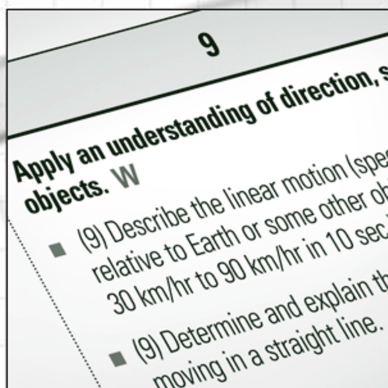

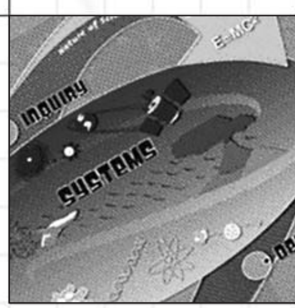

Science

K–10 Grade Level Expectations:

A New Level of Specificity

Washington State's

Essential Academic Learning Requirements

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A New Level of Specificity

"The Science Grade Level Expectations (GLEs) and symbol will help all students learn and apply science concepts. Knowledge of systems, skills of inquiry, and their applications builds students' understanding of the natural world. These GLEs give teachers tools to build students' science proficiency in grades K–10."

- **Dr. Terry Bergeson**
  Superintendent of Public Instruction

Washington's school reform efforts focus on setting clear and high expectations for what students should know and be able to do. The Essential Academic Learning Requirements (EALRs) articulate the state's expectations and learning standards. The Washington Assessment for Student Learning (WASL) measures whether students have met these standards.

The original Science EALRs defined benchmarks, or cumulative indicators, for grades 5, 8, and 10. Written in very broad terms to provide flexibility and local control, each district had the responsibility of determining the learning expectations for students in the other grades. The new Grade Level Expectations (GLEs) provide specific learning standards for students in grades K–10. The GLEs clarify the concepts, properties, and skills all students are expected to know and be able to do.

Just as EALRs were developed by Washington educators, administrators, parents, and community members, developing the Grade Level Expectations involved hundreds of participants and countless feedback opportunities. Drafting teams not only defined what students should know and be able to do at each grade level; they developed descriptions of how students could demonstrate proficiency. The resulting Evidence of Learning statements take the specificity of the EALRs to a new level.

As an example, a fifth grade teacher looking for indications of students' understanding of forces may expect students to demonstrate that understanding in a number of ways, such as by comparing the strength of one force to the strength of another force (e.g., compare how a 5-Newton pull from a spring scale is like the weight of a 1-pound object).

The Office of Superintendent of Public Instruction is committed to helping educators provide high-quality instruction for all Washington students. This document provides all educators, parents, and community members access to essential learning expectations to ensure that all students have the opportunity to learn science. This will lead to science literacy for all. To that end, teachers can use the Evidence of Learning statements as starting points in designing learning and guiding ongoing classroom-based formative assessments.

A Commitment to Achievement

" ... provide students with the opportunity to become responsible citizens, to contribute to their own economic well-being and to that of their families and communities, and to enjoy productive and satisfying lives."

■ **Basic Education Act Preamble**, 1993

For more than a decade, Washington established the commitment that all children would achieve at high levels. The purpose of this reform is clearly spelled out in the preamble of the Basic Education Act of 1993: "Provide students with the opportunity to become responsible citizens, to contribute to their own economic well-being and to that of their families and communities, and to enjoy productive and satisfying lives."

The law established four common learning goals for all Washington students designed to create high-quality academic standards and raise student achievement. The four learning goals provided the foundation for the development of standards, called Essential Academic Learning Requirements for reading, communications, writing, mathematics, science, social studies, health/fitness, and the arts. Establishing an assessment system to measure progress and establishing an accountability system to monitor progress complete the key components of the Basic Education Act.

Washington State Learning Goals

- **Read** with comprehension, **write** with skill, and **communicate** effectively and responsibly in a variety of ways and settings.
- **Know and apply the core concepts and principles** of mathematics; social, physical, and life sciences; civics and history; geography; arts; and health and fitness.
- **Think** analytically, logically, and creatively, and integrate experience and knowledge to form reasoned judgments and solve problems.
- **Understand** the importance of work and how performance, effort, and decisions directly affect **future career and educational opportunities**.

In the last decade, educators at every level contributed tremendous effort to bring greater clarity to the EALRs. The creation of Grade Level Expectations is a logical next step to providing educators with greater specificity, as well as responding to the Elementary and Secondary Education Act of 2001. This federal legislation, known as the *No Child Left Behind Act,* calls for each state to adopt challenging academic standards for all students. These Grade Level Expectations will be used to develop assessments in science as required by this law.

General Expectations: A Vision for All Students

Washington State has embraced the challenge to ensure that all students become scientifically literate, that is, able to understand the natural world by making sense of and applying science ideas and methods. To meet this challenge, Grade Level Expectations (GLEs) were developed from the 1997 Science EALRs through a process involving science educators, school administrators, university scientists, and representatives of prominent businesses from across Washington State.

A drafting team, the Science Curriculum Instructional Framework (SCIF) team, used a research-based process that referenced supporting statements in the American Association for the Advancement of Science (AAAS) **Benchmarks for Science Literacy** and **Atlas of Science Literacy** and the National Research Council (NRC) **National Science Education Standards** (NSES). Out of this collective research, the EALR Benchmark Indicators were clarified and given added specificity, and **Grade Level Expectations** were written in grade bands and given greater clarity with the inclusion of **Evidence of Learning** statements that illustrate demonstrations of the student learning for specific grade levels. Within these bands is a recommended grade-by-grade sequence of concepts and principles (see pages 10 and 11). The GLE document was reviewed by numerous statewide committees (see Acknowledgements).

Four elements emerged from the GLE research on how to meet the challenge that all students become scientifically literate:

Rigor: Students in science need to be challenged to construct explanations and test their understanding of concepts and principles by applying them and discussing them. Students must have minds-on experiences that for many will mean emphasizing active science learning, shifting the emphasis to crafting experiences, and engaging students in understanding concepts and principles. "The perceived need to include all the topics, vocabulary, and information in textbooks is in direct conflict with the central goal of having students learn scientific knowledge with understanding" (NSES, 1996). Such an emphasis includes rigorous assessments of student learning that include inquiry and critical thinking in real world contexts.

Relevance: Scientific literacy also includes understanding the role of science in society and personal life. Students need to recognize that what they learn in their science courses is important to the way they view the world around them. "Americans are confronted increasingly with questions in their lives that require scientific information and scientific ways of thinking for informed decision making. The collective judgment of our people will determine how we manage shared resources such as air, water, and national forests" (NSES, 1996).

Relationship: Integrating science with other subject areas, particularly literacy, can be a powerful and engaging tool for improving students' understanding of how all content areas interrelate.

Resources: Instructional resources must be chosen carefully for their alignment to the GLEs and to reflect Washington's vision for teaching and learning.

Guiding Principles

" The important thing is not to stop questioning."

Albert Einstein

Learning science depends on actively doing science. Active engagement in *hands-on, minds-on* science learning enables students to make sense of the natural world, develop answers to their questions through inquiry, and design solutions to their problems. Toward these ends, the Essential Academic Learning Requirements (EALRs) for science were developed based on the following set of guiding principles:

- All students should be expected to attain a proficient level of achievement and performance on all EALRs.
- All students from kindergarten through 10th grade should have access to a carefully articulated science program each year with opportunities for continued study in grades 11 and 12.
- All students should receive quality feedback about their performance and achievement in science on a continuous basis.
- All students, regardless of gender, cultural or ethnic background, physical or learning disabilities, aspirations, or interest and motivation in science, should have an opportunity to attain science literacy.

The Grade Level Expectations (GLEs) were developed with the goal of providing greater clarity and specificity to the Science EALRs. The following principles guided the work of the Science Curriculum Instructional Framework (SCIF) team.

- **Development:** Student understanding starts with hands-on activities, is abstracted to visual representations, and further abstracted to symbolic forms through writing and reading.
- **Foundations:** Essential concepts have precursors in the early grades that serve as building blocks to further understanding.
- **Growth:** Prior learning and the spiraling of skills, concepts, and principles and the connections to related concepts lead to deeper understanding through the years.

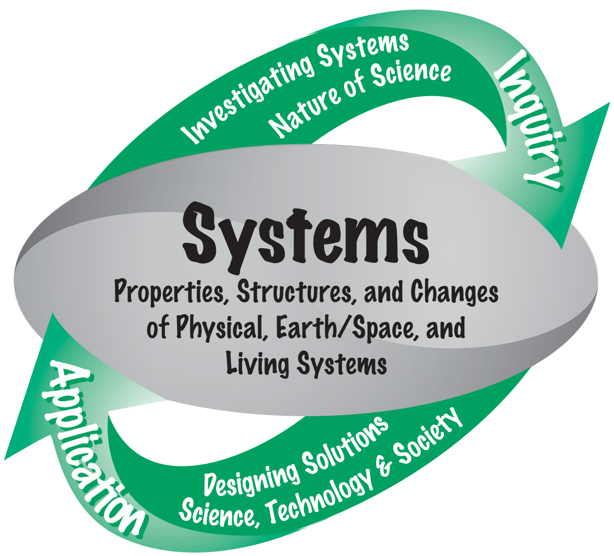
Culturally Responsive Teaching

Children's cultures and backgrounds provide the starting point for learning science. "Where scientific approaches to phenomena conflict with students' values, it is important that teachers better understand those conflicts and take steps to address them" (*Blueprints for Reform,* 1998).

"The GLEs described here provide the basis for addressing these issues, leaving open to the local school districts how to teach the curriculum and creating the opportunity to design instruction that is relevant to the community needs and concerns. At the same time, mastery of the GLEs can assure that children in the community have the kind of sound and broad, non-idiosyncratic grounding in science that will allow further participation at the college and university level" (*Bias and Fairness Review,* 2004).

The Science Symbol

The Washington State science symbol describes the relationship among the systems of the natural world, how those systems are investigated through inquiry, and how the knowledge and processes of science are applied to solve human problems using scientific design. Inquiry contributes to new knowledge about systems. The application of our knowledge of systems, time and again, results in new tools for science (e.g., computers, telescopes, DNA sequencers). It is just such tools and the creativity of the human spirit that lead to greater understanding of systems. In this way the science symbol reflects the structure of the modern scientific endeavor and the transformation of modern society.



The Systems Approach

Systems in the natural world consist of a bounded set of parts, each of which can in turn be thought of as subsystems. Parts interact according to the concepts and principles of science to form conceptual wholes. Systems are open to, and interact with, their environments through inputs, outputs, and transfers of matter, energy, and information.

- A systems approach encourages students to make conceptual connections among systems (e.g., infer a food web from the stomach contents of a fish).
- The goal of the systems approach to science education presented in this document is to have all students gain a greater understanding of how the natural world works.
- We are confident that “students can develop an understanding of regularities in systems, and by extension, the universe” (NSES, 1996).

Environmental Contexts

The systems concept is a unifying theme for integrating science disciplines and restructuring science curricula at the school district level. The systems approach is being used by scientists to investigate the roles that human activities play in global environmental change. Such an approach can be used to develop environmental contexts required by Washington State WAC 180-50-115.

Alignment for Student Achievement

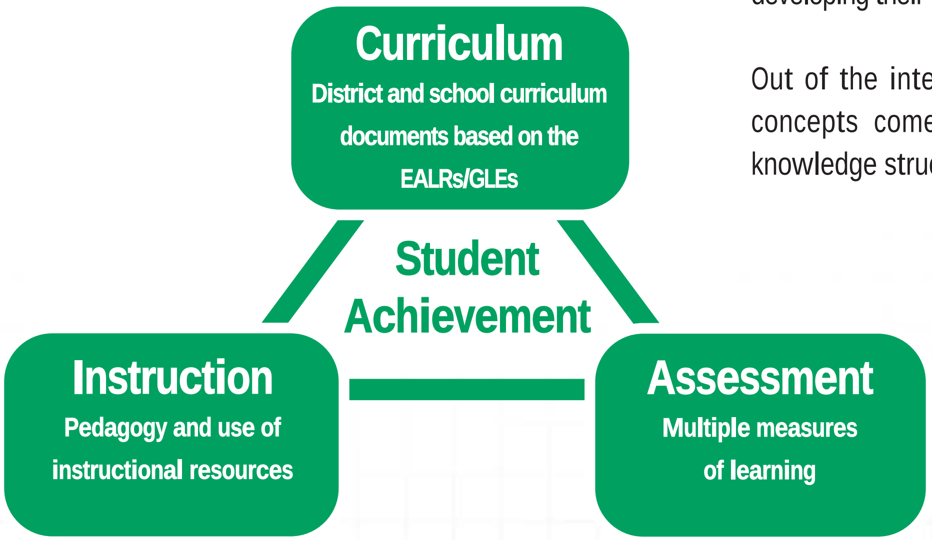
"Without alignment, there can be no fair judgment about how well schools are really doing."

■ **Fenwick English**, 2001

Deep Alignment

To ensure student achievement in science for all students, it is critical that the three elements of a district's science program, including curriculum, instruction, and assessment, be deeply aligned to the Essential Academic Learning Requirements (EALRs) and Grade Level Expectations (GLEs) provided in this document.

Curricula, developed by districts, schools, or teachers, need to be based on the EALRs and GLEs and can take many forms: a district scope and sequence, course syllabi, or unit plans. Instruction refers to both pedagogy and the teacher's use of instructional materials and needs to engage all students in learning. It is important to note that instructional materials alone are not the curriculum; they are instructional tools or resources to support instruction. Assessment should take many forms, both formative and summative.



Deep alignment exists when there is a close match among the curriculum, instruction, and assessment with regard to the content (knowledge, skills, processes, and concepts), the context (conditions of instruction and the tasks in which students are engaged), and the cognitive demand required of the student. When students are assessed on what they have been taught and when what they have been taught aligns with the state standards, achievement increases.

Meaning Making

New ideas take on meaning when they are related to other ideas through a learning cycle such as FERA (Focus-Explore-Reflect-Apply). In combination with a systems approach, deep learning occurs when ideas are not isolated but continually expanded into interconnected knowledge structures. Use of science notebooks helps students organize, track, and advance their thoughts and knowledge of science while also developing their technical writing skills.

Out of the interconnection of experiences, ideas, and concepts comes the creation of rich interconnected knowledge structures.

Science EALRs with Grade Level Expectations

K–10 EALR Statement

K–10 Component

Grade Level Expectations (GLEs)

K	1	2	3	4	5	6	7	8	9	10

- Evidence of Learning
- Evidence of Learning
- Evidence of Learning

EALR 1

Systems: The student knows and applies scientific concepts and principles to understand the properties, structures, and changes in physical, earth/space, and living systems.

The system concept includes inputs, outputs, and transfers of matter and energy, and information to understand how the natural universe functions. The natural world can be understood in terms of the following three system components:

- Properties and Characteristics
- Structures
- Changes

Students develop an understanding of the scientific concepts and principles in the contexts of physical, earth/space, and living systems that can be applied to solve human problems.

EALR 2

Inquiry: The student knows and applies the skills, processes, and nature of scientific inquiry.

Inquiry describes the skills necessary to investigate systems and asks students to understand the nature of science, which gives integrity to scientific investigations. Inquiry represents the application of science concepts and principles to the scientific investigative processes that aims to answer scientific questions about the natural world. These concepts, principles, and processes are expressed in two components:

- Investigating Systems
- Nature of Science

EALR 3

Application: The student knows and applies science concepts and skills to develop solutions to human problems in societal contexts.

Scientific design process skills are used to develop and evaluate scientific solutions to problems in real world contexts.

The application of an understanding of systems and inquiry is comprised of two components:

- Designing Solutions
- Science, Technology, and Society

Understanding Grade Level Expectations

An ***Essential Academic Learning Requirement*** is a broad statement of learning that applies to grades K–10.

The ***Component*** is a K–10 statement that further defines the EALR. There is at least one component for each EALR.

The ***Grade Level Expectation*** is a statement of *cognitive demand,* using Bloom's Taxonomy, and the *essential content* or *process to be learned.* The statement, specific to one or more grades, defines the component.

The ***GLE tag*** is a short name or descriptor for the numbered GLE that describes the content of the GLE.

The recommended grade level for the GLE band.

The ***Evidence of Learning*** is a bulleted list of *student demonstrations* that provide educators with common illustrations of the learning. Because the bulleted list is not exhaustive, educators are encouraged to seek additional evidence of student learning from the National Science Education Standards (NSES) and the American Association for the Advancement of Science (AAAS) Benchmarks. These statements serve as the basis for the development of assessment items on the WASL in science.

EALR 2 — INQUIRY: The student knows and applies the skills, processes, and nature of scientific inquiry.

Component 2.1 Investigating Systems:
Develop the knowledge and skills necessary to do scientific inquiry.

Investigating Systems	2.1.4	Grade 5
	Modeling	**Understand how to use simple models to represent objects, events, systems and processes.** W ■ (5) List similarities and differences between a model and what the model represents (e.g., a hinge and an elbow; a spinning globe and Earth's rotations; steam from a tea kettle and evaporation). ■ (5) Create a simple model to represent common objects, events, systems, or processes (e.g., diagram or map and/or physical model).

The GLE ***Numbering System*** identifies the EALR, the component, and the GLE. For example, in the number 2.1.4, the first number stands for the EALR, the second for the component, and the third for the GLE. Note: Grade levels are not referenced in the numbering system.

Grade Level Expectations with a "**W**" denote the specific expectations that are eligible for the WASL. Not all GLEs have a "**W**."

Recommended Grade-by-Grade Sequence

The **recommended grade-by-grade sequence** through EALR 1 on the next page is a grid districts and buildings can use to track when students are first expected to gain proficiency for any GLE. It is expected that districts will develop implementation plans that will include when concepts and skills are introduced and when, after having reached a level of proficiency, the concepts will be extended and deepened by connecting them to other concepts in the GLE document over the years. Such a process is more than a mere review of previously learned material; it is an ongoing process of creating concept connections that expand and deepen understanding of the concepts, principles, processes, and skills of science. Learning is not a one time experience.

For instance, in the GLE document it is recommended that students be proficient in their understanding of human body systems (GLE 1.2.8) by grades 5, 8, and 10. However, students need to build understanding of those concepts in the between years through a district curriculum that explicitly connects prior learning to current learning using the idea of concept connections. Continuing with human body systems, students studying simple machines in grade 5 should have the opportunity to connect the concepts of levers and forces as they describe the interdependence of skeletal muscle systems in grade 6. Similarly, in grade 10 concepts of the muscular-skeletal system should be linked across to concepts of force learned in grade 9. Concept connections link prior learning to real world contexts by making explicit conceptual links to learning through the grades and across the years.

EALR 2, Inquiry, and EALR 3, Application, are sequenced through the grades by increasing complexity. They do not represent the same sequence flexibility as presented in EALR 1, Systems.

The grade-by-grade sequence was developed in consultation and study with numerous school districts, Educational Service Districts (ESDs), LASER Alliances, staff support from the Pacific Science Institute, and Washington Science Teachers Association (see WSTA at <http://www.wsta.net/html/> for additional district and ESD grade-by-grade sequences).The recommended grade-by-grade sequence represents one of several possible paths students might take in learning the Washington State science standards, assuring the opportunity to learn science for all students from kindergarten through grade 10.

EALR 1 State Recommended Sequence

Districts are ultimately accountable for students learning science. Achievement in science is measured by the WASL in grades 5, 8, and 10. High student mobility across districts and the state presents a challenge to districts. Student transfers can result in duplication of instruction and omissions of content. As districts adopt the recommended sequence of the GLEs over time, students across districts and the state will be assured of a curriculum with minimal omissions or duplications.

	EALR 1 GLEs	K	1	2	3	4	5	6	7	8	9	10
Physical	Properties	■		■		■		■		■		■
	Motion		■		■		■		■		■	
	Waves				■	■		■		■		■
	Energy					■		■		■		■
	Energy Transfer					■		■		■	■	■
	Matter		■	■		■		■		■		■
	Force		■		■		■		■		■	
	Forces and Motion		■		■		■		■		■	
	Conservation			■		■	■		■		■	
Earth/Space	Systems	■	■	■	■	■	■	■	■	■	■	■
	Earth Materials	■		■	■	■			■		■	
	Earth System				■		■		■		■	
	Solar System		■			■		■		■		■
	Earth Processes			■			■		■		■	
	Earth Evolution			■			■		■		■	
	Hydrosphere/Atmosphere		■		■		■		■		■	
	Interactions Solar System					■		■		■		■
Living Systems	Classify Living Things	■		■		■		■		■		■
	Living Systems	■		■	■			■		■		■
	Molecular Heredity			■	■			■		■		■
	Human Biology		■			■		■		■		■
	Life Processes		■		■	■	■		■		■	
	Biological Evolution			■			■		■			■
	Interdependence of Life		■		■		■		■		■	

An Overview of K–10 Science Instruction

The Grade Level Expectations (GLEs) describe a connected series of learning expectations necessary to create scientifically literate citizens. The GLEs define the knowledge and skills that students should gain from kindergarten through the 10th grade. These expectations should not be the end of the science experience for students. Rather, they serve as a solid foundation on which the continued application of science learning contributes to success in high school and beyond.

Below is a conceptual storyline coupled with the scientific investigative skills and an example essential question that is suggested to help districts plan what investigation skill(s) are important for student learning at each grade level.

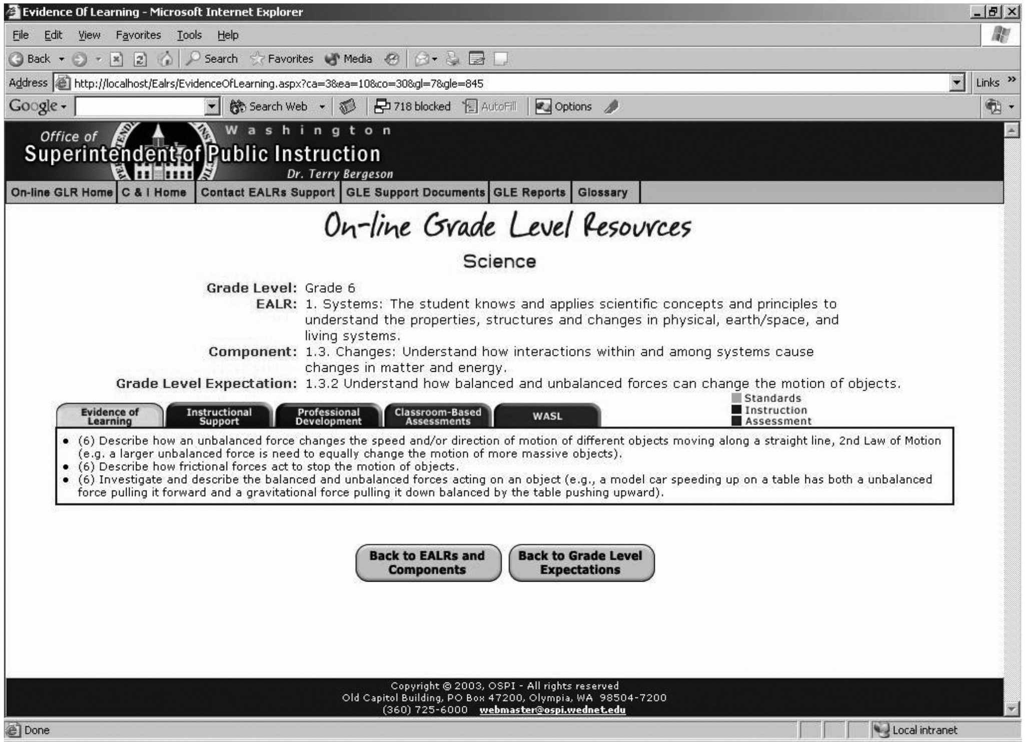
	K	1	2	3	4
Description of the Learner	In kindergarten, students begin their scientific inquiry. They understand that scientists observe carefully and ask questions. Students develop the skills of observing, sorting, and identifying parts and begin using scientific tools to understand the natural world.	In first grade, students learn to find patterns and ask their own questions about their natural world, both living and non-living. For example, students may learn to ask, "What do plant and animals need to live?"; "Why does weather change?"; and "How is weather measured?" Students develop skills with sorting, describing, comparing, and recording their observations.	In second grade, students expand their investigation skills. They use their prior knowledge to begin making predictions and finding patterns based on careful observation. A second grade student will look at and examine more closely the natural world by classifying based on properties and describing characteristics of living and nonliving things. They begin to look for patterns in the natural world.	In third grade, students begin to explore more complex systems and make inferences about their observations. Students are developing an understanding of systems and are able to identify individual parts and how they work together. In order to understand how the connections between the parts interact, students begin to manipulate one part and look for a change in the system. For example, students may study a system of plant growth by observing what happens to plant growth under different light conditions.	In fourth grade, students use their developing investigative skills to begin to compare systems. They examine cause and effect and ask what is a fact and what is an opinion. They are primarily exploring more complex systems in a more complex manner, such as the changes of earth systems over time.
Essential Question	How do we (as scientists) explore and observe our natural world?	How do we ask questions about the natural world?	How do we find patterns within the natural world?	How do we use our understanding of patterns and connections (interdependence) to describe systems in our natural world?	How do we investigate cause and effect in the earth system over time?
Investigative Skills	■ Exploring ■ Observing ■ Sorting	■ Asking Questions ■ Observing ■ Describing ■ Comparing ■ Finding Patterns	■ Predicting ■ Classifying ■ Describing in Detail	■ Inferring ■ Analyzing ■ Quantifying Observations	■ Determining Cause and Effect ■ Comparing and Contrasting ■ Recognizing Fact and Opinion ■ Synthesizing

	5	6	7	8	9/10
Description of the Learner	In fifth grade, students become more sophisticated in their analysis of the interconnections within systems. When investigating, students use data to support their conclusions and logical arguments. They begin to determine factors that contribute to scientific bias.	In sixth grade, students become more like scientists in their thinking and their investigations. They learn how to identify the problems and generate questions that can be answered scientifically. They learn the importance of sound investigative practices. Students begin to apply their understandings to designing solutions to real world problems.	In seventh grade, students become more proficient with both field and controlled investigative skills. When investigating they learn to make judgments about data and determine multiple criteria to support valid conclusions. They examine micro to macro systems with the use of models. Seventh grade students take the ability to investigate the immediate world and apply this to new situations that may be more difficult to experience directly.	In eighth grade, students begin to use concrete evidence to develop a new, more abstract, level of understanding about matter, energy, and systems. Students will begin to develop models to describe complex systems and learn how investigation can provide evidence to test models. Students will begin to differentiate between questions that can be scientifically investigated and those that cannot.	In ninth and tenth grades, students examine scientific theories and master both their field and controlled investigative skills. They develop physical, conceptual, and mathematical models to represent and investigate objects, events, systems, and processes. Students infer and make predictions based on scientific evidence and then apply their skills and knowledge to new situations.
Essential Question	How does our investigative process lead to new questions about the flow of matter and energy within a system?	How do scientists use investigation to solve real problems in my community?	How do we use scientific thinking to analyze systems — micro to macro — across time?	How do we use scientific models to explain systems?	How do we investigate to validate or contribute to our understanding of theories used to explain natural systems?
Investigative Skills	■ Data Analysis ■ Detecting Scientific Bias ■ Inquiry Skills	■ Designing Solutions ■ Decision Making ■ Hypothesizing	■ Analysis of Systems ■ Application to New Systems ■ Making Judgments Supported by Valid Conclusions	■ Analysis of Models ■ Synthesizing Using Data or Models	■ Evaluating Using Data ■ Inferring Using Data ■ Predictions Based on Scientific Evidence ■ Application

Accessing the On-line Grade Level Resources

Aligned GLE support can be accessed via On-line Grade Level Resources at the Curriculum and Instruction home page on the OSPI website. This interactive resource provides the following features:

- GLE reports (grade level, grade spans, K–10 GLEs).
- Links to GLE glossary.
- Aligned instructional support.
- Integration links to other content areas.
- Support for classroom-based assessments.
- Links to WASL strands, learning targets, released items, and annotations.



www.k12.wa.us/CurriculumInstruct/

Science

Essential Academic Learning Requirements:

Grade-by-Grade Sequence for Grade Level Expectations

EALR 1

EALR 1 — SYSTEMS: The student knows and applies scientific concepts and principles to understand the properties, structures, and changes in physical, earth/space, and living systems.

Component 1.1 Properties: Understand how properties are used to identify, describe, and categorize substances, materials, and objects and how characteristics are used to categorize living things.

	GLE	K–2	3–5
Physical Systems	1.1.1 Properties of Substances	**Understand simple properties of common natural and manufactured materials and objects.** ■ (K) Identify and describe a property of an object. ■ (K) Sort common materials and objects using a simple property (e.g., texture, color, size, shape). ■ (2) Sort common objects by multiple simple properties (e.g., texture and color; size and shape). ■ (2) Identify and describe the differences between common natural and manufactured materials and objects using properties.	**Understand how to use properties to sort natural and manufactured materials and objects.** W ■ (4) Identify, describe, and sort objects and materials using observed physical properties such as hardness, shape, state of matter, smell, temperature, texture, weight, and magnetic properties. ■ (4) Sort and classify natural and manufactured materials and objects according to various physical properties (e.g., length, weight, hardness, temperature, color, shape, texture, and smell). ■ (4) Identify and describe the state of water as solid, liquid, or gas in different situations. ■ (4) Identify which states of matter (solid, liquid, or gas) can change shape and which can expand to fill a container.
Physical Systems	1.1.2 Motion of Objects	**Understand the position and motion of common objects.** ■ (1) Know that things may move in many different ways (i.e., back and forth, fast and slow, round and round, straight). ■ (1) Describe that the way to change how something is moving is to give it a push or a pull.	**Understand the relative position and motion of objects.** W ■ (3) Measure and describe the position of one object relative to another object (or surroundings) using positional language (such as in front of, behind, to the left, to the right, above, and below) and a distance scale (such as centimeters). ■ (5) Describe the motion of an object in terms of distance, time, and direction as the object travels in a straight line.

Component 1.1 Properties: Understand how properties are used to identify, describe, and categorize substances, materials, and objects and how characteristics are used to categorize living things.

Physical Systems

	GLE	6 – 8	9 – 10
Properties of Substances	1.1.1	**Understand how to use physical and chemical properties to sort and identify substances.** W ■ (6) Identify, categorize, describe, and sort substances using physical and/or chemical properties (i.e., boiling point, density, freezing point, mass, acidity [pH], solubility, magnetism). ■ (8) Identify an unknown substance using the properties of a known substance. ■ (8) Recognize that the mass of an object is the same when measured anywhere in the universe at any normal speed. ■ (8) Describe why substances with the same volume or same mass may have different densities. ■ (8) Describe the volumetric properties of solids, liquids, and gases (e.g., a gas has the same volume as its container).	**Understand the atomic nature of matter, how it relates to physical and chemical properties and serves as the basis for the structure and use of the periodic table.** W ■ (10) Identify an unknown substance using the substance's physical and chemical properties. ■ (10) Explain and predict the behavior of a substance based upon the substance's atomic structure, physical properties, and chemical properties. ■ (10) Describe the properties of electrons, protons, and neutrons (i.e., electrons have negative charge and very little mass, protons have positive charge and much mass, neutrons have neutral charge and the same mass as protons). ■ (10) Explain how changing the number of electrons, neutrons, and protons of an atom affects that atom, including atomic name, number, and placement on the periodic table. ■ (10) Explain the similar properties of elements in a vertical column (groups or families) of the periodic table. ■ (10) Predict the properties of an element based on the element's location (groups or families) on the periodic table.
Motion of Objects	1.1.2	**Understand the positions, relative speeds, and changes in speed of objects.** W ■ (7) Describe and measure the relative position or change in position of one or two objects. ■ (7) Describe an object's motion as speeding up, slowing down, or moving with constant speed using models, numbers, words, diagrams, and graphs. ■ (7) Measure and describe the speed of an object relative to the speed of another object.	**Apply an understanding of direction, speed, and acceleration when describing the linear motion of objects.** W ■ (9) Describe the linear motion (speed, direction, and acceleration) of an object over a given time interval relative to Earth or some other object (e.g., as a car accelerates onto a freeway the car speeds up from 30 km/hr to 90 km/hr in 10 sec.). ■ (9) Determine and explain the average speed of an object over a given time interval when the object is moving in a straight line.

EALR 1 — SYSTEMS: The student knows and applies scientific concepts and principles to understand the properties, structures, and changes in physical, earth/space, and living systems.

Component 1.1 Properties: Understand how properties are used to identify, describe, and categorize substances, materials, and objects and how characteristics are used to categorize living things.

	GLE	K	1	2	3	4	5
Physical Systems	1.1.3 Wave Behavior				**Understand the behavior of sound in terms of vibrations and pitch and the behavior of light in terms of bouncing off, passing through, and changes in direction.** W ■ (3) Explain that when an object vibrates the object may produce sound that people can hear and give an example. ■ (3) Explain the relationship between the pitch of a sound and the vibrations of the object causing the sound. ■ (3) Describe experiences with sound (i.e., vibrations, echoes, and pitch). ■ (3, 4) Experience, measure, and describe the motion of light as light bounces off and/or passes through an object.		

	GLE	K	1	2	3	4	5
Physical Systems	1.1.4 Forms of Energy				**Understand that energy comes in many forms.** W ■ (4) Describe the forms of energy present in a system (i.e., energy of motion [kinetic], heat energy, sound energy, light energy, electrical energy, chemical energy, and food energy).		

Component 1.1 Properties: Understand how properties are used to identify, describe, and categorize substances, materials, and objects and how characteristics are used to categorize living things.

Physical Systems

	GLE	6 – 7 – 8	9 – 10
Wave Behavior	1.1.3	**Understand sound waves, water waves, and light waves using wave properties, including amplitude, wavelength, and speed. Understand wave behaviors, including reflection, refraction, transmission, and absorption.** W ■ (6) Describe how sound waves and/or water waves affect the motion of the particles in the substance through which the wave is traveling (e.g., air molecules vibrate back and forth as sound waves move through air). ■ (6) Describe the behavior of sound and water waves as the waves are reflected and/or absorbed by a substance. ■ (8) Describe how the observed properties of light, sound, and water are related to amplitude, frequency, wavelength, and speed of waves (e.g., color and brightness of light, pitch and volume of sound, height of water waves, light waves are faster than sound waves). ■ (8) Describe the behavior of light waves when light interacts with transparent, translucent, and opaque substances (e.g., blue objects appear blue in color because the object reflects mostly blue light and absorbs the other colors of light, transparent objects transmit most light through them, lenses refract light). ■ (8) Describe the changes in speed and direction as a wave goes from one substance into another.	**Analyze sound waves, water waves, and light waves using wave properties, including frequency and energy. Understand wave interference.** W ■ (10) Describe the relationship between the wave properties of amplitude and frequency and the energy of a wave (e.g., loud vs. soft sound, high vs. low pitch sound, bright vs. dim light, blue light vs. red light). ■ (10) Explain the relationship between a wave's speed and the properties of the substance through which the wave travels (e.g., all sound regardless of loudness and pitch travels at the same speed in the same air; a wave changes speed only when traveling from one substance to another). ■ (10) Predict and explain what happens to the pitch of sound and color of light as the wave frequency increases or decreases. ■ (10) Compare the properties of light waves, sound waves, and water waves. ■ (10) Describe the effects of wave interference (constructive and destructive).

	GLE	6 – 7 – 8	9 – 10
Forms of Energy	1.1.4	**Understand that energy is a property of matter, objects, and systems and comes in many forms (i.e., heat [thermal] energy, sound energy, light energy, electrical energy, kinetic energy, potential energy, and chemical energy).** W ■ (6) Describe the forms of energy present in matter, objects, and systems (i.e., heat [thermal] energy, sound energy, light energy, electrical energy, kinetic energy, potential energy, and chemical energy). ■ (6) Describe the form of energy stored in a part of a system (i.e., energy can be stored in many forms, "stored energy" is not a form of energy). ■ (8) Compare the potential and kinetic energy within a system at various locations or times (i.e., kinetic energy is an object's energy of motion; potential energy is an object's energy of position).	**Analyze the forms of energy in a system, subsystems, or parts of a system.** W ■ (10) Explain the forms of energy present in a system (i.e., thermal energy, sound energy, light energy, electrical energy, kinetic energy, potential energy, chemical energy, and nuclear energy). ■ (10) Compare the potential and/or kinetic energy of parts of systems at various locations or times (i.e., kinetic energy is an object's energy of motion; potential energy is an object's energy of position). ■ (10) Measure and describe the thermal energy of a system, subsystem, and/or parts of a system in terms of molecular motion (temperature) and energy from a phase change (e.g., observe, measure, and record temperature changes over time while heating ice to boiling water).

EALR 1

EALR 1 — SYSTEMS: The student knows and applies scientific concepts and principles to understand the properties, structures, and changes in physical, earth/space, and living systems.

Component 1.1 Properties: Understand how properties are used to identify, describe, and categorize substances, materials, and objects and how characteristics are used to categorize living things.

	GLE	K–2	3–5
Earth and Space Systems	1.1.5 Nature and Properties of Earth Materials	**Understand physical properties of Earth materials.** ■ (K) Sort rocks based on size, shape, and other physical properties (e.g., color, texture). ■ (2) Illustrate and tell about the properties of water as a solid and liquid. ■ (2) Explain how some Earth materials are used by living things (e.g., water and soil for growing plants).	**Understand physical properties of Earth materials including rocks, soil, water, and air.** W ■ (3) Describe and sort rocks based on physical properties (e.g., color, shape, size, texture). ■ (3) Describe and sort soils based on physical properties (e.g. color, particle size, ability to retain or drain water, texture, smell, support plant growth, source of mineral nutrients [not food] for plants). ■ (4) Describe the states of water on Earth (i.e., clouds, fog, dew, rain, hail, snow, ice) as solid, liquid, or gas. ■ (4) Describe the common conditions or properties of air (i.e., moving, blowing, wind, still, warm, cold, moist, takes up space, has weight).

	GLE	K–2	3–5
Living Systems	1.1.6 Characteristics of Living Matter	**Understand characteristics of living organisms.** ■ (K) Identify observable characteristics of living organisms (e.g., spiders have eight legs; birds have feathers; plants have roots, stems, leaves, seeds, flowers). ■ (2) Observe and describe characteristics of living organisms (e.g., spiders have eight legs; birds have feathers; plants have roots, stems, leaves, seeds, flowers).	**Understand how to distinguish living from nonliving and how to use characteristics to sort common organisms into plant and animal groups.** W ■ (4) Describe the characteristics of organisms. ■ (4) Describe and sort organisms using multiple characteristics (e.g., anatomy such as fins for swimming or leaves for gathering light, behavior patterns such as burrowing or migration, how plants and animals get food differently). ■ (4) Classify and sort common organisms into plant and animal groups.

Component 1.1 Properties: Understand how properties are used to identify, describe, and categorize substances, materials, and objects and how characteristics are used to categorize living things.

	GLE	6–8	9–10
Earth and Space Systems	1.1.5 Nature and Properties of Earth Materials	**Understand how to classify rocks, soils, air, and water into groups based on their chemical and physical properties.** W ■ (7) Describe properties of minerals and rocks that give evidence of how they were formed (e.g., crystal size and arrangement, texture, luster, cleavage, hardness, layering, reaction to acid). ■ (7) Describe properties of soils that give evidence of how the soils were formed (e.g., chemical composition such as acidic, types of particles, particle size, organic materials, layering). ■ (7) Describe how Earth's water (i.e., oceans, fresh waters, glaciers, ground water) can have different properties (e.g., salinity, density). ■ (7) Describe how the atmosphere has different properties at different elevations.	**Understand and analyze how the chemical composition of Earth materials (rocks, soils, water, and air) is related to their physical properties.** W ■ (9) Correlate the chemical composition of Earth materials (i.e., rocks, soils, water, and gases of the atmosphere) with their physical properties (e.g., limestone reaction to acid, the conductivity of copper, ice floats on water).
Living Systems	1.1.6 Characteristics of Living Matter	**Understand how to classify organisms by their external and internal structures.** W ■ (6) Describe how organisms can be classified using similarities and differences in physical and functional characteristics (both internal and external). ■ (8) Explain an inference about whether organisms have a biological relationship or common ancestry based on given characteristics.	**Analyze structural, cellular, biochemical, and genetic characteristics in order to determine the relationships among organisms.** W ■ (10) Analyze the relationship among organisms based on their shared physical, biochemical, genetic, and cellular characteristics and functional processes.

EALR 1 — SYSTEMS: The student knows and applies scientific concepts and principles to understand the properties, structures, and changes in physical, earth/space, and living systems.

Component 1.2 Structures: Understand how components, structures, organizations, and interconnections describe systems.

	GLE	K	1	2	3	4	5
Systems Structure	1.2.1 Structure of Physical Earth/Space and Living Systems	**Understand that things are made of parts that go together.** ■ (K) Identify the parts of objects, organisms, and materials (e.g., toys with moving parts, plants, animals, soils). ■ (1) Describe how the parts of objects, organisms, and materials go together. ■ (2) Construct simple devices to do common tasks using common materials and explain how the parts depend on each other (e.g., cardboard, wood, clay, rubber bands).			**Analyze how the parts of a system go together and how these parts depend on each other.** W ■ (3) Identify the parts of a system (e.g., a device, natural or living thing) and how the parts go together. ■ (3) Describe the function of a part of a system (e.g., a device, natural or living thing). ■ (4) Describe a simple system that can perform a task and illustrate how the parts depend on each using common classroom materials. ■ (4) Explain how one part of a system depends upon other parts of the same system. ■ (5) Predict and explain how a system would work if one of its parts was missing or broken. ■ (5) Describe what goes into (input) and out of (output) a system (e.g., what keeps a system running). ■ (5) Describe the effect on a system when an input in the system is changed.		

	GLE	K	1	2	3	4	5
Physical Systems	1.2.2 Energy Transfer and Transformation				**Understand that energy can be transferred from one object to another and can be transformed from one form of energy to another.** W ■ (4) Identify where or when a part of a simple system has the greatest or least energy (e.g., a toy car has the greatest energy when released from the top of a ramp). ■ (4) Describe transfers of energy (e.g., heat energy is transferred from hot water to a cup). ■ (4) Identify sources of energy in systems (e.g., battery for a flashlight, spring for a toy). ■ (4) Describe transformations of energy (e.g., energy of motion of hands clapping changing into sound energy).		

Component 1.2 Structures: Understand how components, structures, organizations, and interconnections describe systems.

	GLE	6–8	9–10
Systems Structure	1.2.1 Structure of Physical Earth/Space and Living Systems	**Analyze how the parts of a system interconnect and influence each other.** W ■ (6) Explain how the parts of a system interconnect and influence each other. ■ (7) Describe the flow of matter and energy through a system (i.e., energy and matter inputs, outputs, transfers, transformations). ■ (8) Describe the interactions and influences between two or more simple systems.	**Analyze how systems function, including the inputs, outputs, transfers, transformations, and feedback of a system and its subsystems.** W ■ (9) Describe the function of a system's parts or subsystems. ■ (9) Explain inputs, outputs, transfers, transformations, and feedback of matter, energy, and information in a system. ■ (10) Explain the interconnections between a system's parts or subsystems.
Physical Systems	1.2.2 Energy Transfer and Transformation	**Understand how various factors affect energy transfers and that energy can be transformed from one form of energy to another.** W ■ (6) Describe and determine the factors that affect heat energy transfer (e.g., properties of substances/materials [conductors, insulators], distance, direction, position). ■ (6) Describe how an increase in one type of energy of an object or system results in a decrease in other types of energy within that object or system (e.g., a falling object's potential energy decreases while its kinetic energy increases). ■ (6) Describe how waves transfer energy (e.g., light waves transfer energy from sun to Earth; air transfers an object's vibrations from one place to another as sound). ■ (8) Explain the transfer and transformations of energy within a system (e.g., conduction and convection of heat [thermal] energy).	**Analyze energy transfers and transformations within a system, including energy conservation.** W ■ (9) Describe and determine the energy inputted to an object as work (i.e., work on an object is the product of the force acting on the object and the distance the object moves as the force acts). ■ (9) Describe how a machine transfers work and transforms force and distance through a force-distance trade-off (e.g., a small force acting over a long distance can be transformed to a large force acting over a short distance). ■ (9) Examine and explain how energy is transferred within and among systems. ■ (10) Distinguish conditions likely to result in transfers or transformations of energy from one part of a system to another (e.g., a temperature difference may result in the flow of thermal energy from a hot area to a cold area). ■ (10) Describe what happens in terms of energy conservation to a system's total energy as energy is transferred or transformed (e.g., energy is never "lost," the sum of kinetic and potential energy remains somewhat constant). ■ (10) Explain the relationship between the motion of particles in a substance and the transfer or transformation of thermal and electrical energy (e.g., conduction of thermal and electrical energy as particles collide or interact, convection of thermal energy as groups of particles move from one place to another, and light waves transforming into thermal energy). ■ (10) Explain how or whether a phase change, a chemical reaction, or a nuclear reaction absorbs or releases energy in a system (e.g., water vapor forming rain or snow releases energy; water molecules speed up as they absorb energy until the molecules gain enough energy to become water vapor).

Component 1.2 Structures: Understand how components, structures, organizations, and interconnections describe systems.

EALR 1

	GLE	K	1	2	3	4	5
Physical Systems	1.2.3 Structure of Matter	**Know that common materials are made of smaller parts.** ■ (1) Sort objects based on component parts (e.g., toys with wheels). ■ (2) Show that people use magnifiers to observe things they cannot see with their eyes.			**Know that substances are made of small particles.** W ■ (4) Identify small parts of a substance as still being that substance (e.g., a drop of water is still water; a speck of sugar is still sugar). ■ (4) Observe and describe that some particles can only be seen with magnification. ■ (4) Describe objects that are made of only one kind of material and objects made of several kinds of material.		

Component 1.2 Structures: Understand how components, structures, organizations, and interconnections describe systems.

	GLE	6 – 8	9 – 10
Physical Systems	1.2.3 Structure of Matter	**Understand that all matter is made of particles called atoms and that atoms may combine to form molecules and that atoms and molecules can form mixtures.** W ■ (6) Describe that matter is made of particles called atoms and molecules. ■ (6) Describe that elements are made of one kind of atom. ■ (8) Describe how atoms may be combined in various ways and ratios to form molecules. ■ (8) Describe the different atoms and molecules in mixtures (e.g., dissolving carbon dioxide in water produces a type of mixture [solution] of CO_2 and H_20 molecules.)	**Understand the structure of atoms, how atoms bond to form molecules, and that molecules form solutions.** W ■ (10) Describe molecules forming a solution (e.g., salt added to water dissolves, forming a salt water solution, until saturation when no more salt will dissolve). ■ (10) Describe how to separate mixtures and or solutions of several different kinds of substances (e.g., sand, sugar, iron filings). ■ (10) Describe the structure of atoms in terms of protons and neutrons forming the nucleus, which is surrounded by electrons (e.g., a helium atom usually has a nucleus formed by 2 protons and 2 neutrons, which is surrounded by 2 electrons). ■ (10) Describe how atoms bond to form molecules in terms of transferring and/or sharing electrons (e.g., sodium atoms transfer an electron to chlorine atoms to form salt).

EALR 1 — SYSTEMS: The student knows and applies scientific concepts and principles to understand the properties, structures, and changes in physical, earth/space, and living systems.

Component 1.2 Structures: Understand how components, structures, organizations, and interconnections describe systems.

Earth and Space Systems

GLE	K	1	2	3	4	5
1.2.4 Components and Patterns of Earth Systems				**Understand that Earth's system includes a mostly solid interior, landforms, bodies of water, and an atmosphere.** W ■ (3) Identify land masses, bodies of water, and landforms on a globe or a map (e.g., continents, oceans, rivers, mountains). ■ (5) Describe how one part of Earth's system depends on or connects to another part of Earth's system (e.g., Puget Sound water affects the air over Seattle). ■ (5) Identify and describe various landmasses, bodies of water, and landforms (e.g., illustrate continents, oceans, seas, rivers, mountains, plains from a globe and a map). ■ (5) Construct a model that demonstrates understanding of Earth's structure as a system made of parts (e.g., solid surface, water, atmosphere).		

GLE	K	1	2	3	4	5
1.2.5 Components of the Solar System and Beyond (Universe)	**Know daily changes of the position of the Sun.** ■ (1) Observe and record (i.e., draw, construct, build, measure with nonstandard units) changes in the Sun's position in the sky during the day.			**Know how the Sun, Moon, and stars appear from Earth.** W ■ (4) Describe the daily motion of the Sun, Moon, and stars as seen from Earth's surface (e.g., the Sun, the Moon, and the stars all rise in the east and set in the west). ■ (4) Describe how the Moon looks a little different every day as seen from Earth (e.g., the lighted portion of the Moon changes shape every day). ■ (4) Describe how the patterns of stars in the sky stay the same as seen from Earth (e.g., constellations such as the "Big Dipper" always have the same pattern).		

Component 1.2 Structures: Understand how components, structures, organizations, and interconnections describe systems.

	GLE	6	7	8	9	10
Earth and Space Systems	1.2.4 Components and Patterns of Earth Systems	**Understand the components and interconnections of Earth's systems.** W ■ (7) Describe the components of the Earth's systems (i.e., the core, the mantle, oceanic and crustal plates, landforms, the hydrosphere and atmosphere). ■ (7) Describe the interactions among the components of Earth's systems (i.e., the core, the mantle, oceanic and crustal plates, landforms, the hydrosphere and atmosphere). ■ (7) Describe magma (i.e., magma comes from Earth's mantle and cools to form rocks).			**Analyze the patterns and arrangements of Earth systems and subsystems including the core, the mantle, tectonic plates, the hydrosphere, and layers of the atmosphere.** W ■ (9) Identify and describe sources of Earth's internal and external thermal energy. ■ (9) Explain how plate tectonics is caused by Earth's internal energy (e.g., nuclear energy from radioactivity in the core transforms to thermal energy in the mantle that, through convection, causes the motion of tectonic plates). ■ (9) Correlate Earth's surface features to observable weather patterns (e.g., rain shadow, deserts, rain forest).	
	GLE	6	7	8	9	10
Earth and Space Systems	1.2.5 Components of the Solar System and Beyond (Universe)	**Understand the structure of the Solar System.** W ■ (6) Describe how the Earth orbits the Sun and the Moon orbits the Earth. ■ (6) Describe the Sun (i.e., a medium-size star, the largest body in our solar system, major source of energy for phenomena on Earth's surface). ■ (6) Describe how planets, asteroids, and comets orbit the Sun. ■ (6) Describe meteors (e.g., planetary and comet debris that collides with Earth). ■ (8) Compare the relationships among the components of the solar system (e.g., composition, size, atmosphere, gravity, distance from the Sun, number of moons).			**Understand that the Solar System is in a galaxy in a universe composed of an immense number of stars and other celestial bodies.** W ■ (10) Describe how the Solar System is part of the Milky Way Galaxy. ■ (10) Compare how stars and other celestial bodies (at least 100 billion) are similar and different from each other (i.e., size, composition, distance from the Earth, temperature, age, source of light, and movement in space). ■ (10) Describe how other galaxies and other celestial bodies appear from Earth.	

EALR 1 — SYSTEMS: The student knows and applies scientific concepts and principles to understand the properties, structures, and changes in physical, earth/space, and living systems.

Component 1.2 Structures: Understand how components, structures, organizations, and interconnections describe systems.

	GLE	K–2	3–5
Living Systems	1.2.6 Structure and Organization of Living Systems	**Know that living things are made of small parts.** ■ (K) Observe and show how living things look different under a magnifier. ■ (2) Observe and identify the parts of an object seen under a magnifier. ■ (2) Illustrate or draw the small parts that make up the whole living thing.	**Understand that organisms can be a single cell or many cells that form parts with different functions.** W ■ (3) Observe with a microscope and record that living things are made mostly of cells (i.e., plants, animals, and single-celled organisms). ■ (3) Describe how plant and animal cells are similar and different. ■ (3) Describe the life function of a part of a living thing (e.g., wings of a bird).
Living Systems	1.2.7 Molecular Basis of Heredity	**Understand that plants and animals have life cycles.** ■ (2) Observe and describe the life cycle of a plant or animal (e.g., describe the life cycle of a butterfly — egg, caterpillar or larva, cocoon, and butterfly or adult).	**Understand the life cycles of plants and animals and the differences between inherited and acquired characteristics.** W ■ (3) Observe and describe the life cycle of a plant or animal. ■ (3) Describe that the young of plants and animals grow to resemble their parents as they mature into adults. ■ (3) Describe inherited characteristics (e.g., leaf shape, eye color) and learned characteristics (e.g., languages, social customs).
Living Systems	1.2.8 Human Biology	**Know the external parts of the body.** ■ (1) Identify the external parts of the body (e. g., head, hands, fingers, eyes, ears). ■ (1) Draw and name the external parts of the body.	**Understand the organization and function of human body structures and organs and how these structures and organs interconnect.** W ■ (4) Recognize, explain, and give examples of human systems that are composed of organs (e.g., ear for hearing, mouth for speech). ■ (4) Describe the functions of major organs (e.g., the skin protects the human body from harmful substances, unhealthy organisms, and from drying out; the brain get signals from the parts of the human body, controls the life functions, and sends signals out to the body parts). ■ (4) Describe the interdependence of organ systems in the human body (e.g., what would happen if one part of the human body system was missing). ■ (4) Describe how the systems allow the human body to take in and use mineral nutrients (air, food, water) for living, growth, and repair (e.g., breathing in air supplies the oxygen necessary to live). ■ (4) Identify and describe how human body systems compare to the systems of other living organisms (e.g., the human ear compared to an elephant's for hearing sound).

Component 1.2 Structures: Understand how components, structures, organizations, and interconnections describe systems.

Living Systems

GLE	6–8	9–10
1.2.6 Structure and Organization of Living Systems	**Understand that specialized cells within multicellular organisms form different kinds of tissues, organs, and organ systems to carry out life functions.** W ■ (6) Describe and identify how plant and animal cells are similar and different in structure and function. ■ (6) Describe basic cell functions (i.e., extracting energy from food, using energy, and getting rid of waste). ■ (8) Describe the life function of specialized cells or tissues (e.g., blood cells are different from bone cells; leaf tissues capture the energy from sunlight). ■ (8) Describe the life function of organs or organ systems (e.g., the stomach breaks down food and the intestines absorb food in the digestive system).	**Understand cellular structures, their functions, and how specific genes regulate these functions.** W ■ (10) Describe cellular structures that allow cells to extract and use energy from food, eliminate wastes, and respond to the environment (e.g., every cell is covered by a membrane that controls what goes into and out of the cell). ■ (10) Describe how DNA molecules are long chains linking four kinds of smaller molecules, whose sequence encodes genetic information. ■ (10) Describe how genes (DNA segments) provide instructions for assembling protein molecules in cells. ■ (10) Describe how proteins control life functions (e.g., the proteins myosin and actin interact to cause muscular contraction; the protein hemoglobin carries oxygen in some organisms).
1.2.7 Molecular Basis of Heredity	**Understand that organisms pass on genetic information in their life cycle and that an organism's characteristics are determined by both genetic and environmental influences.** W ■ (6) Explain that organisms require a set of instructions for specifying their traits (i.e., heredity is the passage of these instructions from one generation to another). ■ (6) Describe that genes inherited from parents are combined in their offspring to produce a new combination of characteristics. ■ (8) Explain how physical characteristics of living things can be affected by genetic information and/or by interactions with the environment (e.g., nutrition, disease, sanitation). ■ (8) Describe and compare sexual (two parents) and asexual (one parent) life cycles of plants and animals.	**Understand how genetic information (DNA) in the cell is encoded at the molecular level and provides genetic continuity between generations.** W ■ (10) Describe the role of chromosomes in reproduction (i.e., parents pass on chromosomes, which contain genes, to their offspring). ■ (10) Describe the possible results from mutation in DNA (e.g., only mutations in sex cells can be passed to offspring; mutations in other cells can only be passed to descendant cells). ■ (10) Describe how organisms pass on genetic information via asexual life cycles (i.e., the replication of genes in asexual reproduction results in the same gene combinations in the offspring as those of the parent). ■ (10) Describe how organisms pass on genetic information via sexual life cycles (i.e., the sorting and the recombination of genes in sexual reproduction results in a great variety of gene combinations and resultant variations in the offspring of any two parents).
1.2.8 Human Biology	**Understand human life functions and the interconnecting organ systems necessary to maintain human life.** W ■ (6) Describe the components and functions of the organ systems (i.e., circulatory, digestive, reproductive, excretory, nervous-sensory [brain, nerves, spinal cord, hearing, vision], respiratory, and muscular-skeletal systems). ■ (8) Describe relationships among the organ systems of the human body (e.g., the role of the senses and the nervous system for human survival, the relationships between the digestive and excretory systems). ■ (8) Compare human body systems to another organism's body system (e.g., human lungs to plant leaves, human skeletal or circulatory systems to plant stems).	**Analyze how human organ systems regulate growth, development, and life functions.** W ■ (10) Name the structural and functional characteristics of human organ systems, including the endocrine, immune, nervous, reproductive, and skin systems. ■ (10) Describe how the human body maintains relatively constant internal conditions (e.g., temperature, acidity, and blood sugar). ■ (10) Explain how human organ systems help maintain human health. ■ (10) Describe the role of human organ systems during human growth and development. ■ (10) Compare the structure and function of a human body system or subsystem to a nonliving system (e.g., human joints to hinges, enzyme and substrate to interlocking puzzle pieces).

EALR 1 — SYSTEMS: The student knows and applies scientific concepts and principles to understand the properties, structures, and changes in physical, earth/space, and living systems.

Component 1.3 Changes: Understand how interactions within and among systems cause changes in matter and energy.

Physical Systems

GLE	K–2	3–5
1.3.1 Nature of Force	**Know that a push or a pull is a force on an object but some forces can act without touching an object.** ■ (1) Observe and show that a push or a pull on an object is a force on that object. ■ (1) Observe and show that a magnet can push or pull some objects without touching the objects.	**Understand forces in terms of strength and direction.** W ■ (3) Describe a force that is acting on an object in terms of strength and direction (e.g., electrical force, gravitational force, magnetic force, a push, or a pull). ■ (3) Measure the force acting on an object with a spring scale calibrated in Newtons. ■ (5) Compare the strength of one force to the strength of another force (e.g., measure that a 5-Newton pull from a spring scale is like the weight of a 1-pound object).
1.3.2 Forces to Explain Motion	**Know that pushes and pulls can change the motion of common objects.** ■ (1) Observe and show that objects fall toward the ground because of the pull of Earth's gravity. ■ (1) Observe and show that magnets can make some objects move without touching the objects.	**Understand that forces can change the motion of common objects.** W ■ (3) Investigate and report how the position and motion of objects can be changed by a force. ■ (5) Investigate and report how a larger force acting on an object causes a greater change in motion of that object, 2nd Law of Motion (e.g., a 2-Newton pull causes a toy car to speed up more than a 1-Newton force).
1.3.3 Conservation of Matter and Energy	**Know that water can exist in different states: solid and liquid.** ■ (2) Observe and record water changing from solid to liquid. ■ (2) Describe the physical properties of water in solid and liquid states (e.g., hard, cold, wet).	**Understand that a substance remains the same substance when changing state. Understand that two or more substances can react to become new substances.** W ■ (4) Observe and describe water changing state from ice to liquid water to water vapor and back (e.g., with freezing, melting, evaporation, and condensation water remains water). ■ (5) Observe and describe how a substance is the same substance before and after heating or cooling (e.g., solid candle wax can be heated to become liquid candle wax then cooled back to the same solid candle wax). ■ (5) Describe how two different substances can form a simple chemical reaction to produce new substances (e.g., baking soda and vinegar react to form a gas).

Component 1.3 Changes: Understand how interactions within and among systems cause changes in matter and energy.

Physical Systems

GLE		6	7	8	9	10
1.3.1	Nature of Force	**Understand factors that affect the strength and direction of forces.** W ■ (7) Observe and describe factors that affect the strength of forces (e.g., an object with a greater mass has a greater gravitational force [weight]; certain types of magnets have greater magnetic forces; a larger muscle can pull with a greater force). ■ (7) Describe how forces acting on an object may balance each other (e.g., the downward force of gravity on an object sitting on a table is balanced by an upward force from the table). ■ (7) Measure and describe how a simple machine can change the strength and/or direction of a force (i.e., levers and pulleys). ■ (7) Describe pressure as a force (e.g., pressure increases result in greater forces acting on objects going deeper in a body of water).			**Analyze the forces acting on objects.** W ■ (9) Describe how machines transform forces (e.g., a long lever allows a small downward input force to be transformed into a large upward output force). ■ (9) Describe the strength (in Newtons) and direction of forces acting on an object. ■ (9) Measure and describe the sum of all the forces acting on an object. ■ (9) Describe how forces between objects occur, both when the objects are touching and when the objects are apart. ■ (9) Explain that the strength of a gravitational force between two objects depends on the mass of the objects and the distance between the objects.	
GLE		6	7	8	9	10
1.3.2	Forces to Explain Motion	**Understand how balanced and unbalanced forces can change the motion of objects.** W ■ (7) Describe how an unbalanced force changes the speed and/or direction of motion of different objects moving along a straight line, 2nd Law of Motion (e.g., a larger unbalanced force is needed to equally change the motion of more massive objects). ■ (7) Describe how frictional forces act to stop the motion of objects. ■ (7) Investigate and describe the balanced and unbalanced forces acting on an object (e.g., a model car speeding up on a table has both an unbalanced force pulling it forward and a gravitational force pulling it down balanced by the table pushing upward). ■ (7) Investigate and describe pressure differences that result in unbalanced forces moving objects (e.g., pressure differences cause forces that move air masses, move blood through the heart, cause volcanic eruptions).			**Analyze the effects of balanced and unbalanced forces on the motion of an object.** W ■ (9) Describe the balanced forces acting on an object moving at a constant speed along a straight line, 1st Law of Motion (e.g., a car traveling at a constant speed of 60 mph on a straight freeway has a force pushing it forward balanced by frictional forces acting in the opposite direction). ■ (9) Explain how unbalanced forces change the speed and/or direction of motion of different objects moving along a straight line, 2nd Law of Motion (e.g., a 2-kg object needs twice the unbalanced force to speed up the same amount as a 1-kg object). ■ (9) Investigate and describe that forces always come in pairs, 3rd Law of Motion (e.g., pull a spring scale against another spring scale, as water blasts out of a bottle rocket two forces act — a force on the water and an equal force on the rocket).	
GLE		6	7	8	9	10
1.3.3	Conservation of Matter and Energy	**Understand that matter is conserved during physical and chemical changes.** W ■ (7) Observe and describe evidence of physical and chemical changes of matter (e.g., change of state, size, shape, temperature, color, gas production, solid formation, light). ■ (7) Observe and describe that substances undergoing physical changes produce matter with the same chemical properties as the original substance and the same total mass (e.g., tearing paper, freezing water, breaking wood, sugar dissolving in water). ■ (7) Observe and describe that substances may react chemically to form new substances with different chemical properties and the same total mass (e.g., baking soda and vinegar; light stick mass before, during, and after reaction).			**Analyze the factors that affect physical, chemical, and nuclear changes and understand that matter and energy are conserved.** W ■ (9) Investigate and analyze the effect of different factors on the rate of a physical and chemical change (e.g., temperature, surface area, pressure, catalysts). ■ (9) Explain how chemical changes produce substances with different chemical properties and the same total mass. ■ (9) Describe the products of radioactive decay in terms of the conservation of matter and energy (e.g., a radioactive nucleus decays into a new nucleus and emits particles and rays). ■ (9) Recognize and explain that the rate of radioactive decay of a substance is constant, not affected by any factors (e.g., the half-life of a radioactive substance is constant over a long time and a wide range of conditions found on Earth).	

EALR 1 — SYSTEMS: The student knows and applies scientific concepts and principles to understand the properties, structures, and changes in physical, earth/space, and living systems.

Component 1.3 Changes: Understand how interactions within and among systems cause changes in matter and energy.

Earth and Space Systems

	GLE	K–2	3–5
Processes and Interactions in the Earth System	1.3.4	**Know that rocks break down to form pebbles and sand.** ■ (2) Describe how rocks can break down into smaller pieces (e.g., pebbles and sand) by the action of water.	**Know processes that change the surface of Earth.** W ■ (5) Describe how weathering and erosion change the surface of the Earth. ■ (5) Describe how earthquakes, landslides, and volcanic eruptions change Earth's surface.
History and Evolution of the Earth	1.3.5	**Know that fossils provide evidence of plants and animals that existed long ago.** ■ (2) Identify a fossil in a rock. ■ (2) Compare fossils (that represent the remains of prehistoric plants and animals) with similar living organisms (e.g., a fossil leaf with a leaf, a fossil shell with a shell).	**Understand that fossils provide evidence of plants, animals, and environments that existed long ago.** W ■ (5) Observe and describe a fossil in a rock. ■ (5) Know that fossils provide evidence about plants and animals that lived long ago and the nature of the environment at that time.

Component 1.3 Changes: Understand how interactions within and among systems cause changes in matter and energy.

Earth and Space Systems

	GLE	6 / 7 / 8	9 / 10
Processes and Interactions in the Earth System	1.3.4	**Understand the processes that continually change the surface of the Earth.** W ■ (7) Describe the processes by which soils are formed (e.g., erosion and deposition in river systems). ■ (7) Describe how heat (thermal) energy flow and movement (convection currents) beneath Earth's crust cause earthquakes and volcanoes. ■ (7) Describe how constructive processes change landforms (e.g., crustal deformation, volcanic eruption, deposition of sediment). ■ (7)Describe how destructive processes change landforms (e.g., rivers erode landforms). ■ (7) Describe the processes involved in the rock cycle (e.g., magma cools into igneous rocks; rocks are eroded and deposited as sediments; sediments solidify into sedimentary rocks; rocks can be changed by heat and pressure to form metamorphic rocks).	**Analyze processes that have caused changes to the features of Earth's surface, including plate tectonics.** W ■ (9) Describe the processes that cause the movement of material in Earth's systems (e.g., pressure differences that cause convection resulting in winds, mantle movement, and ocean currents; erosion and deposition). ■ (9) Describe the effects of glaciation and floods on the Pacific Northwest. ■ (9) Describe the causes and effects of volcanoes, hot spots, and earthquakes in Washington State and elsewhere (e.g., subduction of the Juan de Fuca plate causes earthquakes that may cause seismic sea waves; earthquakes along the Seattle fault cause P, S, and surface seismic waves). ■ (9) Explain how substances change as they move through Earth's systems (e.g., carbon cycle, nitrogen cycle, burning of wood and fossil fuels).
History and Evolution of the Earth	1.3.5	**Understand how fossils and other evidence are used to document life and environmental changes over time.** W ■ (7) Describe how fossils are formed. ■ (7) Describe different kinds of evidence that are used to document past conditions on Earth (e.g., glacial markings, ash layers, tree rings, rock layers). ■ (7) Describe how fossils and other artifacts provide evidence of how life has changed over time (e.g., extinction of species).	**Analyze a variety of evidence, including rock formations, fossils, and radioactive decay, to construct a sequence of geologic events.** W ■ (9) Explain how decay rates of radioactive materials in rock layers are used to establish the age of fossil remains or the time of geologic events. ■ (9) Describe how rock formations can be used to determine the nature of past geologic events. ■ (9) Correlate evidence of geologic events to the relative and absolute dates of rock layers to construct a sequence of the history of Earth.

Component 1.3 Changes: Understand how interactions within and among systems cause changes in matter and energy.

Earth and Space Systems

	GLE	K	1	2	3	4	5
Hydrosphere and Atmosphere	1.3.6	**Know common weather indicators and understand that weather conditions change from season to season.** ■ (1) Observe, measure, and record weather conditions, noting changes and patterns from day to day and over the seasons (e.g., temperature, wind, rain, snow). ■ (1) Name common weather conditions (e.g., rain, snow, wind).			**Understand weather indicators and understand how water cycles through the atmosphere.** W ■ (3) Observe, measure, and describe weather indicators (i.e., temperature, wind direction and speed, precipitation), noting changes and patterns of change from day to day and over the year. ■ (3) Describe the weather patterns of each season. ■ (5) Describe the effects of water cycling through the land, oceans, and atmosphere (e.g., clouds, rain, snow, hail, rivers).		

	GLE	K	1	2	3	4	5
Interactions in the Solar System and Beyond (Universe)	1.3.7				**Know how the appearance of the Sun, Moon, and stars changes as seen from Earth.** W ■ (4) Describe how the Sun rises and sets at different places and times every day in a yearly pattern. ■ (4) Describe how the appearance of the Moon changes in a predictable pattern (e.g., new Moon to full Moon every 28 days). ■ (4) Describe how star patterns are different at different times of the year as seen from Earth (e.g., constellations such as Orion cannot always be seen during the course of a year).		

Component 1.3 Changes: Understand how interactions within and among systems cause changes in matter and energy.

Earth and Space Systems

GLE	6–8	9–10
1.3.6 Hydrosphere and Atmosphere	**Analyze the relationship between weather and climate and how ocean currents and global atmospheric circulation affect weather and climate.** W ■ (7) Compare weather and climate. ■ (7) Explain the effect of the water cycle on weather (e.g., cloud formation, storms). ■ (7) Explain how ocean currents influence the atmosphere in terms of weather and climate. ■ (7) Explain the causes of atmospheric circulation and oceanic currents (e.g., prevailing winds are the result of hot tropical regions, cold polar regions, and Earth's spin).	**Analyze the factors that influence weather and climate.** W ■ (9) Explain how energy transfers and transformations among the atmosphere, hydrosphere, and landforms affect climate and weather patterns. ■ (9) Explain how greenhouse gases in the atmosphere affect climate (e.g., global warming). ■ (9) Describe how catastrophic events (e.g., volcanic eruptions, forest fires, asteroid impacts) can cause climate and weather changes.
1.3.7 Interactions in the Solar System and Beyond (Universe)	**Understand the effects of the regular and predictable motions of planets and moons in the Solar System.** W ■ (6) Describe the causes of seasonal changes on Earth and other planets (i.e., Earth's tilt causes different parts of Earth to point toward the Sun at different times of the year). ■ (6) Describe the effects of the position of the Sun and Moon on Earth phenomena (i.e., Moon phases, solar and lunar eclipses, shadows on Earth, tides). ■ (8) Describe how the spin of Earth and other planets accounts for the length of a day on those planets. ■ (8) Describe how Earth's and other planets' orbits around the Sun account for the length of a year on those planets.	**Understand how stars, solar systems, galaxies, and the universe were formed and how these systems continue to evolve.** W ■ (10) Explain phenomena caused by the regular and predictable motions of planets and moons in the Solar System. ■ (10) Describe how the Solar System formed. ■ (10) Describe that the Solar System is part of the Milky Way Galaxy and how the Milky Way and other galaxies appear from Earth. ■ (10) Describe the formation and life cycle of stars. ■ (10) Describe the properties of different stars (e.g., size, temperature, age, formation, energy production). ■ (10) Describe how the Big Bang theory explains the observed properties of the universe (e.g., expansion, evolution, structures, element generation by fusion).

EALR 1 — SYSTEMS: The student knows and applies scientific concepts and principles to understand the properties, structures, and changes in physical, earth/space, and living systems.

Component 1.3 Changes: Understand how interactions within and among systems cause changes in matter and energy.

	GLE	K–2	3–5
Living Systems	1.3.8 Life Processes and the Flow of Matter and Energy	**Know that most living things need food, water, and air.** ■ (1) Observe and record that most living things need food, water, and air. ■ (1) Observe and record or demonstrate that plants need light.	**Understand that living things need constant energy and matter.** W ■ (3) Identify sources of energy and matter used by plants to grow and sustain life (e.g., air, water, light, food, mineral nutrients). ■ (4) Identify sources of energy and matter used by animals to grow and sustain life (e.g., air, water, light, food, mineral nutrients). ■ (5) Explain how plants and animals obtain food (e.g., plants make food from air, water, sunlight, mineral nutrients; animals obtain food from other living things).
Living Systems	1.3.9 Biological Evolution	**Know that fossils show how organisms looked long ago.** ■ (2) Observe and record how fossils are similar to living organisms (e.g., leaves, shells).	**Understand that plant and animal species change over time.** W ■ (5) Recognize and tell how some kinds of plants and animals survive well, some survive less well, and some cannot survive at all in particular environments, and provide examples. ■ (5) Recognize and describe how individual plants and animals of the same kind differ in their characteristics and sometimes the differences give individuals an advantage in surviving and reproducing. ■ (5) Demonstrate or describe that fossils can be compared to one another and to living organisms according to their similarities and differences (i.e., some organisms that lived long ago are similar to existing organisms, but some are quite different).
Living Systems	1.3.10 Interdependence of Life	**Know that plants and animals need a place to live.** ■ (1) Observe and show how organisms live in specific places (e.g., fish live in a pond). ■ (1) Describe how animals depend on plants or other animals for food. ■ (1) Describe how animals depend on plants or other animals for shelter.	**Understand that that an organism's ability to survive is influenced by the organism's behavior and the ecosystem in which it lives.** W ■ (3) Describe the characteristics of organisms that allow them to survive in an ecosystem. ■ (3) Describe the role of an organism in a food chain of an ecosystem (i.e., predator, prey, consumer, producer, decomposer, scavenger). ■ (5) Describe how an organism's ability to survive is affected by a change in an ecosystem (e.g., the loss of one organism in a food chain affects all other organisms in that food chain). ■ (5) Describe the path of substances (i.e., air, water, mineral nutrients) through a food chain.

Component 1.3 Changes: Understand how interactions within and among systems cause changes in matter and energy.

Living Systems

GLE	6 – 8	9 – 10
1.3.8 Life Processes and the Flow of Matter and Energy	**Understand how individual organisms, including cells, obtain matter and energy for life processes.** W ■ (7) Describe the different sources of matter and energy required for life processes in plants and animals (e.g., seeds have energy for germination; green plants need light for energy). ■ (7) Describe how organisms acquire materials needed for life processes. ■ (7) Describe how systems interact to distribute materials and eliminate wastes produced by life processes. ■ (7) Describe that both plants and animals extract energy from food, but plants produce their own food from light, air, water, and mineral nutrients, while animals consume energy-rich foods.	**Understand how organisms, including cells, use matter and energy to sustain life and that these processes are complex, integrated, and regulated.** W ■ (9) Describe how organisms sustain life by obtaining, transporting, transforming, releasing, and eliminating matter and energy. ■ (9) Describe how energy is transferred and transformed from the Sun to energy-rich molecules during photosynthesis. ■ (9) Describe how individual cells break down energy-rich molecules to provide energy for cell functions.
1.3.9 Biological Evolution	**Understand how the theory of biological evolution accounts for species diversity, adaptation, natural selection, extinction, and change in species over time.** W ■ (7) Describe how fossils show that extinction is common and that most organisms that lived long ago have become extinct. ■ (7) Describe how individual organisms with certain traits are more likely than others to survive and have off-spring (i.e., natural selection, adaptation). ■ (7) Describe how biological evolution accounts for the diversity of species developed through gradual processes over many generations.	**Analyze the scientific evidence used to develop the theory of biological evolution and the concepts of natural selection, speciation, adaptation, and biological diversity.** W ■ (10) Describe the factors that drive natural selection (i.e., overproduction of offspring, genetic variability of offspring, finite supply of resources, competition for resources, and differential survival). ■ (10) Explain how natural selection and adaptation lead to organisms well suited for survival in particular environments. ■ (10) Examine or characterize the degree of evolutionary relationship between organisms based on biochemical, genetic, anatomical, or fossil record similarities and differences.
1.3.10 Interdependence of Life	**Understand how organisms in ecosystems interact with and respond to their environment and other organisms.** W ■ (7) Describe how energy flows through a food chain or web. ■ (7) Describe how substances such as air, water, and mineral nutrients are continually cycled in ecosystems. ■ (7) Explain the role of an organism in an ecosystem (e.g., predator, prey, consumer, producer, decomposer, scavenger, carnivore, herbivore, omnivore). ■ (7) Describe how a population of an organism responds to a change in its environment.	**Analyze the living and nonliving factors that affect organisms in ecosystems.** W ■ (9) Describe how matter and energy are transferred and cycled through ecosystems (i.e., matter and energy move from plants to herbivores/omnivores to carnivores and decomposers). ■ (9) Compare different ecosystems in terms of the cycling of matter and flow of energy. ■ (9) Describe how population changes cause changes in the cycle of matter and the flow of energy in ecosystems. ■ (9) Describe the living and nonliving factors that limit the size and affect the health of a population in an ecosystem.

EALR 2 — INQUIRY: The student knows and applies the skills, processes, and nature of scientific inquiry.

Component 2.1 Investigating Systems: Develop the knowledge and skills necessary to do scientific inquiry.

Investigating Systems

GLE	K–2	3–5
2.1.1 Questioning	**Understand how to ask a question about objects, organisms, and events in the environment.** ■ (K, 1, 2) Wonder and ask questions about objects, organisms, and events based on observations of the natural world.	**Understand how to ask a question about objects, organisms, and events in the environment.** W ■ (3, 4, 5) Identify the question being answered in an investigation. ■ (3, 4, 5) Ask questions about objects, organisms, and events based on observations of the natural world. ■ (5) Develop a new question that can be investigated with the same materials and/or data as a given investigation.

GLE	K–2	3–5
2.1.2 Planning and Conducting Safe Investigations	**Understand how to plan and conduct simple investigations following all safety rules.** ■ (1, 2) Make observations and record characteristics or properties. ■ (2) Make predictions of the results of an investigation. ■ (2) Plan and conduct an observational investigation that collects information about characteristics or properties. ■ (2) Collect data using simple equipment and tools that extend the senses (e.g., magnifiers, rulers, balances, scales, and thermometers). ■ (K, 1, 2) Follow all safety rules during investigations.	**Understand how to plan and conduct simple investigations following all safety rules.** W ■ (3, 4, 5) Make predictions of the results of an investigation. ■ (5) Generate a logical plan for, and conduct, a simple controlled investigation with the following attributes: • prediction • appropriate materials, tools, and available computer technology • variables kept the same (controlled) • one changed variable (manipulated) • measured (responding) variable • gather, record, and organize data using appropriate units, charts, and/or graphs • multiple trials ■ (5) Generate a logical plan for a simple field investigation with the following attributes: • Identify multiple variables • Select observable or measurable variables related to the investigative question ■ (3, 4, 5) Identify and use simple equipment and tools (such as magnifiers, rulers, balances, scales, and thermometers) to gather data and extend the senses. ■ (3, 4, 5) Follow all safety rules during investigations.

Component 2.1 Investigating Systems: Develop the knowledge and skills necessary to do scientific inquiry.

Investigating Systems

GLE	6 / 7 / 8	9 / 10
2.1.1 Questioning	**Understand how to generate a question that can be answered through scientific investigation.** W ■ (6, 7, 8) Generate multiple questions based on observations. ■ (6, 7, 8) Generate a question that can be investigated scientifically. ■ (6, 7, 8) Generate a new question that can be investigated with the same materials and/or data as a given investigation.	**Understand how to generate and evaluate questions that can be answered through scientific investigations.** W ■ (9, 10) Generate a new question that can be investigated with the same materials and/or data as a given investigation. ■ (9, 10) Generate questions, and critique whether questions can be answered through scientific investigations.
2.1.2 Planning and Conducting Safe Investigations	**Understand how to plan and conduct scientific investigations.** W ■ (6, 7, 8) Make predictions (hypothesize) and give reasons. ■ (6, 7, 8) Generate a logical plan for, and conduct, a scientific controlled investigation with the following attributes: • prediction (hypothesis) • appropriate materials, tools, and available computer technology • controlled variables (kept the same) • one manipulated (changed) variable • responding (dependent) variable • gather, record, and organize data using appropriate units, charts, and/or graphs • multiple trials ■ (6, 7, 8) Generate a logical plan for a simple field investigation with the following attributes: • Identify multiple variables • Select observable or measurable variables related to the investigative question ■ (6, 7, 8) Identify and explain safety requirements that would be needed in the investigation.	**Understand how to plan and conduct systematic and complex scientific investigations.** W ■ (9, 10) Make a hypothesis about the results of an investigation that includes a prediction with a cause-effect reason. ■ (9, 10) Generate a logical plan for, and conduct, a systematic and complex scientific controlled investigation with the following attributes: • hypothesis (prediction with cause-effect reason) • appropriate materials, tools, and available computer technology • controlled variables • one manipulated variable • responding (dependent) variable • gather, record, and organize data using appropriate units, charts, and/or graphs • multiple trials • experimental control condition when appropriate • additional validity measures ■ (9, 10) Generate a logical plan for a simple field investigation with the following attributes: • Identify multiple variables • Select observable or measurable variables related to the investigative question ■ (9, 10) Identify and explain safety requirements that would be needed in an investigation.

EALR 2 — INQUIRY: The student knows and applies the skills, processes, and nature of scientific inquiry.

Component 2.1 Investigating Systems: Develop the knowledge and skills necessary to do scientific inquiry.

Investigating Systems

GLE	K–2	3–5
2.1.3 Explaining	**Understand how to construct a reasonable explanation using evidence.** ■ (2) Categorize and order observational data from multiple trials. ■ (2) Explain an event or phenomenon using observations as evidence (e.g., shape, texture, size, weight, color, motion, and/or other physical properties).	**Understand how to construct a reasonable explanation using evidence.** W ■ (3, 4, 5) Generate a scientific conclusion including supporting data from an investigation (e.g., grass grows taller with more light; with only 2 hours of light each day, grass grew 2 centimeters in two weeks, but with 6 hours of light, grass grew 8 centimeters). ■ (3, 4, 5) Describe a reason for a given conclusion using evidence from an investigation. ■ (4, 5) Generate a scientific explanation of observed phenomena using given data. ■ (5) Predict what logically might occur if an investigation lasted longer or was changed.
2.1.4 Modeling	**Understand that models represent real objects, events, or processes.** ■ (2) Describe how a model (e.g., diagram or map and/or physical model) of something is similar to the real thing, such as an object, event, or process, and how it is different (e.g., size, shape, color). ■ (2) Create a simple model (e.g., diagram or map and/or physical model) of a common object, event, or process.	**Understand how to use simple models to represent objects, events, systems, and processes.** W ■ (3, 4, 5) List similarities and differences between a model and what the model represents (e.g., a hinge and an elbow; a spinning globe and Earth's rotations; steam from a tea kettle and clouds or fog). ■ (3, 4, 5) Create a simple model to represent common objects, events, systems, or processes (e.g., diagram or map and /or physical model). ■ (3, 4, 5) Investigate phenomena using a simple physical or computer model or simulation. ■ (5) Describe reasons for using a model to investigate phenomena (e.g., processes that happen very slowly or quickly; things that are too small or too large for direct observation; phenomena that cannot be controlled or are potentially dangerous).
2.1.5 Communicating	**Understand how to record and report investigations, results, and explanations.** ■ (K, 1, 2) Report observations of simple investigations using drawings and simple sentences. ■ (1, 2) Describe and or draw the materials used in the investigation (e.g., numbers, shapes, colors). ■ (K,1, 2) Report safety procedures used during the investigation. ■ (2) Report the process used and results of the investigation (e.g., verbal, visual, written, and/or mathematical formats).	**Understand how to report investigations and explanations of objects, events, systems, and processes.** W ■ (3, 4, 5) Report observations or data of simple investigations without making inferences. ■ (3, 4, 5) Summarize an investigation by describing: • reasons for selecting the investigative plan • materials used in the investigation • observations, data, results • explanations and conclusions in written, mathematical, oral, and information technology presentation formats • safety procedures used

Component 2.1 Investigating Systems: Develop the knowledge and skills necessary to do scientific inquiry.

Investigating Systems

GLE	6 – 8	9 – 10
2.1.3 Explaining	**Apply understanding of how to construct a scientific explanation using evidence and inferential logic.** W ■ (6, 7, 8) Generate a scientific conclusion including supporting data from an investigation using inferential logic (e.g., chewing gum loses more mass than bubble gum after being chewed for 5 minutes; chewing gum lost 2.00 grams while bubble gum only lost 1.47 grams). ■ (6, 7, 8) Describe a reason for a given conclusion using evidence from an investigation. ■ (6, 7, 8) Generate a scientific explanation of an observed phenomenon using given data. ■ (6) Predict what logically might occur if an investigation lasted longer or changed. ■ (7, 8) Describe the difference between evidence (data) and conclusions.	**Synthesize a revised scientific explanation using evidence, data, and inferential logic.** W ■ (9, 10) Generate a scientific conclusion, including supporting data from an investigation, using inferential logic. (e.g., The fertilizer did help the plants grow faster, but had little effect on the number of seeds that germinated. With the fertilizer, the plants matured 35 days sooner than plants without the fertilizer. Almost all of the 30 seeds used germinated, 13 seeds in the fertilized soil and 14 seeds in the soil without fertilizer.) ■ (9, 10) Describe a reason for a given conclusion using evidence from an investigation. ■ (9, 10) Generate a scientific explanation of an observed phenomenon using given data. ■ (9, 10) Predict and explain what logically might occur if an investigation lasted longer or changed. ■ (9, 10) Explain the difference between evidence (data) and conclusions. ■ (10) Revise a scientific explanation to better fit the evidence and defend the logic of the revised explanation. ■ (9, 10) Explain how scientific evidence supports or refutes claims or explanations of phenomena.
2.1.4 Modeling	**Analyze how models are used to investigate objects, events, systems, and processes.** W ■ (6) Compare models or computer simulations of phenomena to the actual phenomena. ■ (6) Explain how models or computer simulations are used to investigate and predict the behavior of objects, events, systems, or processes. ■ (6, 7, 8) Create a model or computer simulation to investigate and predict the behavior of objects, events, systems, or processes (e.g., phases of the Moon using a solar system model). ■ (7) Explain the advantages and limitations of investigating with a model.	**Analyze how physical, conceptual, and mathematical models represent and are used to investigate objects, events, systems, and processes.** W ■ (9, 10) Compare how a model or different models represent the actual behavior of an object, event, system, or process. ■ (9, 10) Evaluate how well a model describes or predicts the behavior of an object, event, system, or process. ■ (9, 10) Create a physical, conceptual, and/or mathematical (computer simulation) model to investigate, predict, and explain the behavior of objects, events, systems, or processes (e.g., DNA replication).
2.1.5 Communicating	**Apply understanding of how to report investigations and explanations of objects, events, systems, and processes.** W ■ (6, 7, 8) Report observations of scientific investigations without making inferences. ■ (6, 7, 8) Summarize an investigation by describing: • reasons for selecting the investigative plan • materials used in the investigation • observations, data, results • explanations and conclusions in written, mathematical, oral, and information technology presentation formats • ramifications of investigations • safety procedures used ■ (6, 7, 8) Describe the difference between an objective summary of data and an inference made from data.	**Apply understanding of how to report complex scientific investigations and explanations of objects, events, systems, and processes and how to evaluate scientific reports.** W ■ (9, 10) Report observations of scientific investigations without making inferences. ■ (9, 10) Summarize an investigation by describing: • reasons for selecting the investigative plan • materials used in the investigation • observations, data, results • explanations and conclusions in written, mathematical, oral, and information technology presentation formats • ramifications of investigations to concepts, principles, and theories • safety procedures used ■ (9, 10) Describe the difference between an objective summary of data and an inference made from data. ■ (9, 10) Compare the effectiveness of different graphics and tables to describe patterns, explanations, conclusions, and implications found in investigations. ■ (9, 10) Critique a scientific report for completeness, accuracy, and objectivity.

EALR 2 — INQUIRY: The student knows and applies the skills, processes, and nature of scientific inquiry.

Component 2.2 Nature of Science: Understand the nature of scientific inquiry.

Nature of Science

GLE	K–2	3–5
2.2.1 Intellectual Honesty	**Understand that all scientific observations are reported accurately even when the observations contradict expectations.** ■ (K, 1, 2) Record what is observed and explain how it was done accurately and honestly. ■ (1, 2) Keep records and explain that the records have not been changed even when they did not match initial expectations.	**Understand that all scientific observations are reported accurately and honestly even when the observations contradict expectations.** W ■ (3, 4, 5) Explain why scientific observations are recorded accurately and honestly. ■ (3, 4, 5) Explain why scientific records of observations are not changed even when the records do not match initial expectations. ■ (3, 4, 5) Explain why honest acknowledgement of the contributions of others and information sources are necessary.
2.2.2 Limitations of Science and Technology	**Understand that observations and measurement are used by scientists to describe the world.** ■ (K, 1, 2) Raise questions about the natural world and seek answers by making careful observations and trying things out. ■ (1, 2) Make observations and measurements about natural phenomena.	**Understand that scientific facts are measurements and observations of phenomena in the natural world that are repeatable and/or verified by expert scientists.** W ■ (3) Describe how new scientific facts are established every day (e.g., find examples of new facts in current media). ■ (4, 5) Describe whether measurements and/or observations of phenomena are scientific facts. ■ (4, 5) Describe whether a report of an observation is a scientific fact or an interpretation (e.g., seeing a light in the night sky versus seeing a star).
2.2.3 Evaluating Inconsistent Results	**Understand that similar investigations may not produce similar results.** (Grade 2) ■ (2) Observe the procedures of two similar investigations and explain that they produced different results.	**Understand why similar investigations may not produce similar results.** W ■ (3, 4, 5) Describe reasons why two similar investigations can produce different results (e.g., identify possible sources of error). ■ (4, 5) Explain whether sufficient information has been obtained to make a conclusion.

Component 2.2 Nature of Science: Understand the nature of scientific inquiry.

Nature of Science

GLE	6	7	8	9	10
2.2.1 Intellectual Honesty	**Apply curiosity, honesty, skepticism, and openness when considering explanations and conducting investigations.** W ■ (6, 7, 8) Explain why an honest response to questionable results, conclusions, or explanations is important to the scientific enterprise. ■ (8) Describe a flaw in a claim or a conclusion (i.e., limited data, flawed procedure, or overgeneralization). ■ (6, 7, 8) Describe how scientists accurately and honestly record, report, and share observations and measurements without bias. ■ (6, 7, 8) Explain why honest acknowledgement of the contributions of others and information sources are necessary.			**Analyze why curiosity, honesty, cooperation, openness, and skepticism are important to scientific explanations and investigations.** W ■ (9, 10) Explain why honesty ensures the integrity of scientific investigations (e.g., explanations in the absence of credible evidence, questionable results, conclusions or explanations inconsistent with established theories). ■ (9, 10) Explain why a claim or a conclusion is flawed (e.g., limited data, lack of controls, weak logic). ■ (9, 10) Explain why scientists are expected to accurately and honestly record, report, and share observations and measurements without bias. ■ (9, 10) Explain why honest acknowledgement of the contributions of others and information sources are necessary (e.g., undocumented sources of information, plagiarism). ■ (9, 10) Explain why peer review is necessary in the scientific reporting process.	
GLE	**6**	**7**	**8**	**9**	**10**
2.2.2 Limitations of Science and Technology	**Understand that scientific theories explain facts using inferential logic.** W ■ (6, 7, 8) Describe how a principle or theory logically explains a given set of facts. ■ (7, 8) Describe how new facts or evidence may result in the modification or rejection of a theory (e.g., caloric theory of heat, theory of acquired characteristics).			**Analyze scientific theories for logic, consistency, historical and current evidence, limitations, and capacity to be investigated and modified.** W ■ (9, 10) Describe how a theory logically explains a set of facts, principles, concepts and/or knowledge. ■ (9, 10) Describe a theory that best explains and predicts phenomena and investigative results. ■ (9, 10) Explain how scientific theories are open to investigation and have the capacity to be modified.	
GLE	**6**	**7**	**8**	**9**	**10**
2.2.3 Evaluating Inconsistent Results	**Analyze inconsistent results from scientific investigations to determine how the results can be explained.** W ■ (6, 7, 8) Compare two or more similar investigations and explain why different results were produced (e.g., insufficient data could be interpreted as inconsistent results). ■ (6, 7, 8) Explain whether sufficient information has been obtained to make a conclusion. ■ (7, 8) Explain why the results from a single investigation or demonstration are not sufficient to describe a phenomenon.			**Evaluate inconsistent or unexpected results from scientific investigations using scientific explanations.** W ■ (9, 10) Evaluate similar investigations with inconsistent or unexpected results. ■ (9, 10) Explain whether sufficient data has been obtained to make an explanation or conclusion (e.g., reference previous and current research; incorporate scientific concepts, principles, and theories). ■ (9, 10) Explain why results from a single investigation or demonstration are not conclusive about a phenomenon.	

EALR 2 — INQUIRY: The student knows and applies the skills, processes, and nature of scientific inquiry.

Component 2.2 Nature of Science: Understand the nature of scientific inquiry.

Nature of Science

GLE		K	1	2	3	4	5
2.2.4	Evaluating Methods of Investigation				**Understand how to make the results of scientific investigations reliable.** W ■ (3, 4, 5) Describe how the method of investigation insures reliable results (i.e., reliability means that repeating an investigation gives similar results). ■ (4, 5) Identify and describe ways to increase the reliability of the results of an investigation (e.g., multiple trials of an investigation increase the reliability of the results).		

GLE		K	1	2	3	4	5
2.2.5	Evolution of Scientific Ideas	**Know that ideas in science change as new scientific evidence arises.** ■ (1, 2) Tell how scientific inquiry results in facts, unexpected findings, ideas, evidence, and explanations.			**Understand that scientific comprehension of systems increases through inquiry.** W ■ (3, 4, 5) Describe how scientific inquiry results in facts, unexpected findings, ideas, evidence, and explanations. ■ (4, 5) Describe how results of scientific inquiry may change our understanding of the systems of the natural and constructed world. ■ (5) Explain how ideas about the natural and/or constructed world have changed because of scientific inquiry.		

Component 2.2 Nature of Science: Understand the nature of scientific inquiry.

	GLE	6	7	8	9	10
Nature of Science	2.2.4 Evaluating Methods of Investigation	**Understand how to make the results of scientific investigations reliable and how to make the methods of investigation valid.** W ■ (6) Describe how the method of an investigation ensures reliable results (e.g., multiple trials ensure more reliable results). ■ (6, 7, 8) Describe how to increase the reliability of the results of an investigation (e.g., repeating an investigation exactly the same way increases the reliability of the results). ■ (7, 8) Describe how the method of an investigation is valid (i.e., validity means that the investigation answered the investigative question with confidence; the manipulated variable caused the change in the responding or dependent variable). ■ (7, 8) Describe the purpose of the steps and materials of an investigation's procedure in terms of the validity of the investigation. ■ (8) Modify an investigation to improve the validity of the investigation and explain how the modifications improved the validity (e.g., more controlled variables, more accurate measuring techniques, greater sample size).			**Analyze scientific investigations for validity of method and reliability of results.** W ■ (9, 10) Describe how the methods of an investigation ensured reliable results. ■ (9, 10) Explain how to increase the reliability of the results of an investigation (e.g., repeating an investigation exactly the same way increases the reliability of the results). ■ (9, 10) Describe how the methods of an investigation ensured validity (i.e., validity means that the investigation answered the investigative question with confidence; the manipulated variable caused the change in the responding or dependent variable). ■ (9, 10) Explain the purpose of the steps of an investigation in terms of the validity of the investigation. ■ (9, 10) Explain how to improve the validity of an investigation (e.g., control more variables, better measuring techniques, increased sample size, control for sample bias, include experimental control condition when appropriate, include a placebo group when appropriate). ■ (10) Explain an appropriate type of investigation to ensure reliability and validity for a given investigative question (e.g., descriptive, controlled, correlational, comparative, see Appendix D and Appendix E).	
	GLE	**6**	**7**	**8**	**9**	**10**
Nature of Science	2.2.5 Evolution of Scientific Ideas	**Understand that increased comprehension of systems leads to new inquiry.** W ■ (6, 7, 8) Describe how scientific inquiry results in new facts, evidence, unexpected findings, ideas, and explanations. ■ (7, 8) Describe how results of scientific inquiry may change our understanding of the systems of the natural and constructed world. ■ (6, 7, 8) Describe how increased understanding of systems leads to new questions to be investigated. ■ (7, 8) Describe how new ideas need repeated inquiries before acceptance. ■ (8) Describe how new investigative questions arise at the completion of scientific inquiry.			**Understand how scientific knowledge evolves.** W ■ (9) Explain how existing ideas were synthesized from a long, rich history of scientific explanations and how technological advancements changed scientific theories. ■ (9, 10) Explain how scientific inquiry results in new facts, evidence, unexpected findings, ideas, explanations, and revisions to current theories. ■ (9, 10) Explain how results of scientific inquiry may change our understanding of the systems of the natural and constructed world. ■ (9, 10) Explain how increased understanding of systems leads to new questions to be investigated. ■ (9, 10) Explain how new ideas need repeated inquiries before acceptance. ■ (9, 10) Use new tools to investigate a system to discover new facts about the system that lead to new ideas and questions.	

EALR 3 — APPLICATION: The student knows and applies science concepts and skills to develop solutions to human problems in societal contexts.

Component 3.1 Designing Solutions: Apply knowledge and skills of science and technology to design solutions to human problems or meet challenges.

Designing Solutions

GLE	K–2	3–5
3.1.1 Identifying Problems	**Know and understand problems that can be solved or have been solved by using scientific design.** ■ (2) Identify and explain problems that can be solved through investigations and/or with tools. ■ (2) Identify and describe a problem in a given situation (e.g., "I want to make the plant grow faster"). ■ (2) Identify and name a common material, object, or tool that helps solve a simple problem.	**Understand problems found in ordinary situations in which scientific design can be or has been used to design solutions.** W ■ (3,4, 5) Describe an appropriate question that could lead to a possible solution to a problem. ■ (3,4, 5) Describe how science and technology could be used to solve a human problem (e.g., using an electric lamp as a source of varied light for plant growth). ■ (3,4, 5) Describe the scientific concept, principle, or process used in a solution to a human problem (e.g., a student using the force of a stretched spring for a push or pull). ■ (3,4, 5) Describe how to scientifically gather information to develop a solution (e.g., find an acceptable information source, do an investigation, and collect data).
3.1.2 Designing and Testing Solutions	**Understand how to construct and test a solution to a problem.** ■ (2) Propose, construct, and test a solution to a problem: • give examples of possible solutions to the problem • select and construct a solution to the problem • test a solution to the problem	**Understand how the scientific design process is used to develop and implement solutions to human problems.** W ■ (3, 4, 5) Propose, implement, and document the scientific design process used to solve a problem or challenge: • define the problem • scientifically gather information and collect measurable data • explore ideas • make a plan • list steps to do the plan • scientifically test solutions • document the scientific design process ■ (3, 4, 5) Describe possible solutions to a problem (e.g., preventing an injury on the playground by creating a softer landing at the bottom of a slide). ■ (3, 4, 5) Describe the reason(s) for the effectiveness of a solution to a problem or challenge.
3.1.3 Evaluating Potential Solutions	**Understand how well a design or a product solves a problem.** ■ (2) Choose and justify at least one reason why a design or product would or would not work to solve a specific problem.	**Analyze how well a design or a product solves a problem.** W ■ (3, 4, 5) Identify the criteria for an acceptable solution to a problem or challenge. ■ (3, 4, 5) Describe the reason(s) for the effectiveness of a solution to a problem or challenge using scientific concepts and principles. ■ (3, 4, 5) Describe the consequences of the solution to a problem or challenge (e.g., sharpening a crayon results in using up crayons faster). ■ (3, 4, 5) Describe how to change a system to solve a problem or improve a solution to a problem. ■ (3, 4, 5) Test how well a solution works based on criteria, and recommend and justify, with scientific concepts or principles and data, how to make it better (e.g., sharpen a crayon using sandpaper; one grit is better than another).

EALR 3 — APPLICATION: The student knows and applies science concepts and skills to develop solutions to human problems in societal contexts.

Component 3.1 Designing Solutions: Apply knowledge and skills of science and technology to design solutions to human problems or meet challenges.

	GLE	6–8	9–10
Designing Solutions	3.1.1 Identifying Problems	**Analyze common problems or challenges in which scientific design can be or has been used to design solutions.** W ■ (6, 7, 8) Describe how science and technology could be used to solve all or part of a human problem and vice versa (e.g., understanding erosion can be used to solve some flooding problems). ■ (6, 7, 8) Describe the scientific concept, principle, or process used in a solution to a human problem (e.g., understanding of the relationship between electricity and magnetism has been used to make electric motors and generators). ■ (6, 7, 8) Explain how to scientifically gather information to develop a solution (e.g., collect data by measuring all the factors and establish which are the most important to solve the problem). ■ (6, 7, 8) Describe an appropriate question that could lead to a possible solution to a problem.	**Analyze local, regional, national, or global problems or challenges in which scientific design can be or has been used to design a solution.** W ■ (9, 10) Explain how science and technology could be used to solve all or part of a human problem and vice versa (e.g., understanding the composition of an Earth material can be useful to humans, such as copper ore being used to make copper wire). ■ (9, 10) Explain the scientific concept, principle, or process used in a solution to a human problem (e.g., understanding the effect of seismic waves on structures can be used to design buildings to withstand an earthquake). ■ (9, 10) Explain how to scientifically gather information to develop a solution (e.g., perform a scientific investigation and collect data to establish the best materials to use in a solution to the problem). ■ (9, 10) Describe an appropriate question that could lead to a possible solution to a problem. ■ (9, 10) Describe a change that could improve a tool or a technology.
	GLE	6–8	9–10
	3.1.2 Designing and Testing Solutions	**Apply the scientific design process to develop and implement solutions to problems or challenges.** W ■ (6, 7, 8) Propose, implement, and document a scientific design process used to solve a problem or challenge: • define the problem • scientifically gather information and collect measurable data • explore ideas • make a plan • list steps to do the plan • scientifically test solutions • document the scientific design process ■ (6, 7, 8) Explain possible solutions to the problem (e.g., use pulleys instead of levers to lift a heavy object). ■ (6, 7, 8) Explain the reason(s) for the effectiveness of a solution to a problem or challenge.	**Evaluate the scientific design process used to develop and implement solutions to problems or challenges.** W ■ (9, 10) Research, propose, implement, and document a scientific design process used to solve a problem or challenge: • define the problem • scientifically gather information and collect empirical data • explore ideas • make a plan • list steps to do the plan • scientifically test solutions • document the scientific design process ■ (9, 10) Evaluate possible solutions to the problem (e.g., describe how to clean up a polluted stream). ■ (9, 10) Evaluate the reason(s) for the effectiveness of a solution to a problem or challenge.
	GLE	6–8	9–10
	3.1.3 Evaluating Potential Solutions	**Analyze multiple solutions to a problem or challenge.** W ■ (6, 7, 8) Describe the criteria to evaluate an acceptable solution to the problem or challenge. ■ (6, 7, 8) Describe the reason(s) for the effectiveness of a solution to a problem or challenge using scientific concepts and principles. ■ (7, 8) Describe the consequences of the solution to the problem or challenge (e.g., using rocks on the edge of a stream to prevent erosion may destroy habitat). ■ (7, 8) Describe how to change a system to solve a problem or improve a solution to a problem. ■ (8) Compare the effectiveness of different solutions to a problem or challenge based on criteria, using scientific concepts and principles.	**Evaluate consequences, constraints, and applications of solutions to a problem or challenge.** W ■ (9, 10) Explain the criteria to evaluate the solution(s) to a problem or challenge. ■ (9, 10) Explain the effectiveness of the solution to the problem or challenge using scientific principles and concepts. ■ (9, 10) Explain the consequences of the solution(s) to the problem or challenge (e.g., doubling the fertilizer will probably not double the plant growth and could cause harm to the ecosystem). ■ (9, 10) Explain how to change a system to solve a problem or improve a solution to a problem. ■ (9, 10) Compare and evaluate the effectiveness of different solutions to a problem or challenge based on criteria, using scientific concepts and principles.

EALR 3 — APPLICATION: The student knows and applies science concepts and skills to develop solutions to human problems in societal contexts.

Component 3.2 Science, Technology, and Society: Analyze how science and technology are human endeavors, interrelated to each other, society, the workplace, and the environment.

Science, Technology, and Society

GLE	K	1	2	3	4	5
3.2.1 All Peoples Contribute to Science and Technology	**Know that science and technology are practiced by all peoples around the world.** ■ (2) Identify ways that people around the world use science and technology. ■ (2) Identify ways that people around the world use science and technology to invent things and ideas.			**Understand that science and technology have been practiced by all peoples throughout history.** ■ (3, 4, 5) Describe how individuals of diverse backgrounds have made significant scientific discoveries or technological advances. ■ (3, 4, 5) Describe how advancements in science and technology have developed over time and with contributions from diverse people.		

GLE	K	1	2	3	4	5
3.2.2 Relationship of Science and Technology	**Know that people have invented tools for everyday life.** ■ (K, 1, 2) Describe ways in which common tools help people in their everyday life.			**Understand that people have invented tools for everyday life and for scientific investigations.** W ■ (3) Describe tools (technology) invented to advance scientific investigations (e.g., thermometers, rulers, microscopes, telescopes). ■ (4) Describe how scientific tools help people design solutions to human problems (e.g., hand lens to see the detailed structure of leaves). ■ (5) Describe how common tools help people design ways to adapt to different environments (e.g., sewing needle to make clothes). ■ (5) Describe how scientific ideas and discoveries are used to design solutions to human problems, extend human ability, or help humans adapt to different environments (e.g., prosthetics used to replace lost limbs).		

Component 3.2 Science, Technology, and Society: Analyze how science and technology are human endeavors, interrelated to each other, society, the workplace, and the environment.

Science, Technology, and Society

GLE	6	7	8	9	10
3.2.1 All Peoples Contribute to Science and Technology	**Analyze how science and technology have been developed, used, and affected by many diverse individuals, cultures, and societies throughout human history.** ■ (6, 7, 8) Explain how the contributions of diverse individuals have led to the development of science and technology. ■ (8) Explain how science and technology have affected individuals, cultures, and societies throughout human history.			**Analyze how scientific knowledge and technological advances discovered and developed by individuals and communities in all cultures of the world contribute to changes in societies.** ■ (9) Explain how life has changed throughout history because of scientific knowledge and technological advances from a variety of peoples. ■ (10) Compare the impacts of diverse cultures and individuals on science and technology.	

GLE	6	7	8	9	10
3.2.2 Relationship of Science and Technology	**Analyze scientific inquiry and scientific design and understand how science supports technological development and vice versa.** W ■ (7, 8) Describe how scientific investigations and scientific research support technology (e.g., investigation into materials led to Gortex and Kevlar). ■ (7, 8) Describe how technology supports scientific investigations and research (e.g., microscopes led to the discovery of unicellular organisms). ■ (7, 8) Describe how a scientifically designed solution to a human problem can lead to new tools that generate further inquiry (e.g., microscopes, telescopes, and computers). ■ (7, 8) Compare the processes of scientific inquiry and scientific design in terms of activities, results, and/or influence on individuals and/or society.			**Analyze how the scientific enterprise and technological advances influence and are influenced by human activity.** W ■ (9, 10) Describe how science and/or technology have led to a given social or economic development. ■ (10) Explain risks associated with investigations involving living things (e.g., drug trials on animals, testing of genetically engineered plants, release of African snails into the environment after experimentation). ■ (10) Identify the limits of scientific research in solving a given social, environmental, and/or economic problem. ■ (10) Compare advantages and/or disadvantages of using new technology or science in terms of ethics, politics, and environmental considerations. ■ (10) Explain the concept of proprietary discovery (e.g., patents on genes).	

Component 3.2 Science, Technology, and Society: Analyze how science and technology are human endeavors, interrelated to each other, society, the workplace, and the environment.

Science, Technology, and Society

GLE	K–2	3–5
3.2.3 Careers and Occupations Using Science, Mathematics, and Technology	**Know how knowledge and skills of science, mathematics, and technology are used in common occupations.** ■ (1) Tell at least one way that science, mathematics, or technology is used by a person in a job.	**Understand how knowledge and skills of science, mathematics, and technology are used in common occupations.** ■ (3, 4, 5) Identify science, math, and technology skills used in a career. ■ (3, 4, 5) Identify occupations using scientific, mathematical, and technological knowledge and skills.

GLE	K–2	3–5
3.2.4 Environmental and Resource Issues	**Understand how humans depend on the natural environment.** ■ (K, 1, 2) Describe what humans obtain from their environment (e.g., a school garden yields vegetables; a sheep yields wool, which is used to make sweaters). ■ (1, 2) Describe what organisms obtain from their environment (e.g., a school plant needs water and sunlight).	**Understand how humans depend on the natural environment and can cause changes in the environment that affect humans' ability to survive.** W ■ (3, 4, 5) Describe how resources can be conserved through reusing, reducing, and recycling. ■ (3, 5) Describe the effects conservation has on the environment. ■ (3, 5) Describe the effects of humans on the health of an ecosystem. ■ (3, 5) Describe how humans can cause changes in the environment that affect the livability of the environment for humans. ■ (3, 5) Describe the limited resources humans depend on and how changes in these resources affect the livability of the environment for humans.

Component 3.2 Science, Technology, and Society: Analyze how science and technology are human endeavors, interrelated to each other, society, the workplace, and the environment.

Science, Technology, and Society

GLE	6, 7, 8	9, 10
3.2.3 Careers and Occupations Using Science, Mathematics, and Technology	**Analyze the use of science, mathematics, and technology within occupational/career areas of interest.** ■ (6, 7, 8) Examine scientific, mathematical, and technological knowledge and skills used in an occupation/career. ■ (6, 7, 8) Research occupations/careers that require knowledge of science, mathematics, and technology.	**Analyze the scientific, mathematical, and technological knowledge, training, and experience needed for occupational/career areas of interest.** ■ (9, 10) Research and report on educational requirements associated with an occupation(s)/career(s) of interest. ■ (9, 10) Examine the scientific, mathematical, and technological knowledge, training, and experience needed for occupational/career areas of interest.
3.2.4 Environmental and Resource Issues	**Analyze how human societies' use of natural resources affects the quality of life and the health of ecosystems.** W ■ (6, 7, 8) Discriminate between renewable and nonrenewable resources in an ecosystem. ■ (6, 7, 8) Explain the effects that the conservation of natural resources has on the quality of life and the health of ecosystems. ■ (6, 7, 8) Explain the effects of various human activities on the health of an ecosystem and/or the ability of organisms to survive in that ecosystem (e.g., consumption of natural resources; waste management; urban growth; land use decisions; pesticide, herbicide, or fertilizer use).	**Analyze the effects human activities have on Earth's capacity to sustain biological diversity.** W ■ (9, 10) Explain how the use of renewable and nonrenewable natural resources affects the sustainability of an ecosystem. ■ (9, 10) Explain how human activities affect Earth's capacity to sustain biological diversity (e.g., global warming, ozone depletion).

Glossary of Scientific Terms

Apply: The skill of selecting and using information in other situations or problems.

Challenges: Problems that can be solved using science concepts and principles, inquiry, and technology.

Claim: A valid conclusion of a scientific investigation.

Common: Refers to materials and processes most students have experienced.

Concept: An abstract, universal idea of phenomena or relationships between phenomena in the natural world.

Confidence: Assurance that the conclusions of an investigation are reliable and valid.

Conservation: A law that states that matter and/or energy in a closed system are constant.

Conservation of Energy: Energy cannot be created or destroyed — only changed from one form to another.

Conservation of Mass: Mass can be neither created nor destroyed during a chemical reaction — only changed from one form to another.

Constraints: The limitations imposed on possible solutions to human problems or challenges.

Constructed world: Systems or subsystems of the natural world built entirely or in part by people.

Control: A standard condition against which other conditions can be compared in a scientific experiment.

Controlled variable: The conditions that are kept the same in a scientific investigation.

Correlational: A type of scientific investigation in which the causality between variables cannot be directly inferred.

Describe: The skill of developing a detailed picture, image, or characterization using diagrams and/or words, written or aural.

Design: The application of scientific concepts and principles and the inquiry process to the solution of human problems that regularly provide tools to further investigate the natural world.

Discriminate: The skill of distinguishing accurately between and among evidence.

e.g.: Refers to specific examples of Evidence of Learning

Effect: The result or consequence of an action, influence, or causal agent.

Empirical: Measurements based on actual observations or experience, rather than on theory.

Error: Mistakes of perception, measurement, or process during an investigation; an incorrect result or discrepancy.

Established: A proven, or demonstrated, inference or theory.

Evaluate: The skill of collecting and examining data to make judgments and appraisals using established evidence.

Evidence: Observations, measurements or data collected through established and recognized scientific processes.

Evolution: A series of gradual or rapid changes, some regular, some random, that account for the present form and function of phenomena both living and nonliving.

Examine: The skill of using a scientific method of observation to explore, test, or inquire about a theory, hypothesis, inference, or conclusion.

Experiment: An investigation under which the conditions for a phenomenon to occur are artificial, or arranged beforehand by the observer.

Explain: The skill of making a theory, hypothesis, inference, or conclusion plain and comprehensible — includes supporting details with an example.

Explain how: The skill of making a process plain and comprehensible — includes supporting details with an example.

Explain that: The skill of making plain and comprehensible a theory, hypothesis, inference, or conclusion — includes supporting details with an example.

Feedback mechanism: The process in which part of the output of a system is returned to its input in order to regulate further output.

Human problems: Difficulties for individuals or populations that invite or call for a solution.

Hypothesis: A testable explanation for a specific problem or question, based on what has already been learned. A statement usually in an "if, then" format that posits a causal or correlational relationship between variables. The manipulated variable is stated in the "if" statement and represents the possible causal agent. The effect is stated in the "then" phrase and is the responding or measured variable of the investigation.

Idea: A general perception, thought, or concept formed by generalization.

i.e.: Refers to specific lists in Evidence of Learning that must be included in the GLE.

Inference: The skill of arriving at a decision or conclusion by reasoning from known facts; in a scientific investigation, the logic used to establish correlational or causal relationships among variables in the system being investigated.

Information explosion: The rapid expansion of knowledge of the natural world, in part brought about by the feedback of new knowledge and new technologies into the scientific, technological, and communication enterprises.

Information technology: The branch of technology devoted to (a) the study and application of data and the processing thereof, i.e., the automatic acquisition, storage, manipulation (including transformation), management, movement, control, display, switching, interchange, transmission or reception of data, and (b) the development and use of the hardware, software, firmware, and procedures associated with this processing.

Input: The addition of matter, energy, or information to a system; a change of matter or energy in the system; a living organism learning something new.

Inquiry: The skill of the investigative process characterized by asking questions of the natural world, developing hypotheses, testing hypotheses by manipulating variables and measuring responding variables, and drawing inferences from data to develop correlations between variables or cause-effect relationships between variables.

Integrity: A state of honesty; freedom from corrupting influence, motive, or bias in the collection and interpretation of data and observations; a completeness or totality of the investigative process.

Interactions: The influences between variables in a system or between subsystems described as correlational or causal.

Interpretation: The display and inferences drawn from data collected during a scientific investigation.

Investigation: A multifaceted and organized scientific study of the natural world that involves making observations; asking questions; gathering information through planned study in the field, laboratory, or research setting; and using tools to gather data that is analyzed to find patterns and is subsequently communicated.

Law: An observed regularity of the natural world; a generalization that scientists make from research findings and can use to accurately predict what will happen in many situations.

Logical plan: An investigative plan that has coherence among all its attributes, including hypotheses, observations and data to support the hypotheses, and logical inference to support conclusions.

Manipulated variable: The factor of a system being investigated that is deliberately changed to determine that factor's relationship to the responding variable.

Model: A representation of a system, subsystem, or parts of a system that can be used to predict or demonstrate the operation or qualities of the system.

Natural world: The aspect of human experience that is observable and can be empirically verified.

Observation: The skill of recognizing and noting some fact or occurrence in the natural world, including the act of measuring.

Output: The removal of matter, energy, or information from a system; a change of matter or energy in the system; a living organism produces and excretes a substance.

Phenomena: Events or objects occurring in the natural world.

Prediction: The skill of extrapolating to a future event or process based on theory, investigation, or experience.

Principles: Rules or laws concerning the functioning of systems of the natural world.

Properties: The basic or essential attributes shared by all members of a group.

Proprietary discovery: Ideas, artifacts, devices, or processes that are patentable.

Relationship: The connections between systems, subsystems, or parts of systems described by the concepts and principles of science that may range from correlational to causal (cause-effect).

Reliability: An attribute of any investigation that describes the consistency of producing the same observations or data.

Responding variable: The factor of a system being investigated that changes in response to the manipulated variable and is measured.

Science: The systematized knowledge of the natural world derived from observation, study, and investigation; also the activity of specialists to add to the body of this knowledge.

Skepticism: The attitude in scientific thinking that emphasizes that no fact or principle can be known with complete certainty; the tenet that all knowledge is uncertain.

Solutions: Artifacts of the scientific design process in response to human problems that can include devices or processes such as environmental impact statements.

Subsystem: The subset of interrelated parts within the larger system.

System: An assemblage of interrelated parts or conditions through which matter, energy, and information flow.

Technology: The application of science to solve practical problems, do something more efficiently, or improve the quality of life.

Theory: An integrated, comprehensive explanation of many facts capable of generating hypotheses and testable predictions about the natural world.

Transfer: The movement of energy from one location in a system to another system or subsystem.

Transformation: The changes in the kind of energy that take place in moving through a system.

Trials: Repetitions of data collection protocols in an investigation.

Validity: An attribute of an investigation that describes the quality of data produced in an investigation; the investigative question is answered with confidence; insures that the manipulated variable caused the change in the responding or dependent variable.

Variable: Any changed or changing factor used to test a hypothesis or prediction in an investigation that could affect the results.

Appendix A: Cognitive Demand
Adapted from Bloom's Taxonomy of the Cognitive Domain

	Cognitive Demand/Type	Evidence of Learning Terms	
Know	**Knowledge:** Recall — Remembering previously learned materials. **Example GLE:** Know that common materials are made of smaller parts. *Examples of Evidence of Learning* ■ Recognize common science terms and symbols in text (cm., g., sec.). ■ Identify basic concepts and principles.	■ Match ■ Define ■ Repeat ■ Memorize ■ Label/Name ■ Outline/Format ■ Recount	■ Record ■ Recognize ■ Identify ■ Sort ■ List ■ State
Understand	**Comprehension:** Understand — Grasping the meaning of material: translation, interpretation, extrapolation. **Example GLE:** Understand that things are made of parts that go together. *Examples of Evidence of Learning* ■ Make, confirm, and revise prediction based on prior knowledge and evidence from investigations. ■ Interpret data as evidence in the context of concepts and principles.	■ Locate ■ Restate ■ Paraphrase ■ Describe ■ Summarize ■ Cite ■ Interpret ■ Document/ Support	■ Infer ■ Predict ■ Illustrate ■ Show ■ Express ■ Explain
Apply	**Application:** Generalize — Using learned material in new situations. **Example GLE:** Apply understanding of how to construct a scientific explanation using evidence and inferential logic. *Examples of Evidence of Learning* ■ Apply laws and theories to practical situations. ■ Construct charts and graphs from data and observations to support conclusions.	■ Select ■ Use ■ Manipulate ■ Organize ■ Imagine ■ Test	■ Demonstrate ■ Solve ■ Dramatize ■ Frame ■ Apply ■ Construct

	Cognitive Demand/Type	Evidence of Learning Terms	
Analyze	**Analysis:** Breakdown — Breaking down systems into their component parts or subsystems so that they may be more easily understood. **Example GLE:** Analyze how physical, conceptual, and mathematical models represent and are used to investigate objects, events, systems, and processes. *Examples of Evidence of Learning* ■ Compare and contrast different interpretations of data from an investigation. ■ Generalize about processes, concepts, and common themes from multiple sources. ■ Examine how a system's change may lead to long-lasting effects.	■ Examine ■ Classify ■ Research ■ Debate/Defend ■ Map ■ Characterize ■ Compare/ Contrast ■ Conclude/Draw Conclusions	■ Refute ■ Similarities/ Differences ■ Distinguish/ Differentiate ■ Relate to ■ Outline ■ Generalize
Synthesize	**Synthesis:** Compose — Putting material together to form a new system. **Example GLE:** Synthesize a revised scientific explanation using evidence (data), existing explanations, and inferential logic. *Examples of Evidence of Learning* ■ Write a laboratory report that includes conclusions and discussion. ■ Propose a plan for an investigation.	■ Propose ■ Plan ■ Compose ■ Formulate ■ Design ■ Construct	■ Imagine/ Speculate ■ Create ■ Invent ■ Integrate
Evaluate	**Evaluation:** Judge — Judging according to a set of criteria stated by the evaluator. **Example GLE:** Evaluate inconsistent or unexpected results from scientific investigations using scientific explanations. *Examples of Evidence of Learning* ■ Read an article and decide if it reports science concepts correctly. ■ Judge the integrity of data and logical consistency and correctness of conclusions.	■ Evaluate ■ Judge ■ Weigh ■ Consider ■ Appraise ■ Recommend ■ Select the Best/Tell Why	■ Critique/ Criticize ■ Choose/Justify Choice ■ Scale ■ Value

Appendix B: WASL Vocabulary Grades 5, 8, and 10

Students should be able to understand and use the terms on the WASL vocabulary lists. The lists are not inclusive of all science terms used on the WASL. Any term that is two or more grade levels below the level being assessed may be used on the WASL without being included on these lists. All other science terms will be defined. Additionally, students in grade 8 are expected to understand and use terms listed for grade 5. Likewise, students in grade 10 are expected to understand and use the terms listed for grades 5 and 8.

Grade 5 Vocabulary

absorb
affect
air
amount
amount of time
axis
balance scale
bone
brain
cause
cell
centimeter (cm)
changed (manipulated) variable
characteristic
chart
classify
climate
color
compost
conclude
conclusion
condensation
condense
conserve (as ecology)
consumer
conversion
continent
cycle
data
decomposer
demonstrate
depend
describe
design
diagram
diameter
direction
dissolve
Earth
earthquake
echo
ecosystem
effect
egg
electrical
electricity
energy
energy of motion (kinetic)
erode
erosion
eruption
evaporate
evaporation
event
explain
explanation
fair test
feet
flower
food
food chain
force
forest
fossil
fossil remains
freeze
friction
function
gas
germinate
glacier
gram (g)
graph
grassland
gravity
habitat
hand lens
hardness
heart
heat energy
identify
inch (in)
inclined plane
inherited
input
invent
invention
investigate
investigation
kilogram (kg)
kilometer (km)
lake
leaf
learned (acquired) characteristic
lever
liquid
liter (L)
living
logical
lung
machine
magnetic
magnifying glass
mass
material
matter
measured (responding) variable
melt
meter (m)
mile (mi)
milliliter (mL)
mineral nutrient
model
molecule
Moon
mountain
muscle
Newtons (N)
nonliving
mineral
nutrient (mineral)
object
observation
observe
ocean
orbit (as a noun)
orbit (as a verb)
organism
organize
ounce
output
oxygen
part
pattern
picture
pitch
plan
planet
pollution
pound
precipitation
predict
prediction
problem
procedure
process
producer
property
pull
pulley
push
question
radius
rate
recycle (as ecology)
reduce (as ecology)
report
reproduce
reproduction
result
river
root
scavenger
scientific
scientist
sea
sediment
seed
shadow
shape
size
skeleton
soil
solar
solid
solution (as to problems)
solve
sort
sound
special
speed
spin (rotate)
spring scale
sprout
state of matter
stem
stream
strength
structure
substance

Grade 5 Vocabulary *continued*

summary
Sun
system
table
temperature
texture
thaw
thermometer
tool
vapor
variable
variable kept the same (controlled)
versus (vs.)
vibration
volcano
volume
waste
water
weather
weathering
weight
wind

Grade 8 Vocabulary

accuracy
acid
acidity
acquired (learned) characteristic
adaptation
air pressure
artery
atmosphere
atom
attract
bacteria
blood vessel
body of water
camouflage
carbohydrates
carbon dioxide
cell
charge
chemical
circuit
cleavage of minerals
cold-blooded
compare
compound
conduction
contrast
controlled variable (kept the same)
convection
core
crust
density
description
dew point
digest
digestive system
eclipse
electron
element
environment
evidence
evolution
extinct
factor
fat
filter
frequency
frictional force
gender
genetic
germination
groundwater
heat (thermal) energy
herbicide
hypothesis
igneous
image
insoluble
interpret
interpretation
intestine
issue
kinetic energy
landform
landform profile
landmass
landslide
leverage
lunar
luster of minerals
magnetic pole
magnetism
manipulated (changed) variable
mantle
metamorphic
meter stick
microorganism
microscope
millimeter (mm)
mixture
natural selection
nerves
neutron
nitrogen
nucleus
opinion
organ
organic
particle
pattern
pesticide
pH
phase of the moon
phenomena
phenomenon
potential energy
predator
pressure
prey
property
protein
proton
radiation
reaction
recycle
reflect
reflection
relationship
relative position
relative speed
reliable
repel
report
resource
respiration
responding (dependent) variable
reuse
river system
rock cycle
sedimentary
solar system

Appendix C: Scientific Inference

The designs of scientific investigations of the natural world are structured to enable inferences to be made that contribute to explanations of how natural systems of the world work (what causes what) and allow for accurate predictions.

Inference: Reasoning based on observation and experience; to arrive at a decision or conclusion by reasoning from known facts; in a scientific investigation, the logic used to establish correlational or causal relationships among variables in the system being investigated.

Hypothesizing

The hypothesis implies a cause-effect relationship between the responding, measured, or dependent variable and the manipulated or changed variable and is usually stated using an if-then phrase.

If the Manipulated Variable is changed, then the Responding Variable will change.

Planning

Strong inference requires an investigative plan that will be respected by the scientific community because it can be replicated exactly, getting the same observations or data repeatedly.

How can the Manipulated Variable be changed, the Responding Variable measured, and all other variables kept the same?

Interpreting

Interpretation is causality inferred from measurements. A strong inference will predict future outcomes by explaining how the manipulated variable caused the responding variable to change.

Explain how the Responding Variable changed as a result of the Manipulated Variable being changed.

Measuring

The changes measured in the responding variable determine the inference that will be possible. Stronger inferences can be made when both the validity (measuring what you intend to measure) and reliability (measuring consistently) of measurement are high.

Measure the Responding Variable each time the Manipulated Variable is deliberately changed.

Appendix D: Controlled Scientific Investigations

Scientific investigations range from controlled to correlational and many in between. The essence of a scientific investigation is that variables are identified and, to the degree possible, controlled, that is, kept the same. Controlling one variable allows scientists to isolate a variable and test its effect on a system. Finding an effect usually leads to further questions. Often such questions arise because new variables are discovered. In such a way, scientists seek to understand how systems of the natural world work and use that knowledge and understanding to design solutions to human problems. The following charts summarize important attributes of controlled scientific investigations that describe effective practices.

Grades Kindergarten through 2

- Ask questions that lead to exploration and investigation.
- Identify a problem to be solved.
- Follow a simple procedure when instructions are given step by step.
- Manipulate materials purposefully.
- Observe using one or a combination of the senses.
- Make and record observations and measurements using written language, pictures, and charts.
- Estimate measurements.
- Identify and use a variety of sources of science information and ideas.
- Make predictions based on observed patterns.
- Select and use materials to carry out an exploration or investigation.
- Identify materials and suggest a plan for how to use the materials to carry out an investigation.
- Follow given safety procedures and rules and explain why they are needed.

Grades 3 through 5

- Keep variables the same (controlled).
- Change a variable (manipulated independent).
- Measure a variable (responding dependent).
- Make a prediction related to a given investigative question.
- Identify one of the variables kept the same (controlled) in a given investigation.
- Identify the one variable changed (manipulated) in a given investigation.
- Identify what variable is being measured as a result of a variable changed in a given investigation.
- Make a logical plan for a second investigation for a different question involving a minimal change from a given investigation [with a different changed (manipulated) or measured variable for a controlled investigation]. A logical plan includes step-by-step instructions clear enough that others could do the investigation.
- Identify or describe simple materials, equipment, and tools (such as magnifiers, rulers, balances, scales, and thermometers) for gathering data and extending the senses.
- Identify or describe ways to record and organize observations/data from multiple trials or long periods of time using data tables, charts, and/or graphs.
- Identify or describe safety rules for an investigation.
- Give reasons for predictions to a question.
- Use simple materials, equipment, and tools (such as magnifiers, rulers, balances, scales, and thermometers) for gathering data and extending the senses.
- Gather, record, and organize observations/data from multiple trials using data tables, charts, and/or graphs.
- Identify and use units of measure appropriate for an investigation.
- Follow safety rules during investigations.

Grades 6 through 8

- Make a prediction (hypothesis) related to an investigative question and give reasons for the prediction.
- Identify one of the controlled variables (kept the same) in a given investigation.
- Identify the manipulated (changed) variable in a given investigation.
- Identify the responding (dependent) variable in a given investigation.
- Make a logical plan for a second investigation for a different investigative question that can be answered using a similar plan [with a different manipulated (changed) variable for a controlled investigation]. A logical plan includes step-by-step instructions clear enough that others could do the investigation.
- Describe appropriate materials, tools, and/or computer technology to gather data for an investigation.
- Describe ways to record and organize observations/data from multiple trials and/or long periods of time using data tables, charts, and/or graphs.
- Describe and/or explain safety requirements for an investigation.
- Use appropriate materials, tools, and available computer technology to gather data for an investigation.
- Gather, record, and organize observational data from multiple trials using data tables, charts, and/or graphs.
- Identify and use units of measure appropriate for an investigation.
- Follow safety requirements during investigations.

Grades 9 through 10

- Make a hypothesis (prediction with cause-effect reason) related to an investigative question.
- Identify two of the controlled variables (kept the same) in a given investigation.
- Identify the manipulated (independent) variable in a given investigation.
- Identify the responding (dependent) variable in a given investigation.
- Make a logical plan for a second investigation for a different investigative question that can be answered using a similar plan [with a different manipulated (changed) variable for a controlled investigation]. A logical plan includes step-by-step instructions clear enough that others could do the investigation.
- Describe appropriate materials, tools, and techniques, including mathematical analysis and available computer technology, to gather and analyze data.
- Describe ways to record observations/data from multiple trials and/or long periods of time using data tables, charts, and/or graphs.
- Explain safety requirements for an investigation.
- Describe an experimental control condition when appropriate for an investigation (an experimental control condition is an unchanged condition that is used to insure the manipulated variable caused the changes in the responding variable when investigating complex systems).
- Describe validity measures, in addition to controlled and manipulated variables, for an investigation (validity means that the investigation answered the investigative question with confidence; the manipulated variable caused the change in the responding or dependent variable).

Appendices

Appendix E: Scientific Field Investigations

Field investigations allow students to connect abstract ideas to the world around them, starting from their immediate environment in the lower grades to the world as planet Earth in the upper grades. Field investigations generally take place in the outdoors. However they may encompass investigations of human systems such as water treatment facilities. The important point of field investigations is that students are able to make connections to the real world of ideas they may have learned about from print and media resources and laboratory investigations. Using the environment as a context for learning creates opportunities for multiple intelligences, critical thinking, and problem solving while opening possibilities to integrate reading, writing, mathematics, social studies, visual arts, speaking, and listening. The following charts summarize important attributes of scientific field investigations.

Grades Kindergarten through 2

Essential (general) question: Identifies and asks overreaching question about the system being investigated.

Question: Ask the question being investigated in the field study.

Planning the field investigation:

- Ask questions about objects and events in the immediate environment, and develop ideas about how those questions might be answered.
- Demonstrate and describe ways of using materials and tools to help answer the question.
- Describe the study site and time frame.
- Make a list of what is to be measured or observed.
- Record how, when, and where samples are taken.
- Record logical steps so that the field study could be repeated.
- Identify and follow all safety rules for exploring the immediate environment.

Collecting and analyzing data:

- Record data (measurements) in a systematic way using drawings, tables, charts, graphs, or maps.
- Identify patterns and order in objects and events studied: create drawings, graphs, tables, or maps.
- Work with others and share and communicate ideas about explorations during the investigation.
- Undertake personal actions to care for the immediate environment and contribute to responsible group decisions.

Grades 3 through 5

Essential (general) question: Identifies and asks overreaching question about the system being investigated.

Question: Ask the question being investigated in the field study.

Planning the field investigation:

- Predict (hypothesize), when appropriate, comparative and correlative studies.
- List materials.
- Describe the study site and time frame.
- Identify manipulated or changed variable(s).
- Identify consistent sampling (controls).
- Record responding variable(s) (measured or observed) when appropriate.
- Record how, when, and where samples are taken.
- Record logical steps so that the field study could be repeated.
- Identify and follow all safety rules for a field investigation.

Collecting and analyzing data:

- Record data (measurements) in a systematic way using drawings, tables, charts, graphs, or maps.
- Organize and analyze data to look for patterns and trends. When appropriate sort measurements (observations) into categories; calculate means, modes, or medians; and create graphs, tables, or maps.
- Construct a reasonable explanation using evidence: Answer the investigative (study) question or respond to the prediction using supporting data.

Grades 6 through 8

Essential (general) question: Identifies and asks overreaching question about the system being investigated.

Question: Ask the question being investigated in the field study.

Planning the field investigation:

- Predict (hypothesize), when appropriate, comparative and correlative studies.
- List materials.
- Describe the study site and time frame.
- Record manipulated (changed) variable(s).
- Record consistent sampling (controls).
- Conduct representative (random) sampling when appropriate.
- Record responding (dependent) variable when appropriate.
- Record how, when, and where samples are taken.
- Identify and account for extraneous factors — factors that might have an effect on the focus variable(s).
- Record logical steps so that the field study could be repeated.
- Understand and follow all safety rules for a field investigation.

Collecting and analyzing data:

- Record data (measurements) in a systematic way using tables, charts, graphs, or maps.
- Organize and analyze data to look for patterns and trends. When appropriate sort measurements (observations) into categories; calculate means, modes, or medians; create graphs, tables, or maps; and compare data to standards.

Constructing a reasonable explanation using evidence:

- Answer the investigative (study) question or respond to the prediction using supporting data.
- Compare data to other studies, when appropriate, to answer essential (general) question.

Grades 9 through 10

Essential (general) question: Identifies and asks overreaching question about the system being investigated.

Question: Ask the question being investigated in the field study.

Planning the field investigation:

- Predict (hypothesize), when appropriate, comparative and correlative studies.
- List materials.
- Describe the study site and time frame.
- Record manipulated variable(s).
- Record consistent sampling (controls).
- Conduct representative (random) sampling when appropriate.
- Record responding (dependent) variable (measured, observed, changed, or continuous) when appropriate.
- Record how, when, and where samples are taken.
- Identify and account for extraneous factors — factors that might have an effect on the focus variable(s).
- Record logical steps so that the field study could be repeated.
- Plan, explain, and follow safety rules for a field investigation.

Collecting and analyzing data:

- Record data (measurements) in a systematic way using tables, charts, graphs, or maps.
- Organize and analyze data to look for patterns and trends. When appropriate sort measurements (observations) into categories; calculate means, modes, or medians; create graphs, tables, or maps; compare data to standards; and perform statistical analysis to correlate continuous variables (10th grade).

Constructing a reasonable explanation using evidence:

- Answer the investigative (study) question or respond to the hypothesis using supporting data.
- Compare data to other studies, when appropriate, to answer the essential question.
- Compare data to standards, when appropriate, to answer a larger question.

Appendices

Appendix F: Scientific Design Process

The scientific design process begins by framing an everyday challenge or problem in which scientific design can be or has been used to develop solutions. Multiple solutions based on scientific concepts are proposed and some are implemented. Implemented solutions are evaluated based on the constraints and the consequences of the solution.

Grades Kindergarten through 2

Document each of the following steps of the design process in notebook.

Gather Information

- Describe the information needed to solve a problem (e.g., context and constraints of the problem).

Explore Ideas

- Describe possible ideas for solving the problem.

Plan

- Draw a simple plan to solve the problem, following all appropriate safety guidelines in Appendix G.

Implement Plan

- Construct a prototype of the solution.

Evaluate the Solution

- Try the prototype.
- Describe or tell how the prototype does or does not solve the problem.

Redesign

- Construct a new prototype based on the results of the evaluation of the first prototype.

Grades 3 through 5

Document each of the following steps of the design process in notebook.

Gather Information

- Describe the information needed to solve a problem (e.g., context and constraints of the problem).

Explore Scientific Ideas

- Describe possible ideas for solving the problem.
- Identify scientific concepts or principles that can be applied to the solution.

Plan

- Document a simple plan to solve the problem by drawing a diagram, following all appropriate safety guidelines in Appendix G.

Implement Plan

- Construct a prototype of the solution.

Scientifically Evaluate the Solution

- Test the prototype.
- Measure at least one variable that is related to an input or output of the solution.
- Describe or tell how the prototype does or does not solve the problem.

Redesign

- Construct a new prototype based on the results of the evaluation of the first prototype.

Grades 6 through 8

Document each of the following steps of the design process in notebook.

Gather Scientific Information

- Write and explain the information needed to solve a problem (e.g., context and constraints of the problem).

Explore Scientific Ideas

- Describe possible ideas for solving the problem.
- Identify scientific concepts or principles that can be applied to the solution.

Plan

- Document a scientific plan to solve the problem by writing an explanation with a labeled diagram, following all appropriate safety guidelines in Appendix G.

Implement Plan

- Construct a prototype of the solution.

Scientifically Evaluate the Solution

- Test the prototype.
- Measure one variable that is related to an input and one variable that is related to an output of the solution. Report the measurements (data) in an appropriate format.
- Describe or tell how the prototype does or does not solve the problem.

Redesign

- Construct a new prototype based on the results of the evaluation of the first prototype.
- Compare the effectiveness of the initial and redesigned prototypes based on the constraints of the problem.

Grades 9 through 10

Document each of the following steps of the design process in notebook.

Gather Scientific Information

- Write and explain the information needed to solve a problem (e.g., context and constraints of the problem).

Explore Scientific Ideas

- Describe possible ideas for solving the problem.
- Identify scientific concepts or principles that can be applied to the solution.

Plan

- Document a scientific plan to solve the problem by writing an explanation with a labeled diagram, following all appropriate safety guidelines in Appendix G.

Implement Plan

- Construct a prototype or a model of the solution.

Scientifically Evaluate the Solution

- Test the prototype or model.
- Measure one variable that is related to an input and one variable that is related to an output of the solution. Report the measurements (data) in an appropriate format.
- Explain criteria to evaluate the solution to the problem.
- Explain the effectiveness of the solution using scientific concepts and principles.
- Explain the consequences of the solution.

Redesign

- Construct a new prototype or model based on the results of the evaluation of the first prototype or model.
- Compare the effectiveness of the initial and redesigned prototypes or models based on the evaluation criteria.
- Explain how well the final solution meets predetermined constraints (e.g., cost, reliability, size, materials, human resources, time, money, environmental issues).

Appendix G: Safety for Classrooms and Laboratories

Districts are asked to select safety bullets from the Safety Guidelines on the facing page to complete the safety bullets on this poster. You can obtain a color safety poster at http://www.k12.wa.us/CurriculumInstruct/Science/default.aspx.

Safety Guidelines for the Elementary Grades

- Never do any investigation without the approval and direct supervision of your teacher.
- Always wear your safety goggles when your teacher tells you to do so.
- Never remove your goggles during an activity.
- Know the location of all safety equipment in or near your classroom.
- Never play with the safety equipment.
- Tell your teacher immediately about any broken, chipped, or scratched glassware so that it may be properly cleaned up and disposed of.
- Tie back long hair and secure loose clothing when working around flames.
- Wear your laboratory apron or smock to protect your clothing when instructed to do so.
- Never assume that anything that has been heated is cool. Hot glassware looks just like cool glassware.
- Never taste anything during a laboratory activity. If an investigation involves tasting, it will be done in the cafeteria.
- Clean up your work area upon completion of your activity.
- Clean work surfaces with soap and water.
- Wash your hands with soap and water upon completion of an investigation.
- Never eat around areas where you are conducting investigations.
- Do not touch your eyes or mouth when doing an investigation.

References:

1. NSTA. (2004). *Exploring Safely: A Guide for Elementary Teachers.*
2. American Chemical Society. (2001). *Safety in the Elementary (K–6) Science Classroom.*
3. Council of State Science Supervisors (CSSS). (2004). *Science and Safety: It's Elementary.* Available: <http://csss.enc.org/media/scisaf_cal.pdf>.

Safety Guidelines for the Secondary Grades

- School districts must adopt a written Chemical Hygiene Plan that includes safety standards, hazardous material management, and disposal procedures for chemical and biological wastes. These procedures must meet or exceed the standards adopted by *OSPI: Health and Safety Guide,* section K.
- School authorities and teachers share the responsibility of establishing and maintaining safety standards.
- School authorities are responsible for providing safety equipment (i.e., fire blankets, fire extinguishers), personal protective equipment (i.e., eye wash stations, goggles), Material Safety Data Sheets (MSDS), and training appropriate for each science teaching situation.
- All science teachers must be involved in an established and ongoing safety training program, relative to the established safety procedures, that is updated on an annual basis.
- Teachers shall be notified of individual student health concerns.
- The maximum number of occupants in a laboratory teaching space shall be based on the following:
  1. the building and fire safety codes;
  2. occupancy load limits;
  3. design of the laboratory teaching facility; and
  4. appropriate supervision and the special needs of students.
- Materials intended for human consumption shall not be permitted in any space used for hazardous chemicals and or materials.
- Students and parents will receive written notice of appropriate safety regulations to be followed in science instructional settings.

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1. NSTA. (2004). *Inquiring Safely: A Guide for Middle School Teachers.*
2. NSTA. (2004). *Investigating Safely: A Guide for High School Teachers.*
3. OSPI. (2000). *OSPI: Health and Safety Guide,* section K. Available: <http://www.k12.wa.us/schfacilities/healthsafetyguide.aspx>.
4. Council of State Science Supervisors (CSSS). (1998). *Science Safety: Making the Connection.* Available: http://csss.enc.org/media/scisafe.pdf>.

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