram illustrating how the processes of evaporation, condensation, precipitation, surface runoff, ground infiltration, and transpiration contribute to the cycling of water through Earth's reservoirs. Models the natural purification of water as it moves through the water cycle. Given textual information, compares natural purification to processes used in local sewage treatment plants.

Objective IV.2 – Analyze the characteristics and importance of freshwater found on Earth's surface and its effect on living systems.

- Below Proficient – The Level 1 Student – Given a picture or diagram, recognizes properties of water: exists in all three phases and dissolves many substances. Recognizes biotic and abiotic factors that affect freshwater systems. Recognizes that pollution can make water unavailable.

- Approaching Proficient – The Level 2 Student – Identifies properties of water: exists in all three states and dissolves many substances, density of solid vs. liquid water. Describes biotic and abiotic factors that affect freshwater ecosystems. Given basic information, cites evidence about how pollution can make water unavailable. Given textual evidence, identifies how communities manage water resources.
- Proficient – The Level 3 Student – Identifies the properties of water: exists in all three states, dissolves many substances, exhibits adhesion and cohesion, density of solid vs. liquid water. Given experimental data, interprets biotic and abiotic factors that affect freshwater ecosystems. Using given data, interprets water quality and concludes how pollution can make water unavailable or unsuitable for life. Given textual information, cites evidence on how communities manage water resources.
- Highly Proficient – The Level 4 Student – Explains the properties of water: exists in all three states, dissolves many substances, exhibits adhesion and cohesion, density of solid vs. liquid water. Plans and conducts an experiment to investigate biotic and abiotic factors that affect freshwater ecosystems. Collects data to evaluate water quality and concludes how pollution can make water unavailable or unsuitable for life. Reports on how communities manage water resources to address social, economic, and environmental concerns.

Objective IV.3 – Analyze the physical, chemical, and biological dynamics of the oceans and the flow of energy through the oceans.

- Below Proficient – The Level 1 Student – Given pictorial information, identifies how the oceans formed from outgassing by volcanoes and ice from comets. Identifies that salt water and cold water are more dense than fresh or warm water. Recognizes that freshwater and saltwater have different chemical and physical properties. Recognizes convection currents. Recognizes human influences on ocean systems.
- Approaching Proficient – The Level 2 Student – Diagrams how the oceans formed from outgassing by volcanoes and ice from comets. Identifies how salinity, temperature, and pressure at different depths and locations in oceans and lakes affect saltwater ecosystems. Identifies chemical properties and physical properties of freshwater and saltwater. When given a model identifies the energy flow in the physical dynamics of oceans. Identifies the impact of human activities on ocean systems.
- Proficient – The Level 3 Student – Describes how the oceans formed from outgassing by volcanoes and ice from comets. Describes how

salinity, temperature, and pressure at different depths and locations in oceans and lakes affect saltwater ecosystems. Given data, interprets an experiment comparing chemical properties and physical properties of freshwater samples to saltwater samples from different sources. Interprets a diagram modeling energy flow in the physical dynamics of oceans. Cites examples of the impact of human activities on ocean systems.

- Highly Proficient – The Level 4 Student - Creates a diagram or reports about how the oceans formed from outgassing by volcanoes and ice from comets. Investigates how salinity, temperature, and pressure at different depths and locations in oceans and lakes affect saltwater ecosystems. Designs and conducts an experiment comparing chemical properties and physical properties of freshwater samples to saltwater samples from different sources. Models energy flow in the physical dynamics of oceans. Evaluates the impact of human activities on ocean systems.

## Interaction of Earth Science with Society

Objective V.1 – Characterize Earth as a changing and complex system of interacting spheres.

- Below Proficient – The Level 1 Student – Identifies Earth’s biosphere, geosphere, atmosphere, and hydrosphere. Given illustrations or diagrams, recognizes how Earth’s systems continually change. Given a pictorial example, recognizes how technological advances help human understanding of scientific principles.
- Approaching Proficient – The Level 2 Student – Identifies energy flowing and matter cycling within Earth’s biosphere, geosphere, atmosphere. Given textual evidence, identifies how Earth’s systems are dynamic and continually react to natural and human caused changes. Given textual examples, cites evidence about how technological advances lead to increased human knowledge. Given a graph or text example, identifies human-caused change. Given a visual, identifies feedback loops.
- Proficient – The Level 3 Student – Illustrates how energy flowing and matter cycling within Earth’s biosphere, geosphere, atmosphere, and hydrosphere give rise to processes that shape Earth. Explains how Earth’s systems are dynamic and continually react to natural and human caused changes. Explains how technological advances lead to increased human knowledge and ability to predict how changes affect Earth’s systems. Interprets an experiment that investigates how

Earth's biosphere, geosphere, atmosphere, or hydrosphere react to human-caused change. Given evidence, summarizes how scientists study feedback loops to inform the public about Earth's interacting systems.

- Highly Proficient – The Level 4 Student – Designs and conducts an experiment to investigate how Earth's biosphere, geosphere, atmosphere, or hydrosphere react to human-caused change. Given evidence, compares and contrasts opposing views on how scientists study feedback loops to inform the public about Earth's interacting systems.

Objective V.2 - Describe how humans depend on Earth's resources.

- Below Proficient – The Level 1 Student – Given pictorial scenarios, identifies Earth's resources. Given external information, identifies how human populations depend on Earth resources. Given a scenario, identifies the role of scientists in the discussion of Earth resource use.
- Approaching Proficient – The Level 2 Student – Given a map, identifies how Earth's resources are distributed across an area. Given external information, cites evidence about how human populations depend on and affect Earth's resources. Given a scenario, cites evidence of the role of scientists in providing data to inform the discussion of Earth resource use. Identifies a claim about how Earth science literacy can help the public make informed choices related to the use of natural resources.
- Proficient – The Level 3 Student – Investigates how Earth's resources are distributed across an area. Summarizes how human populations depend on Earth's resources and how changing conditions over time have affected these resources. Identify how resource development and use alters Earth systems. Describes the role of scientists in providing data to inform the discussion of Earth resource use. Summarizes and cites evidence for the claim that Earth science literacy can help the public make informed choices related to the extraction and use of natural resources.
- Highly Proficient – The Level 4 Student – Investigates how Earth's resources are distributed across the state, the country, and the world. Compares and contrasts opposing views on how human populations depend on Earth resources for sustenance and how changing conditions over time have affected these resources. Predicts how resource development and use alters Earth systems. Develops a logical argument about the role of scientists in providing data to inform the discussion of Earth resource use. Justifies the claim that Earth science

literacy can help the public make informed choices related to the extraction and use of natural resources.

Objective V.3 - Indicate how natural hazards pose risks to humans.

- Below Proficient – The Level 1 Student – Identifies a natural hazard. States that human activities that can contribute to natural hazards. Identifies technology used to predict natural hazards.
- Approaching Proficient – The Level 2 Student – Identifies natural hazards that occur locally and globally. Identifies examples of human activities that can contribute to natural hazards. Given textual evidence, cites scientists' use of technology to estimate when and where natural hazards may occur. Given textual scenarios, cites evidence about how social, economic, and environmental issues affect decisions about human-engineered structures.
- Proficient – The Level 3 Student – Describes natural hazards that occur locally and globally. Given examples, justifies the statement that human activities that can contribute to natural hazards. Summarizes how scientists use technology to continually improve estimates of when and where natural hazards may occur. Explains how social, economic, and environmental issues affect decisions about human-engineered structures.
- Highly Proficient – The Level 4 Student - Describes how natural hazards that occur locally and globally pose a risk to humans. Evaluates and gives examples of human activities that can contribute to the frequency and intensity of some natural hazards. Compares and contrasts opposing views about how social, economic, and environmental issues affect decisions about human-engineered structures.