

Model Proficiency Scales for Science Priority Performance Indicators (Grades 9-12)

Purpose

The purpose of this document is to provide SU/SDs with model proficiency scales to accompany the [Science Proficiency-Based Graduation Hierarchy](#). This document is part of the larger [Vermont Framework for Proficiency](#). The model proficiency scales were informed by extended feedback from and work with the field.

Document Overview

Each of the four Critical Proficiencies (CPs) is indicated by a separate header. Below the header for each CP (Structure and Function, Cause and Effect, Energy and Matter, and Systems and Systems Models) is the text of that Critical Proficiency. Each Critical Proficiency includes Priority Performance Indicators (PPIs) that were developed for that Critical Proficiency, based on Next Generation Science Standards.

Below each CP are the proficiency scales associated with each PPI. The lefthand column of each proficiency scale includes the text for the PPI as well as parentheses that indicate which Performance Expectation(s) make up that PPI.

The first step in developing proficiency scales is determining what a student must know and do in order to demonstrate proficiency in a given PPI. This begins with unpacking the grade band performance expectation(s) that correspond to the selected PPI. The combined learning targets identified through the unpacking process become the “proficient” level of the proficiency scale, which requires application of skills and knowledge (e.g., synthesis of information, transfer to a novel context, etc.). The “beginning” level is comprised of qualitative descriptors of the foundational skills or knowledge a student demonstrates first when working toward proficiency while the “developing” level identifies foundational skills or knowledge a student demonstrates as a steppingstone to “proficient.” Finally, the “expanding” level requires creative and flexible application of skills and knowledge at an advanced level. For more information about the unpacking process, see [Vermont Framework for Proficiency: Developing Proficiency Scales](#).

It is important to remember that the beginning and developing levels of the scales illustrate the learning trajectory of skills and/or knowledge expectations that build toward proficiency and do not indicate less rigor for a student. For clarity on how the language used in the scales represents depth of knowledge or differentiation of skill, refer to Hess’ Cognitive Rigor Matrices for the different content areas: [Reading-Listening](#), [Writing-Speaking](#), [Math-Science](#), [Social Studies-Humanities](#), [Fine Arts](#), [Health and Physical Education](#), and [World Language](#).



Critical Proficiency: Structure and Function

Demonstrate that the way an object or organism is shaped or structured determines many of its properties and functions.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>Matter and Its Interactions Construct and revise an explanation for the outcome of reactions based on the structure of atoms and molecules and knowledge of chemical properties (e.g., trends in periodic table). HS-PS1-2</p>	<p>I can</p> <ul style="list-style-type: none"> Identify elements on the periodic table; and Distinguish foundational elemental properties, such as whether an element is a metal or nonmetal. 	<p>I can</p> <ul style="list-style-type: none"> Utilize the periodic table to predict the reactivity of elements; Use the periodic table to identify chemical properties of the main group elements (those in s-block and p-block in Groups 1, 2, and 13 - 18); and Explain how physical change differs from chemical change. 	<p>I can</p> <ul style="list-style-type: none"> Apply periodic trends to predict the chemical behavior of elements in reactions; Construct an explanation for the probable products of chemical reactions based on atom and molecule types; and Assess and adjust my initial explanations for reaction outcomes using new evidence and insights. 	<p>I can</p> <ul style="list-style-type: none"> Develop detailed explanations for complex chemical reactions; and Use my knowledge to design experiments and predict their outcomes; <p style="text-align: center;">-or-</p> <p>I can create additional evidence that expands upon proficient.</p>

Critical Proficiency: Structure and Function

Demonstrate that the way an object or organism is shaped or structured determines many of its properties and functions.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>Waves and Their Applications: Structure of Waves and Their Applications in Technology Support a claim regarding the relationships among the frequency, wavelength, and speed of waves traveling in various media. Understand how wave behavior is applied in the development of technological devices used to transmit and capture information and energy. HS-PS4-1; HS-PS4-5</p>	<p>I can</p> <ul style="list-style-type: none"> Recognize that waves exist and are related to transmitting information and energy; and Identify and define the characteristics of a wave. 	<p>I can</p> <ul style="list-style-type: none"> Differentiate between a mechanical wave and an electromagnetic wave; Explain fundamental principles of wave behavior and how they transmit and capture information and energy; and Describe the interactions of waves with different materials and mediums. 	<p>I can</p> <ul style="list-style-type: none"> Support a claim about the relationships among frequency, wavelength, and speed of waves and how they travel through various media; Investigate and analyze technological devices like radios, microwave ovens, and optical fibers and how they use waves for communication and energy transfer; and Identify specific wave principles applied in these devices and explain their functions in technical terms. 	<p>I can</p> <ul style="list-style-type: none"> Provide multiple examples of wave interactions, including refraction, reflection, and absorption, and explain how these phenomena affect wave speed and transmission; Design and conduct detailed investigations into technological devices such as radios, microwave ovens, and optical fibers, analyzing advanced principles of wave behavior, such as signal interference, bandwidth limitations, and energy loss during transmission; <p style="text-align: center;">-or-</p> <p>I can create additional evidence that expands upon proficient.</p>

Critical Proficiency: Structure and Function

Demonstrate that the way an object or organism is shaped or structured determines many of its properties and functions.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>From Molecules to Organisms</p> <p>Explain how an organism's structure relates to its function and how components form interacting systems with specific roles in multicellular organisms.</p> <p>HS-LS1-1; HS-LS1-2</p>	<p>I can</p> <ul style="list-style-type: none"> Identify that organisms are made up of different parts that have different functions; and Recognize that different organisms have different shapes or structures and therefore function differently. 	<p>I can</p> <ul style="list-style-type: none"> Demonstrate understanding that a multicellular organism has components that perform specific roles within the organism; and Identify the functions that occur within a multicellular organism. 	<p>I can</p> <ul style="list-style-type: none"> Explain how an organism's structure is related to its function; and Model how different components within a multicellular organism interact and have specific roles within the system to which they are associated. 	<p>I can</p> <ul style="list-style-type: none"> Analyze and provide evidence for how an organism's structure is intricately linked to its function; Construct an argument that connects the interdependence of system components to the organism's ability to respond to internal and external stimuli; and Use a wide range of examples and evidence to support explanations and make connections to real-world applications; <p style="text-align: center;">-or-</p> <p>I can create additional evidence that expands upon proficient.</p>

Critical Proficiency: Cause and Effect

Use evidence to support that cause-and-effect relationships can be suggested and predicted for complex natural and human designed systems.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>Earth's Systems</p> <p>Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.</p> <p>HS-ESS2-7</p>	<p>I can</p> <ul style="list-style-type: none"> Identify that different species live in different geographical areas of Earth; and Identify that different species have characteristics that make them better suited for different areas on Earth. 	<p>I can</p> <ul style="list-style-type: none"> Use evidence to interpret how the Earth's systems have changed over time; Support using evidence that species evolve to best survive in given environmental conditions; and Demonstrate understanding that there is a relationship between the characteristics of a species and the environment in which they live. 	<p>I can</p> <ul style="list-style-type: none"> Construct an evidence-based argument that showcases the coevolution of Earth's systems and life on Earth; and Construct an evidence-based argument that the evolution of life can be strongly influenced by the changing or altering of Earth's physical systems and/or that Earth's systems can be influenced by the evolution of life. 	<p>I can</p> <ul style="list-style-type: none"> Identify and model feedback loops that exist between Earth's systems and life on Earth; and Use a wide range of evidence, including historical data, scientific findings, and real-world examples to support the argument; <p style="text-align: center;">-or-</p> <p>I can create additional evidence that expands upon proficient.</p>

Critical Proficiency: Cause and Effect

Use evidence to support that cause-and-effect relationships can be suggested and predicted for complex natural and human designed systems.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>Earth's Systems</p> <p>Make an evidence-based claim that one change to Earth's surface or atmosphere can create feedbacks that cause changes to other Earth's systems.</p> <p>HS-ESS2-2; HS-ESS3-5</p>	<p>I can</p> <ul style="list-style-type: none"> Identify changes that occur as a result of an action on a system or object; and Identify that there are different systems on Earth, and that changes happen within these systems. 	<p>I can</p> <ul style="list-style-type: none"> Provide evidence that cause-and-effect relationships occur within or between Earth's systems; and Identify changes that happen within Earth's systems that cause changes in other systems. 	<p>I can</p> <ul style="list-style-type: none"> Model the relationships that occur between systems at the Earth's surface and/or within the atmosphere; and Make an evidence-based claim to detailing how there will be a change to one system when there is a change to another system. 	<p>I can</p> <ul style="list-style-type: none"> Make an evidence-based claim supported by data that connects changes in a system to the feedback loops acting on or within that system; and Using data, predict what will happen to one system if or when there is a change in another system; <p style="text-align: center;">-or-</p> <p>I can create additional evidence that expands upon proficient.</p>

Critical Proficiency: Cause and Effect

Use evidence to support that cause-and-effect relationships can be suggested and predicted for complex natural and human designed systems.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>Ecosystems: Interactions, Energy, and Dynamics</p> <p>Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.</p> <p>HS-LS2-6; HS-LS2-7</p>	<p>I can</p> <ul style="list-style-type: none"> Identify the components that make up an ecosystem; and List the roles or niches of the flora, fauna, and physical environment of an ecosystem. 	<p>I can</p> <ul style="list-style-type: none"> Describe the different niches in which organisms within an ecosystem exist; Identify patterns exhibited in stable ecosystems; Make connections between how the change in the population of one species might affect the population of another species; and Predict how the change in the physical environment of an ecosystem might affect the species that live in that ecosystem. 	<p>I can</p> <ul style="list-style-type: none"> Evaluate the evidence and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions; Analyze data to support the claim that a change in the population of one species may affect the population of another species; and Provide evidence supporting the claim that a change in conditions may result in a new ecosystem. 	<p>I can</p> <ul style="list-style-type: none"> Analyze the impacts of changes to an ecosystem and make connections to how those impacts may affect other systems or ecosystems; and Apply evidence for how complex ecosystem interactions maintain stability in the ecosystem; <p style="text-align: center;">-or-</p> <p>I can create additional evidence that expands upon proficient.</p>

Critical Proficiency: Cause and Effect

Use evidence to support that cause-and-effect relationships can be suggested and predicted for complex natural and human designed systems.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>Biological Evolution: Unity and Diversity</p> <p>Construct an explanation based on evidence for how natural selection leads to adaptation of populations and evaluate the claims that changes in the environmental conditions may result in changes in the populations of species.</p> <p>HS-LS4-4; HS-LS4-5</p>	<p>I can</p> <ul style="list-style-type: none"> Distinguish between evolution, natural selection, adaptation, population, and species; Recognize that different areas of the Earth are defined by different climates and environmental conditions; and Identify characteristics of species that live within different ecosystems. 	<p>I can</p> <ul style="list-style-type: none"> Identify patterns in the characteristics of different species that live in the same ecosystem or biome; Predict how the change in the population of one species might affect the population of another species; and Predict how the change in the physical environment of an ecosystem might affect the species that live in that ecosystem. 	<p>I can</p> <ul style="list-style-type: none"> Construct an explanation based on evidence for how natural selection leads to adaptation of populations; and Evaluate the evidence of cause-and-effect relationships between changes in environmental conditions and the populations of species. 	<p>I can</p> <ul style="list-style-type: none"> Analyze data to forecast the impacts on species' populations due to changes in the ecosystem; and Gather, analyze and evaluate information that provides evidence for how the rate of change on an environment affects the distribution or disappearance of traits in species; <p>- or -</p> <p>I can create additional evidence that expands upon proficient.</p>

Critical Proficiency: Energy and Matter

Analyze energy and matter flows within, between, and among systems to understand the systems behavior.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>Matter and Its Interactions</p> <p>Investigate the claim that atoms, and therefore mass, are conserved during a chemical reaction. Compare and contrast the changes in atoms involved in a nuclear reaction to those involved in a chemical reaction.</p> <p>HS-PS1-7; HS-PS1-8</p>	<p>I can</p> <ul style="list-style-type: none"> Using a simple model, represent the law of conservation of mass; Identify that atoms of different elements have different atomic masses; and Define nuclear reaction and chemical reaction. 	<p>I can</p> <ul style="list-style-type: none"> Assess that there are the same number of atoms of each element in the reactants as there are in the products of a chemical reaction; Interpret whether a reaction is chemical or nuclear based on the products; and Compare and contrast the differences between a chemical reaction and a nuclear reaction. 	<p>I can</p> <ul style="list-style-type: none"> Provide evidence through experimentation that mass is conserved during a chemical reaction Predict the products of a chemical reaction given the reactants and their amounts; and Predict the products of a nuclear reaction by identifying the emission particles of the radioactive decay of the nuclei. 	<p>I can</p> <ul style="list-style-type: none"> Use results from investigation or real-world examples that support the law of conservation; Mathematically model the applications of nuclear reactions in the real-world; and Critique the benefits and risks of chemical and/or nuclear reactions in our society; <p>- or -</p> <p>I can create additional evidence that expands upon proficient.</p>

Critical Proficiency: Energy and Matter

Analyze energy and matter flows within, between, and among systems to understand the systems behavior.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>Energy Provide evidence through the process of investigation that the transfer of energy between components with different energy amounts in a system leads to a state of balance or equilibrium. HS-PS3-4; <i>HS-PS3-1*</i></p>	<p>I can</p> <ul style="list-style-type: none"> Identify/define the types of energy that exist within a system; and Provide an example a state of equilibrium in a system. 	<p>I can</p> <ul style="list-style-type: none"> Use data or observations to identify whether components of a system are in a state of equilibrium; and Identify characteristics of the components in a system that indicate the components have different energy amounts. 	<p>I can</p> <ul style="list-style-type: none"> Provide evidence through investigation that the transfer of energy between two or more components with different energy amounts occurs in a system; and Model how a system will change when two or more components with different amounts of energy reach a state of equilibrium. 	<p>I can</p> <ul style="list-style-type: none"> Design and perform an experiment to describe energy changes in a system, both quantitatively and conceptually; and Draw connections between the outcomes of a system reaching equilibrium and the resulting consequences in our society; <p style="text-align: center;">- or -</p> <p>I can create additional evidence that expands upon proficient.</p>

* This PPI is written in the context of physical science disciplinary core idea (DCI), however, the concepts in this PPI can also be met through the life science DCI (e.g., HS-LS1-3) or through the Earth Science DCI (e.g., HS-ESS2-3 or HS-ESS2-4).

Critical Proficiency: Energy and Matter

Analyze energy and matter flows within, between, and among systems to understand the systems behavior.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>Ecosystems: Interactions, Energy, and Dynamics Support claims for the cycling of matter and flow of energy among organisms and/or environments in an ecosystem, a biome, or spheres of the Earth. HS-LS2-4; HS-LS2-5</p>	<p>I can</p> <ul style="list-style-type: none"> Identify different types of energy and/or matter that exist within an ecosystem, biome, or sphere; and Identify that similar types of matter or energy exist in different places within an ecosystem, biome, or sphere. 	<p>I can</p> <ul style="list-style-type: none"> Organize data that shows overlap of where similar types of matter or energy exist within or between ecosystems, biomes, or spheres; and Describe how matter or energy can move within or between ecosystems, biomes, or spheres. 	<p>I can</p> <ul style="list-style-type: none"> Use evidence to support claims for the cycling of matter and flow of energy among organisms and/or environments in ecosystems, biomes, or spheres; Predict how the flow of energy and/or matter may change if the balance of matter or energy changes in an ecosystem, biome, or sphere; and Design and use a model to describe the transfer of energy in an ecosystem, biome, or sphere. 	<p>I can</p> <ul style="list-style-type: none"> Synthesize evidence from real-world examples and current events of how changes in the cycling of matter and/or energy in an environment can cause changes in the environment or organisms within an ecosystem, biome, or sphere; <p style="text-align: center;">- or -</p> <p>I can create additional evidence that expands upon proficient.</p>

Critical Proficiency: Energy and Matter

Analyze energy and matter flows within, between, and among systems to understand the systems behavior.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>Earth's Systems</p> <p>Demonstrate understanding of how variations in the flow of energy into and out of Earth's systems result in changes in climate.</p> <p>HS-ESS2-4</p>	<p>I can</p> <ul style="list-style-type: none"> Identify sources of energy on Earth; and Define different climate zones on Earth. 	<p>I can</p> <ul style="list-style-type: none"> Delineate and identify the geographical locations and features of the different climate zones on Earth; Model the flow of energy from the sun to Earth's surface; and Identify different ways scientists learn about Earth's prehistoric climate record. 	<p>I can</p> <ul style="list-style-type: none"> Model how the flow of energy varies between different locations on Earth; Use evidence to defend the claim that variations in the flow of energy into and out of Earth's systems result in changes in climate; and Apply scientific principles to explain shifts in Earth's climate. 	<p>I can</p> <ul style="list-style-type: none"> Model the differences in variations in the flow of energy over different time scales resulting in changes in climate; Use historical climate data from multiple sources to model the climate history on Earth and extrapolate this information to predict the potential impacts of climate change on Earth's systems; and Provide evidence to show how changes in climate are affecting the local region; <p style="text-align: center;">- or -</p> <p>I can create additional evidence that expands upon proficient.</p>

Critical Proficiency: Systems and Systems Models

Define the boundaries and initial conditions of a system, analyze inputs and outputs, and describe and predict behavior using models.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>Earth and Human Activity</p> <p>Use a representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.</p> <p>HS-ESS3-6</p>	<p>I can</p> <ul style="list-style-type: none"> Identify multiple systems on Earth; and Define characteristics of the different systems on Earth. 	<p>I can</p> <ul style="list-style-type: none"> Describe relationships among Earth's systems; Identify human activities that may impact one or more of Earth's systems; and Observe how human activity is impacting one or more of Earth's systems in the community. 	<p>I can</p> <ul style="list-style-type: none"> Model how human activity (behavior or engineering activity) is impacting one or more of Earth's systems; and Analyze data and/or computational models to determine how a change in one sphere causes one or more changes in another sphere. 	<p>I can</p> <ul style="list-style-type: none"> Connect how human activity impacting one of Earth's spheres causes impacts to one or more of Earth's other spheres; and Build an argument supported by evidence about how future human activity might impact one or more of Earth's systems; <p style="text-align: center;">-or-</p> <p>I can create additional evidence that expands upon proficient.</p>

Critical Proficiency: Systems and Systems Models

Define the boundaries and initial conditions of a system, analyze inputs and outputs, and describe and predict behavior using models.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>Engineering Design Model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints, and how those solutions affect interactions within and between systems. HS-ETS1-4</p>	<p>I can</p> <ul style="list-style-type: none"> Identify a complex real-world problem; Define or identify the systems impacted by the problem; and Identify any solutions in place to help remediate the problem. 	<p>I can</p> <ul style="list-style-type: none"> Determine the criteria and constraints of a real-world problem; and Identify any solutions in place and define the impact(s) those solutions are having on the systems. 	<p>I can</p> <ul style="list-style-type: none"> Model the impact of a proposed solution to a complex real-world problem, identifying the criteria and constraints of the solution; and Determine how the solution(s) will affect interactions within and between systems. 	<p>I can</p> <ul style="list-style-type: none"> Design a solution to a complex, real-world problem, identifying the criteria and constraints of the solution; or Compare and contrast solutions to a real-world problem, identifying the criteria and constraints of the solution; and Use a model or simulation to empirically evaluate the impacts the solution will have on systems; <p style="text-align: center;">- or -</p> <p>I can create additional evidence that expands upon proficient.</p>

Critical Proficiency: Systems and Systems Models

Define the boundaries and initial conditions of a system, analyze inputs and outputs, and describe and predict behavior using models.

Priority Performance Indicator	Beginning	Developing	Proficient	Expanding
<p>Earth and Human Activity</p> <p>Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.</p> <p>HS-ESS3-5</p>	<p>I can</p> <ul style="list-style-type: none"> Define geoscience data; and Identify Earth's systems or components of landscapes that are impacted or influenced by climate and/or climate events. 	<p>I can</p> <ul style="list-style-type: none"> Identify themes or concepts represented by geoscience data that help to inform society about weather and climate; Compare regional climate models and/or data; and Identify how climate events impact Earth's systems. 	<p>I can</p> <ul style="list-style-type: none"> Analyze geoscience data and outcomes from climate models to construct an evidence-based forecast regarding the rate of global or regional climate change; Use data to make informed predictions about the potential impacts of climate change on Earth's systems based on one variable; and Describe how the impacts of climate change on Earth's systems affect human systems (i.e., economic or societal). 	<p>I can</p> <ul style="list-style-type: none"> Use data to make informed predictions about the potential impacts of climate change on Earth's systems based on multiple variables; and Predict how a change in the rate of global or regional climate change may impact human systems (i.e., economic or societal). <p style="text-align: center;">- or -</p> <p>I can create additional evidence that expands upon proficient.</p>