Measurements of Student Progress

Test and Item Specifications

Grade 8 Science

Office of Superintendent of Public Instruction
OSPI

The purpose of the Measurements of Student Progress (MSP) is to measure the level of science proficiency that Washington students have achieved based on the *Washington State K-12 Science Learning Standards*. In the 2009 revision, the *Washington State K-12 Science Learning Standards* are organized by Big Ideas and Core Content. Each area of Core Content has specific performance expectations. The purpose of the Test and Item Specifications document is to guide the development of scenarios and items which align to the *Washington State K-12 Science Learning Standards*.

Test and Item Specifications Grade 8

Contents

Purpose Statement

The Test and Item Specifications describe how the scenarios and items for the Science Measurements of Student Progress (MSP) are developed.

The section titled Test Development Guidelines is written to guide the development of the Science MSP. Classroom teachers should find this section quite useful when creating MSP-like scenarios and items for use in classroom-based assessments.

The Standards section gives an overview of the 6-8 grade band of the *Washington State K-12 Science Learning Standards* (adopted June 2009).

The Test Organization section is a technical description of the exam that assures the assessment will validly measure the science standards in a reliable manner every year. The section is written to guide the developers of the Science MSPs.

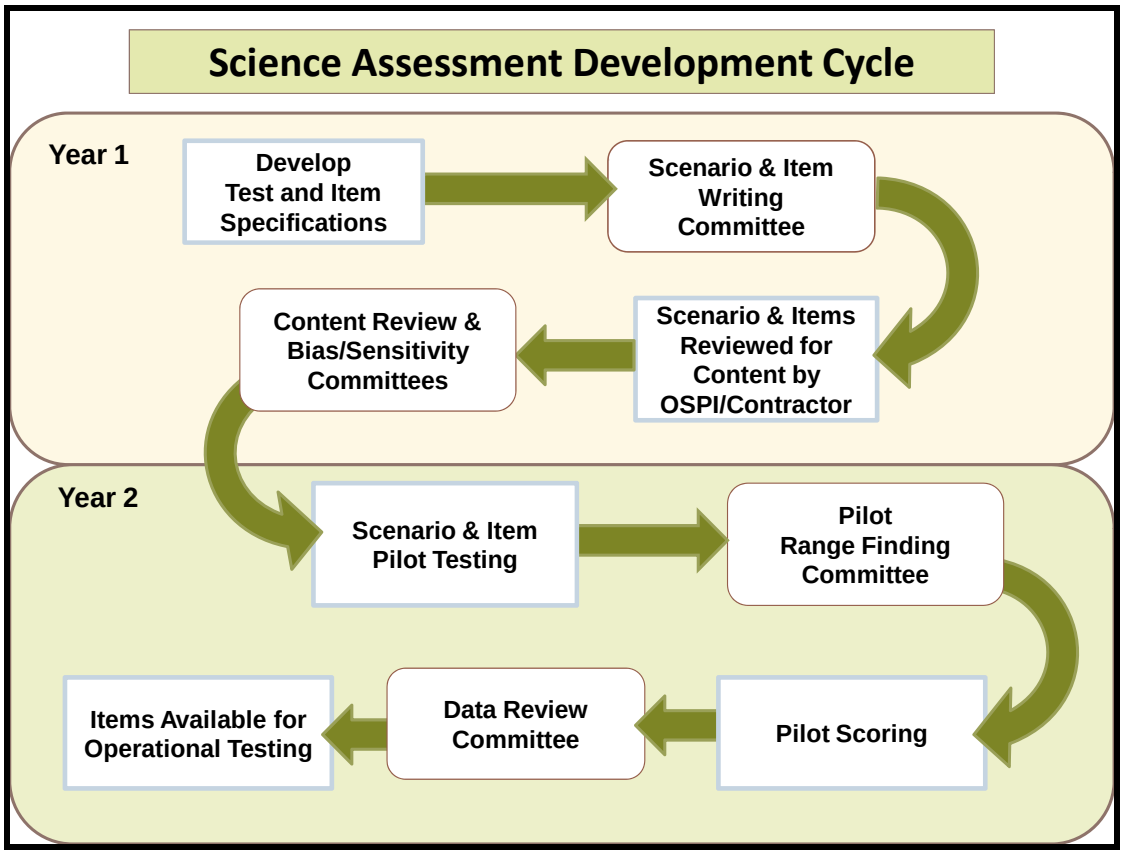
The Item Specifications section is useful for anyone interested in specific Science MSP items; every item on the Science MSP is described in this section.

Test Development Timeline

The Science MSP is written by trained science educators from Washington State. Each scenario and item is planned by the OSPI Science Assessment Team in conjunction with an educational assessment contractor and then written, reviewed, and revised during a scenario writing workshop. From there, the development process involves formal reviews with science educators for all scenarios and items and for the scoring criteria in the rubrics of completion and short-answer items. The development process assures the assessment contains items that meet the following criteria:

- Authentic scenarios describing what students might do in school
- Tight alignment to a specified science item specification
- Valid measure of a specified science learning standard
- Constructed response item scoring rubrics that can be applied in a valid manner
- Constructed response items that can be scored in a reliable manner

The Science Assessment Development Cycle flow-chart summarizes the two-year process of review and piloting that precedes scenarios and items being used on an operational exam.



Test Development Guidelines

The items on the MSP reflect the content standards and performance expectations of the *Washington State K-12 Science Learning Standards*. The guidelines in this document assist in writing items that match the standards, with sufficient restrictions to construct a valid and reliable on-demand assessment.

The scenario and item writer should be familiar with all scenario, item and rubric development guidelines listed in this section as well as specific considerations listed within each Big Idea.

Considerations and procedures that make scenario and item development more efficient and effective include, but are not limited to, the following guidelines.

Scenario Development Guidelines

Introduction to Scenarios

Since 2001, the Washington science assessment has presented items within scenarios which provide context for a group of items. Advisory groups composed of national education experts, science assessment experts, and science educators decided to utilize the scenario structure for several reasons. First, scenarios are less likely to lead to discrete teaching of science facts, concepts and skills. Second, it is easier for students to demonstrate their scientific knowledge when they move from item to item within a scenario than when they have to orient to a new context for each item. Third, scenarios are consistent with the structure of the standards.

Overview of a Scenario

The organization of a scenario is summarized by the following example.

Directions tell the students which items are connected to the scenario.

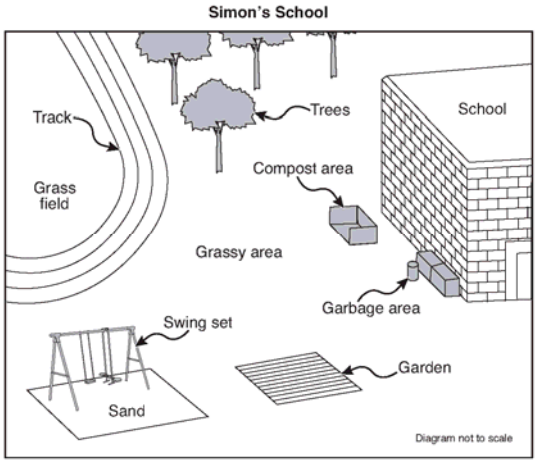
A title signals the start of a new scenario.

One- or two-page scenario establishes the context for the items that follow.

Compost Pile

Directions: Use the following information to answer questions 1 through 3 on page x through x.

Simon's school has an area for a compost pile. A compost pile contains plant waste that can be decomposed. Compost is used in the garden. The diagram below shows the location of Simon's compost pile at his school.



(This 5th grade released scenario is provided as an example.)

A group of up to eight items follows the scenario.

Multiple-choice and completion items can appear together on a page. Students fill in the bubble or write a word or short phrase in the answer box.

1 Which one of these problems can be solved by putting waste in the compost pile?

- O **A.** Disposing of empty pop cans
- O **B.** Disposing of plastic containers
- O **C.** Disposing of leftover vegetables

2 Other than the worms in the compost pile, what is a living object in the school yard ecosystem?

Write your answer in the box.

Short-answer items fill an entire page. Students write their answers on the lines provided.

3 Simon asked his friends for ideas to help the compost pile decompose. They had these suggestions:

- ✓ turn (mix) the compost
- ✓ add leafy material to the compost
- ✓ add insects to the compost

Describe how **two** of these suggestions will help the plant waste decompose in the compost pile.

In your description, be sure to:

- Choose two of the suggestions.
- Describe how each suggestion will help the plant waste **decompose** in the compost pile.

First Suggestion:
Second Suggestion:

(These 5th grade items are provided as an example.)

Common characteristics of scenarios

The following characteristics are common to all scenarios in the science MSP. In addition, there are unique characteristics for each of the three types of scenarios: Systems, Inquiry, and Application.

- Scenarios will be examples of situations students would encounter beyond school or of investigations to which they can relate.
- Scenarios should be **necessary but not sufficient** for student responses.
- Scenarios include short, textual information written at approximately a sixth grade reading level. Necessary eighth grade science words may also be included.
- Grade-level-appropriate terms that are pertinent to the scenario but may not be familiar to some students are defined in parentheses when they first appear. These terms will be italicized every time they appear throughout the scenario and associated items.
- Scenarios may have a combination of up to three elements (e.g., a data table, a diagram, and/or a written description).
- Titles for scenarios should be accurate, friendly, and interesting, but not distracting or misleading. Avoid titles that may have copyright issues (e.g., song titles).
- Character names on each test will be representative of the ethnic diversity of Washington students. The names will generally be short and simple to read.

Released scenarios are used to illustrate the unique characteristics of each of the three types of scenarios (Systems, Inquiry, and Application) on the following pages.

Systems Scenario Guidelines

Systems scenarios describe a physical, Earth/space, or living system. Systems scenarios may include systematic observations, models, or open-ended explorations of a system.

General Description of a System
The following characteristics are common to Systems scenarios.

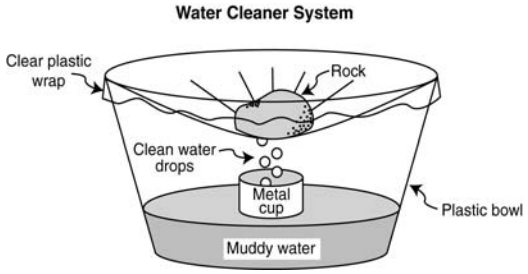
A Systems scenario explores only one system. There may be subsystems within the system and the system may be part of a larger system; however, the focus of the scenario should be a single system.

A short introduction defines the system by describing the system as an object or as connections of objects within defined boundaries.

Clean Water

Darcie and Matt made a Water Cleaner System for a class science project. Darcie and Matt used their scientific understanding of the water cycle in the design of their Water Cleaner System. They used equipment provided by their teacher.

A labeled diagram of the system defines the boundaries of the system and labels the parts of the system.



Darcie and Matt poured muddy water into the bottom of a large plastic bowl. They put a metal cup into the middle of the muddy water in the plastic bowl. Then they stretched clear plastic wrap over the top of the plastic bowl. They put a rock on top of the plastic wrap, causing the plastic wrap to sag in the middle.

Additional text can describe a phenomenon that occurs within that system, including descriptions of the inputs, transfers, and/or outputs of matter, information, and/or energy in the system.

Their Water Cleaner System functioned with the energy input from the Sun.

(This released scenario is provided as an example.)

Inquiry Scenario Guidelines

Inquiry scenarios describe an investigation into a physical, Earth/space, or living system. Inquiry scenarios can be either controlled experiments or field studies and model age-appropriate investigations.

General Description of a Controlled Experiment
The following characteristics are common to Inquiry scenarios involving controlled experiments.

A short paragraph provides a context for the experiment.

The experimental question includes the manipulated and responding variables.

The hypothesis includes the manipulated and responding variables.

Materials necessary to carry out the experiment are listed.

A labeled setup diagram shows an overview of the experiment.

Danger! Mudflow!

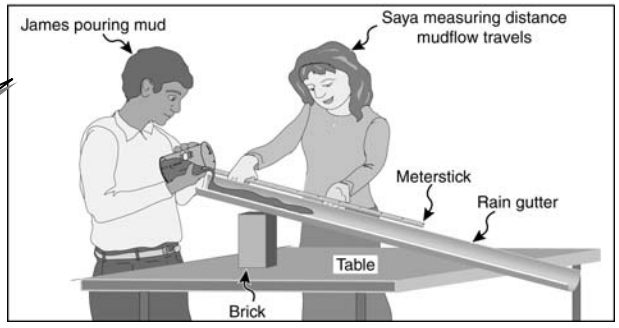
Saya and James wanted to investigate mud, a mixture of soil and water. They wondered how water affects a mudflow. They built a model as shown below and did the following controlled experiment.

Question: What is the effect of the volume of water in mud on the distance a mudflow travels?

Hypothesis: As the volume of water in mud increases, a mudflow will travel farther because water erodes soil.

Materials:
dry soil
water
balance
stirring rod
graduated cylinder
beaker
piece of rain gutter
brick
meterstick

Controlled Experiment Setup



(This released scenario is provided as an example.)

Steps to carry out the experiment are provided as a numbered list. The procedure is different from instructions to do the experiment; some details are unnecessary for the purpose of the assessment.

The responding variable is measured for each condition of the manipulated variable.

The manipulated variable has at least two conditions.

Other variables are controlled so they do not confound the results.

The conditions of the manipulated variable and the results for the responding variable are included in the data table.

Procedure:

1. Put the rain gutter on the table and use the brick to hold one end of the gutter up, making a slope.
2. Stir 100 grams of dry soil and 20 milliliters (mL) of water together in a beaker to make mud.
3. Pour the mud into the top of the raised end of the rain gutter.
4. Measure and record the distance the front of the mudflow traveled as Trial 1.
5. Rinse and dry the rain gutter to remove the mud.
6. Repeat steps 2 through 5 two times as Trials 2 and 3.
7. Repeat steps 2 through 6 for 25 mL of water, 30 mL of water, and 35 mL of water.
8. Calculate and record the average distance the mudflow traveled for each volume of water used.

Data:

Volume of Water vs. Distance Mudflow Traveled

Volume of Water (milliliters)	Distance Mudflow Traveled (centimeters)			
	Trial 1	Trial 2	Trial 3	Average
20	19	25	20	21
25	97	84	97	93
30	112	108	126	115
35	144	167	170	160

Repeated trials are needed for reliability.

(This released scenario is provided as an example.)

General Description of a Field Study

The following characteristics are common to Inquiry scenarios involving field studies.

A short paragraph provides a context for the field study.

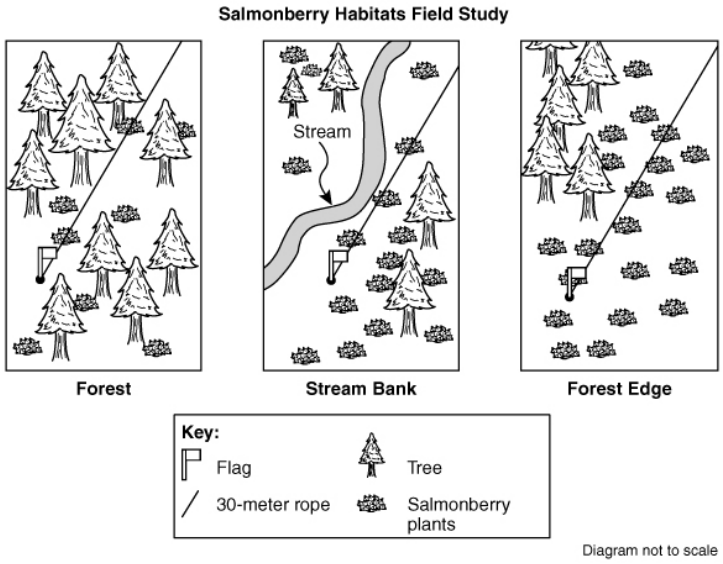
The field study question investigates a relationship between an independent (manipulated) and a dependent (responding) variable.

A labeled diagram shows an overview of the field study.

Salmonberry Habitats

Greta and Scott did a field study with a park ranger to learn where black bears find salmonberries to eat in the forests of Washington. They did the following field study.

Field Study Question: How does the number of salmonberry plants change among different habitats



(This sample scenario is provided as an example.)

Steps to carry out the field study are provided as a numbered list. The procedure is different from instructions to actually do the field study; some details are unnecessary for the purpose of the assessment.

The dependent (responding) variable is measured for each condition of the independent (manipulated) variable.

The independent (manipulated) variable has at least two conditions.

Other variables are controlled so they do not confound the results.

Procedure:

1. Go to the forest habitat. Record the location, date, and time.
2. Choose three different locations in the forest habitat. Mark each location with a flag and attach a 30-meter rope. Label the flags as Location 1, Location 2, and Location 3.
3. Using a compass, walk 30 meters north from Location 1. Mark the line walked with the rope.
4. Count the number of salmonberry plants that touch the 30-meter rope and record as Location 1.
5. Repeat steps 3 and 4 for Locations 2 and 3 for the forest habitat.
6. Repeat steps 1 through 5 for the stream bank and forest edge habitats.
7. Calculate and record the average number of salmonberry plants for each habitat.

Data Collected:

Location: Forest, stream bank, and forest edge habitat
Date and Time: May 1, 2, and 3, 1:00 P.M.

Habitat vs. Number of Salmonberry Plants

Habitat	Number of Salmonberry Plants (on a 30-meter rope)			
	Location 1	Location 2	Location 3	Average
Forest	7	3	8	6
Stream bank	19	17	21	19
Forest edge	23	22	27	24

A data table includes all pertinent variables and data collected.

Repeated trials are needed for reliability.

(This sample scenario is provided as an example.)

Application Scenario Guidelines

Application scenarios describe a technological design process students used to solve a problem. The problem must be one that involves a physical, Earth/space, or living system.

General Description of a Technological Design Process
The following characteristics are common to Application scenarios involving the technological design process.

A short paragraph provides a context for the technological design process.

The problem or challenge is defined.

A short summary of research about the problem is included.

Scientific information or concepts and principles that contribute to solving the problem (e.g., chart(s) of information, investigation results, or explaining how a scientific concept is used) are included throughout the scenario.

More than one idea that could solve the problem is explored. The problem and given materials of the scenario allow for various possible solutions.

School Garden

The school garden produced only 13 kilograms (kg) of vegetables from tomato plants, lettuce plants, green bean plants and green pepper plants. The students wanted to redesign the garden the next year to increase the amount of vegetables produced by the plants. The students documented the stages of their design process as follows.

Problem: Increase the production of the garden to 26 kg of vegetables.

Research the Problem: Look up the amount of sunlight, water, and mineral nutrient needs of plants. Analyze the garden soil for mineral nutrients and compare to ideal soil.

Soil Analysis

Mineral Nutrients	Garden Soil Compared to Ideal Soil
Nitrates	33% of ideal amount
Phosphates	33% of ideal amount
Potassium	50% of ideal amount

Explore Ideas:
- ✓ Water the garden at different times of the day to prevent plant disease.
- ✓ Change the amount of sunlight reaching the garden by shading part of the garden.
- ✓ Add *compost* (decomposed plant material) to the soil.
- ✓ Loosen the soil with a shovel.

(This released scenario is provided as an example.)

The chosen plan is summarized and includes a scientific reason for choosing the solution.

The steps to implement the plan are described.

The solution is clearly illustrated in a labeled picture or labeled diagram.

How to test the effectiveness of the solution is briefly described.

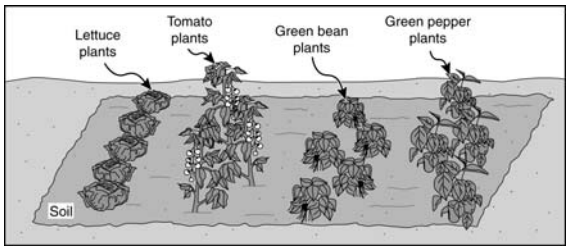
The test results are shown with a brief description and/or a chart.

Plan Summary: Add *compost* to increase the mineral nutrient levels of the garden soil.

Steps to Do the Plan:

1. Remove all of last year's plants and weeds from the garden.
2. Mix *compost* into the garden soil.
3. Plant the garden with the same type and number of plants as last year.
4. Water the garden in the morning every day.
5. Weed the garden every week.

Diagram of Solution:



Test Solution: Record observations of the plants in a notebook. Measure and record the mass of each type of vegetable harvested.

Test Results: The amount harvested from each type of plant is shown in the Mass Harvested table. A total mass of 18 kg was harvested.

Mass Harvested

Plant	Mass
Lettuce	4 kg
Tomatoes	8 kg
Green beans	3 kg
Green peppers	3 kg
Total	**18 kg**

(This released scenario is provided as an example.)

Item Development Guidelines

Considerations and procedures that make item development more efficient and effective include, but are not limited to, the following guidelines.

Standards

- Students are expected to know content from previous grade levels. However, items will only assess standards from the 6-8 grade band of the *Washington State K-12 Science Learning Standards*.
- An item may assess all or part of an item specification.

General Considerations

- A stimulus may include appropriate and relevant tables, charts, graphs, diagrams, and/or pictures.
- Items should avoid use of "not" or "if" unless that term is essential to communicate understanding of the task. Consider substituting "when" for "if."
- Items will include language that is unbiased and that will not disadvantage a particular group of students.

Cognitive Complexity

- Each item is assigned a cognitive complexity rating using Webb's Depth-of-Knowledge, as summarized in Appendix A.
- The cognitive complexity assigned to each item is confirmed through the stages of the item development process.
- The MSP is designed to include a range of cognitive complexity levels.

Vocabulary/Context

Clear Language

- Item stems and stimulus materials should be straightforward and use simple syntax.
- The stimulus should be as clear and simple as possible.
- The amount of reading should be kept to a minimum.
- Items will clearly indicate what is expected in a response and will help students focus their responses.
- Items should avoid the use of pronouns.

Vocabulary

- Items use language targeted to the previous grade level or lower readability, except for required scientific terms listed in the Vocabulary section of this document.
- A "Glossary of Non-Science Terms" is available for any student who may not be familiar with the non-science vocabulary in the items (e.g., soda can, puddle).

Rules for Multiple-Choice Items

- Each multiple-choice item has four answer choices, the correct answer and three distractors (wrong answer choices).
- A multiple-choice item will have a stem (a question, or a statement followed by a question).
- Multiple-choice item stems will present a clear indication of what is required so students will know what to do before looking at the answer choices.
- The four answer choices will be approximately the same length, will have the same format, and will be syntactically and semantically parallel. For example:

Not parallel:	Parallel:
A. Number of times the goldfish gills moved in a minute **B.** The kind of fish used in the experiment **C.** How long they counted the gill movements **D.** Water temperature	**A.** Breathing rate of goldfish **B.** Markings on each goldfish **C.** Time to count gill movements **D.** Change in temperature of the water

- The answer choices will be arranged in numerical or chronological order or according to length.
- Students should not be able to rule out a distractor or to identify the answer simply because of superficial or trivial characteristics, syntactic complexity, or concept complexity.
- Distractors can reflect common errors or misunderstandings, naive pre-conceptions, or other misconceptions.
- Distractors will not be partially correct.
- The options "All of the above" and "None of the above" will not be used.

Rules for Completion Items

- Completion items should be written in the form of a clear and specific question.
- The question should allow for a very limited number of correct responses.
- The question will be followed by the phrase “Write your answer in the box.” An answer box space will be centered under the item.
- Answers will not be scored for labels. Labels should be included in the question and/or answer space.

Rules for Short-Answer Items

- Short-answer items will be in the form of a statement and give clear indications of the response required of students.
- When appropriate, bullets after phrases like "In your procedure, be sure to include:" or “In your description, be sure to:” will provide extra details to assist students in writing a complete response.

- A response that requires multiple parts may be scaffolded within the response box to draw attention to the parts.
- Any short-answer item that requires the students to use information from a stimulus will specifically prompt for the information, e.g., “Use data from the table to …” or “Support your answer with information from the chart.”

Scoring Rubric Development Guidelines

- An item-specific scoring rubric will be developed for each completion and short-answer item during the writing of the item.
- Completion items will be scored with a 2-level scoring rubric (0 or 1).
- Short-answer items will be scored with a 3-level scoring rubric (0, 1, or 2).
- Some short-answer items will be scored by attributes that are converted to score points.
- Scoring rubrics will not consider conventions of writing (complete sentences, usage/grammar, spelling, capitals, punctuation, and paragraphing).
- Scoring rubrics will be edited during pilot range finding based on student responses.
- Scoring rubrics may be edited during operational range finding based on student responses.

Standards

The content of the *Washington State K-12 Science Learning Standards* is organized according to twelve Big Ideas of Science: nine in the domains of Life, Physical, and Earth and Space Science and three that cut across and unite all of the science domains: Systems, Inquiry, and Application. The following tables summarize the twelve Big Ideas of Science in the 6-8 grade band. The Core Content statements are shaded, followed by a summary of the Big Ideas in white.

Crosscutting Concepts and Abilities	
EALR 1 Systems	**Inputs, Outputs, Boundaries & Flows**
	Look at a complex situation and see how it can be analyzed as a system with boundaries, inputs, outputs, and flows.
EALR 2 Inquiry	**Questioning and Investigating**
	Investigate an answerable question through valid experimental techniques. Conclusions are based on evidence and are repeatable.
EALR 3 Application	**Science, Technology, and Problem Solving**
	Work with other members of a team to apply the full process of technological design and relevant science concepts to solving a problem.

EALR 4: The Domains of Science			
Physical Science	**Balanced and Unbalanced Forces**	**Atoms and Molecules**	**Interactions of Energy and Matter**
	Objects in motion are affected by balanced and unbalanced forces. Speed and direction of motion change due to these forces.	Substances have unique properties based on their atomic structure. As atoms combine in a closed system their mass is conserved.	Energy and matter interact resulting in energy transfers and transformations. There are multiple forms of energy.
Earth and Space Science	**The Solar System**	**Cycles in Earth Systems**	**Evidence of Change**
	Our Solar System is held together by gravity. Moon phases and eclipses are explained.	Earth is an interacting system of solids, liquids, and gases. Important Earth processes include the water cycle and the rock cycle.	Layers of rocks and different types of fossils provide clues to how conditions on Earth have changed over time.
Life Science	**From Cells to Organisms**	**Flow of Energy Through Ecosystems**	**Inheritance, Variation and Adaptation**
	Cell type and organization provide living systems structure and function.	Energy flows through ecosystems from a primary source through all living organisms.	Multiple lines of evidence support biological evolution. These include genetics, reproduction, adaptation and speciation.

Test Organization

The Science MSP includes three item formats: Multiple-Choice, Completion, and Short-Answer.

Multiple-Choice Items (MC)	Completion Items (CP)	Short-Answer Items (SA)
• Each multiple-choice item has four answer choices, the correct answer and three distractors. • There will be 24-29 multiple-choice items per operational test, worth one point each.	• Each completion item requires the student to enter a numerical answer, a word, or a short phrase. • There will be 1-6 completion items per operational test, worth one point each.	• Each short-answer item requires a constructed response. • The item may include a bulleted list to indicate the required elements in a response. • There will be five short-answer items per operational test, worth two points each.

Operational Test Forms

Each operational test book will contain the same items in a given year. Approximately 33% of the points of the test book are anchored or linking items with established calibration from previous years. Operational test forms will contain five embedded pilot items, which will either be associated with a pilot scenario or stand-alone items.

At grade 8, the test will be administered in a single testing session, which will be about 90-110 minutes long, plus an additional 25 minutes for set-up and directions. The test will contain 30 multiple-choice/completion items as well as five short-answer items. More details about the item composition are summarized in the Test Map shown below.

Test Map

EALR	MC/CP	SA	Percent of Test
Systems	7-9	0-1	At least 20%
Inquiry	6-12	0-2	30%
Application	4-8	0-2	20%
Domains of Science items not associated with a cross-cutting concept or ability	6-12	0-2	No more than 30%
Total Number of Items	**30**	**5**	
Total Number of Points	**30**	**10**	

Hypothetical Example Tests

Three hypothetical Grade 8 Science MSP tests are summarized on the next two pages. Each example shows the stimuli included on the test as a combination of different scenario types plus stand-alone items. Each example also demonstrates how points on the test can be spread across the four EALRs for items that assess only a domain of science (EALR 4), items that assess

only a cross-cutting ability (EALRs 1 through 3), or items that assess both a cross-cutting ability and grade-level appropriate science domain knowledge.

Hypothetical Test 1:

Stimuli Included

Scenarios:

Earth Science **System**
Life Science **System**
Earth Science **Inquiry** (Controlled Experiment)
Life Science **Inquiry** (Field Study)
Physical Science **Application**

+ 5 Stand-Alone Items

Point Distribution within EALRs

	EALR 4 Domains of Science			EALR 1-3 alone	Total
	Physical	Earth/Space	Life		
EALR 1 SYSTEMS	2	2	4	0	8
EALR 2 INQUIRY				12	12
EALR 3 APPLICATIONS	2			7	9
EALR 4 alone	3	5	3	N/A	11
Total	7	7	7	19	40

Hypothetical Test 2:

Stimuli Included

Scenarios:

Physical Science **System**
Earth Science **Inquiry** (Field Study)
Physical Science **Inquiry** (Controlled Experiment)
Earth Science **Application**
Life Science **Application**

+ 6 Stand-Alone Items

Point Distribution within EALRs

	EALR 4 Domains of Science			EALR 1-3 alone	Total
	Physical	Earth/Space	Life		
EALR 1 SYSTEMS	5	4	5	0	14
EALR 2 INQUIRY			1	10	11
EALR 3 APPLICATIONS	3	2		3	8
EALR 4 alone	1	3	3	N/A	7
Total	9	9	9	13	40

Hypothetical Test 3:

Stimuli Included

Scenarios:

Physical Science **System**
Earth Science **Inquiry** (Field Study)
Life Science **Inquiry** (Controlled Experiment)
Physical Science **Inquiry** (Controlled Experiment)
Life Science **Application**

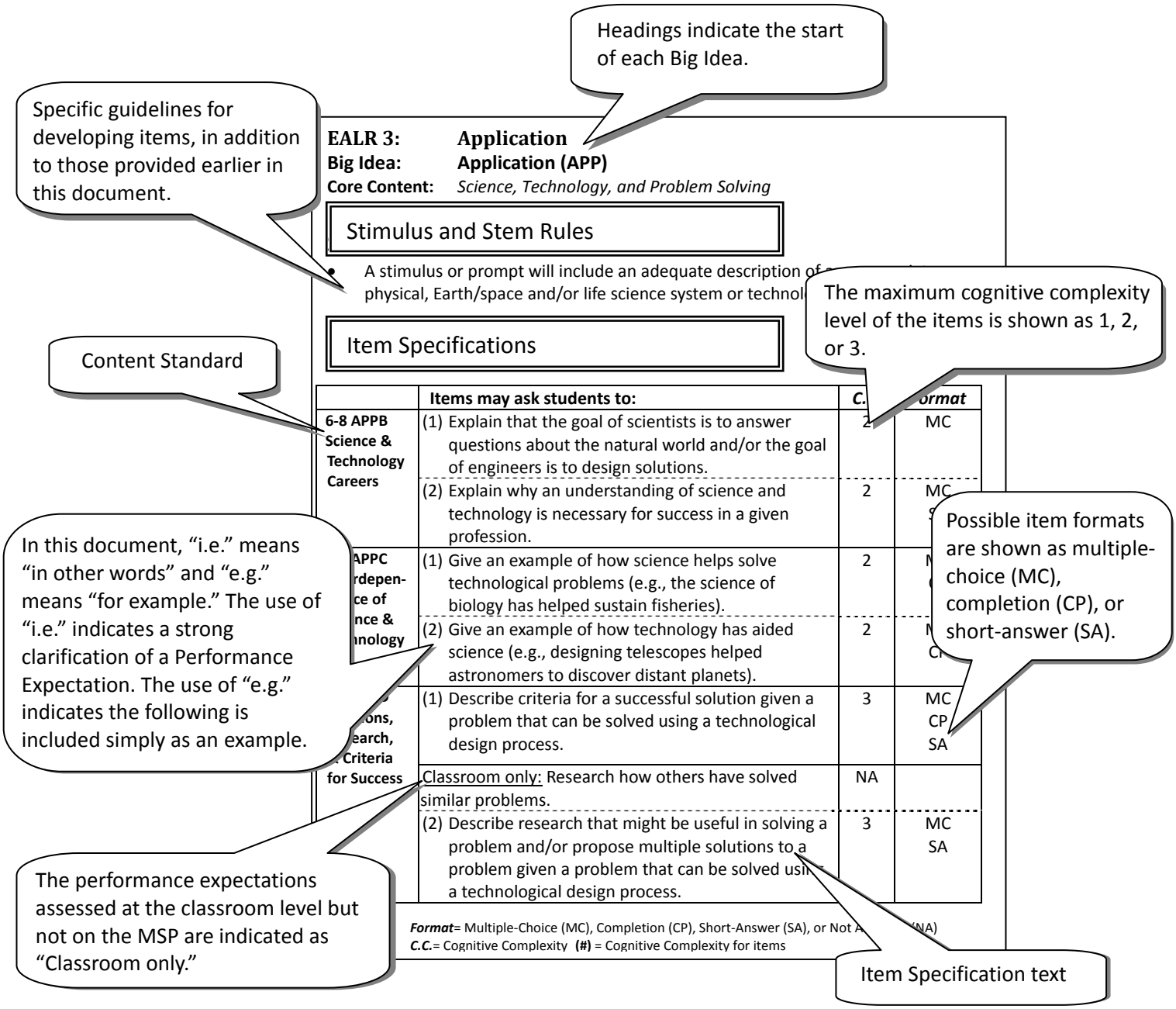
+ 4 Stand-Alone Items

Point Distribution within EALRs

	EALR 4 Domains of Science			**EALR 1-3 alone**	**Total**
	Physical	Earth/Space	Life		
EALR 1 SYSTEMS	3	4	2	0	9
EALR 2 INQUIRY		2	2	9	13
EALR 3 APPLICATIONS	1		2	4	7
EALR 4 alone	5	2	4	N/A	11
Total	9	8	10	13	40

Item Specifications

Item specifications pages have the following characteristics:



Item Specification Numbering System

Content Standard → **APPC(2)** ← (Item Specification)

EALR 1: Systems
Big Idea: Systems (SYS)
Core Content: *Inputs, Outputs, Boundaries, and Flows*

Stimulus and Stem Rules

- A stimulus or stem will include an adequate description of an appropriate physical, Earth/space, and/or life science system.

Item Specifications

	Items may ask students to:	*C.C.*	*Format*
6-8 SYSA Systems & Subsystems	(1) Describe a subsystem or a larger encompassing system of a given system (e.g., a refrigerator is a system made up of a motor, a door, and shelves, and it is also part of a larger house system; the ocean is a system made up of living and nonliving parts, and it is also part of a larger Earth system).	2	MC CP
6-8 SYSB Boundaries of Systems	(1) Explain where the boundaries of a system should be drawn to investigate a given scientific question.	3	MC
	(2) Explain factors that might influence where the boundaries of the system can be drawn for the purposes of an investigation to answer the question (e.g., the distance a type of insect moves during its lifetime might influence where the system boundaries are drawn).	3	MC SA
6-8 SYSC Inputs & Outputs Between Systems	(1) Give an example of an output of matter or energy from a given system that can become input for another system (e.g., household waste goes to a compost and becomes input for a garden; an output of energy from a person pushing down on a bike pedal becomes an input of energy to the bike system to turn the wheels).	2	MC CP
6-8 SYSD Open & Closed Systems	(1) Describe whether a given system is open or closed in terms of matter and/or energy (e.g., matter may circulate in a closed system, but may not enter or leave; matter may flow in and out of an open system; energy may enter or leave both closed and open systems).	2	MC SA
6-8 SYSE Changes in Inputs to Systems	(1) Predict how a given open system is likely to change if the input of matter or energy is more or less than the output (e.g., changing the amount of water behind a dam affects the reservoir behind the dam and the river in front of the dam).	2	MC
6-8 SYSF Societal Issues & Systems	(1) Given a complex societal issue with strong science and technology components, describe the issue from a systems point of view, highlighting how changes in one part of the system are likely to influence other parts of the system.	3	MC SA

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for items

EALR 2: Inquiry

Big Idea: Inquiry (INQ)

Core Content: *Questioning and Investigating*

Stimulus and Stem Rules

- A stimulus or stem will include an adequate description of an appropriate physical, Earth/space and/or life science system or investigation.

Item Specifications

	Items may ask students to:	***C.C.***	***Format***
6-8 INQA Questions	(1) Identify a question that can be answered through scientific investigation.	2	MC
6-8 INQB Plan an Investigation	(1) Describe a plan to answer a given question for a controlled experiment with the following attributes: • At least one controlled (kept the same) variable • One manipulated (independent) variable • One responding (dependent) variable • Data to be gathered and recorded from multiple trials • Logical steps	3	SA MC
	(2) Describe a plan to answer a given question for a field study with the following attributes: • Method for collecting data (controlled variable) • Conditions to be compared (independent variable) • Data to be collected (dependent variable) • Data to be gathered and recorded from multiple observations • Logical steps	3	SA MC
	(3) Describe a plan for an investigation using a model or simulation.	2	MC
	(4) Describe a reason for a given hypothesis and/or explain how a planned investigation will test a hypothesis.	2	MC SA
	Classroom only: Work collaboratively with other students to carry out the investigations.	NA	NA
6-8 INQC Interpret Data from an Investigation	Assessed in Mathematics (6.6.G, 7.4.C, 7.4.E, 7.6.G, 8.3.A, 8.3.B, 8.5.G): Communicate results using pictures, tables, charts, diagrams, graphic displays and text that are clear, accurate and informative.	NA	NA
	(1) Interpret patterns and/or variations in data from an investigation.	2	MC
	Assessed in INQC (1), INQF(1), and Mathematics (6.2.B, 7.4.C, 7.4.D, 7.4.E, 8.3.A, 8.3.B): Use statistical procedures (e.g., median, mean or mode) to analyze data and make inferences about relationships.	NA	NA

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for items

	Items may ask students to:	***C.C.***	***Format***
6-8 INQD Analyze an Investigation	(1) Identify controlled (kept the same) variables in a given description of a scientific investigation.	2	MC
	(2) Identify the manipulated (independent) variable in a given description of a scientific investigation.	2	MC CP
	(3) Identify the responding (dependent) variable in a given description of a scientific investigation.	2	MC CP
	(4) Identify any variables not controlled in an experiment and/or explain how they might affect results in a given description of a scientific investigation.	2	MC SA
	(5) Describe that the purpose for controlling variables is to be sure that an investigation is valid (i.e., the investigative question was answered with confidence; the manipulated variable caused the change in the responding variable; alternative explanations for results can be eliminated).	2	MC
6-8 INQE Models	Classroom only: Create a model or simulation to represent the behavior of objects, events, systems, or processes.	NA	NA
	(1) Describe how a model can be used to explain the relationship between two variables (e.g., a stream table can model the relationship between the movement of water and the development of landforms).	3	MC SA
	(2) Describe how a model or simulation is similar to and/or different from the actual object, event, system or process being modeled.	3	MC SA
6-8 INQF Conclusions from Data	(1) Generate a scientific conclusion using inferential logic and including supporting data given a description of and the results from a scientific investigation.	3	MC SA
	(2) Describe the differences between an objective summary of the findings of an investigation and an inference made from the findings (e.g., the difference between citing data and drawing a conclusion, respectively).	2	MC
6-8 INQG Communicate Clearly	Assessed in INQB, INQF, and INQH: Prepare a written report of an investigation by clearly describing the question being investigated, what was done, and an objective summary of results. The report should provide evidence to accept or reject the hypothesis, explain the relationship between two or more variables, and identify limitations of the investigation.	NA	NA
6-8 INQH Intellectual Honesty	(1) Describe flaw(s) in a scientific claim or conclusion (e.g., uncontrolled variables, overgeneralizations from limited data, experimenter bias) given a description of a system or investigation.	2	MC
	Classroom only: Listen actively and respectfully to research reports by other students.	NA	NA
	(3) Critique explanations using logical arguments and evidence.	3	MC SA
	Classroom only: Engage in reflection and self-evaluation.	NA	NA

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for items

	Items may ask students to:	***C.C.***	***Format***
6-8 INQI Consider Ethics	(1) Describe concerns or precautions in response to scenarios of scientific investigation involving animal experiments, research in natural ecosystems, or studies involving human subjects.	2	MC SA

EALR 3: Application

Big Idea: Application (APP)

Core Content: *Science, Technology, and Problem Solving*

Stimulus and Stem Rules

- A stimulus or stem will include an adequate description of an appropriate physical, Earth/space, and/or life science system or technological design process.

Item Specifications

	Items may ask students to:	*C.C.*	*Format*
6-8 APPA Advances in Technology	(1) Describe how a given familiar technology has changed over time in response to societal changes.	2	MC
6-8 APPB Science & Technology Careers	(1) Explain that the goal of scientists is to answer questions about the natural world and/or the goal of engineers is to design solutions.	2	MC SA
	(2) Explain why an understanding of science and/or technology is necessary for success in a given profession.	2	MC SA
6-8 APPC Interdepen-dence of Science & Technology	(1) Give an example of how science helps solve technological problems (e.g., the science of biology has helped sustain fisheries).	2	MC SA
	(2) Give an example of how technology has aided science (e.g., designing telescopes helped astronomers to discover distant planets).	2	MC
6-8 APPD Solutions, Research, & Criteria for Success	(1) Describe criteria for a successful solution given a problem that can be solved using a technological design process.	3	MC SA
	Classroom only: Research how others have solved similar problems.	NA	NA
	(2) Describe research that might be useful in solving a problem and/or propose multiple solutions to a problem given a problem that can be solved using a technological design process.	3	MC SA
6-8 APPE Choosing a Solution	(1) Describe multiple solutions and reasons for choosing each given a problem that can be solved using a technological design process.	3	SA
	(2) Describe a reason(s) for choosing a solution given possible solution(s) and a problem that can be solved using a technological design process.	3	MC SA
	Classroom only: Collaborate with other students to generate creative solutions to a problem.	NA	NA

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for items

	Items may ask students to:	***C.C.***	***Format***
6-8 APPF Testing Solutions	(1) Write a summary of a solution and/or describe a scientific test of the solution, given a problem that can be solved using a technological design process.	3	MC SA
	(2) Describe a redesign of a solution given a problem, an attempted solution, and results from a test of the solution.	3	MC SA
	Classroom only: Present the recommended design using models or drawings and an engaging presentation.	NA	NA
6-8 APPG Benefits of Science & Technology	Classroom only: Contrast the benefits of science and technology enjoyed by people in industrialized and developing nations.	NA	NA
6-8 APPH Technology & Culture	Classroom only: Describe scientific or technological contributions to society by people in various cultures.	NA	NA

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for items

EALR 4: Physical Science

Big Idea: **Force and Motion (PS1)**

Core Content: *Balanced and Unbalanced Forces*

Stimulus and Stem Rules

- A stimulus or stem will include an adequate description of an appropriate physical science system.

Item Specifications

	Items may ask students to:	*C.C.*	*Format*
6-8 PS1A Time, Distance, & Average Speed	(1) Identify or calculate an object's average speed given distance traveled over an interval of time, using S = d/t (e.g., a battery-powered toy car travels 20 meters in 5 seconds, so its average speed is 4 meters per second).	2	MC CP
	(2) Describe the motion of an object based on a graph of the object's position vs. time.	2	MC
	(3) Identify the position vs. time graph that could represent an object's motion given average speed or position and time data of that object.	2	MC
6-8 PS1B Frictional Forces	(1) Identify friction as a force that can help objects start moving, stop moving, slow down, or change direction.	1	MC CP
	(2) Describe the frictional forces acting on a given object.	2	MC SA
6-8 PS1C Balanced & Unbalanced Forces	(1) Identify the forces acting on an object as balanced or unbalanced given a description of the motion of the object (i.e., speeding up, slowing down, changing direction, unchanging).	2	MC
	(2) Predict the resulting motion of an object given a description of the initial motion of the object and the forces acting on the object.	2	MC
6-8 PS1D Force & Mass	(1) Compare the motion of objects with different masses that receive the same unbalanced force.	2	MC CP

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for items

EALR 4: Physical Science

Big Idea: Matter: Properties and Changes (PS2)

Core Content: *Atoms and Molecules*

Stimulus and Stem Rules

- A stimulus or stem will include an adequate description of an appropriate physical science system.

Item Specifications

	Items may ask students to:	*C.C.*	*Format*
6-8 PS2A Characteristic Intrinsic Properties	(1) Identify characteristic intrinsic properties of a substance (i.e., properties that are independent of the amount of a substance; density, solubility, boiling point, melting point).	1	MC CP
	(2) Identify an unknown substance using characteristic intrinsic properties of the substance (i.e., density, solubility, boiling point, melting point) given properties of possible substances.	2	MC CP
	(3) Predict the behavior of one or more substances given characteristic intrinsic properties of the substances (i.e., density, solubility, boiling point, melting point).	2	MC
	(4) Describe or compare characteristic intrinsic properties of one or more substances (i.e., density, solubility, boiling point, melting point) given behaviors of the substances.	2	MC
6-8 PS2B Compounds & Mixtures	(1) Distinguish between compounds and mixtures of substances (i.e., mixtures are combinations of substances whose chemical properties are preserved; compounds are two or more kinds of atoms bound together in well-defined molecules or crystals with different physical and chemical properties from the reacting substances).	1	MC CP
	(2) Describe how to separate a given mixture using differences in properties (i.e., density, solubility, phase change temperature differences, size, magnetic attraction).	2	MC SA
	(3) Describe that the chemical and physical properties of a compound are different from those of the reactants from which the compound was formed.	1	MC
6-8 PS2C Atoms & Elements	(1) Identify that all matter is made of atoms.	1	MC CP
	(2) Identify the relationship between atoms and elements (i.e., matter made of only one kind of atom is called an element).	1	MC CP
6-8 PS2D Molecules & Compounds	(1) Describe the relationship(s) among atoms, elements, molecules, and compounds (e.g., elements are matter made from only one kind of atom; compounds are matter made from two or more kinds of atoms bound together in molecules).	1	MC CP

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for items

	Items may ask students to:	***C.C.***	***Format***
6-8 PS2E States of Matter & Particles	(1) Describe or compare the motion of the particles that make up solids, liquids and/or gases (i.e., particles in solids vibrate in place while packed in a nearly rigid structure; particles in liquids move around each other; particles in gases move almost independently).	1	MC CP
	(2) Describe or compare the arrangement of the particles that make up solids, liquids, and/or gases placed in a container (e.g., particles of a gas are relatively far apart, move independently, and fill the entire volume of a closed container).	2	MC CP
6-8 PS2F Conservation of Mass	(1) Describe or predict changes in mass of systems undergoing physical and/or chemical changes (e.g., water boiling, vinegar and baking soda reacting to produce a gas, iron rusting).	2	MC CP
	(2) Apply the concept of conservation of mass to account for the mass before and after a physical or chemical change in open and/or closed systems (e.g., water boiling, vinegar reacting with baking soda to produce a gas).	2	MC CP

EALR 4: Physical Science

Big Idea: Energy: Transfer, Transformation, and Conservation (PS3)

Core Content: *Interactions of Energy and Matter*

Stimulus and Stem Rules

- A stimulus or stem will include an adequate description of an appropriate physical science system.

Item Specifications

	Items may ask students to:	*C.C.*	*Format*
6-8 PS3A Energy Forms, Transfers, & Transform-ations	(1) List forms of energy in a given system (i.e., light, thermal (heat), chemical, electrical, kinetic, sound).	1	MC CP
	(2) Describe how energy is transformed from one form to another and/or how energy is transferred from one place to another in a given system other than an electrical circuit.	2	MC CP SA
6-8 PS3B Conduction, Convection, & Radiation	(1) Describe that thermal (heat) energy transfers from warmer objects to cooler ones until the objects reach the same temperature.	2	MC CP
	(2) Describe energy transfer by conduction, radiation, convection, and/or mechanical mixing in a given system.	2	MC CP
6-8 PS3C Thermal Energy & Temperature	(1) Describe the relationship between the temperature of a substance and the average kinetic energy (motion) of particles making up the substance.	2	MC
	(2) Describe that a thermal insulator resists the flow of heat (i.e., thermal energy transfer).	1	MC
6-8 PS3D Light Energy	(1) Describe that light from the Sun is made up of a mixture of all colors of light.	1	MC
	(2) Identify evidence that light from the Sun (i.e., white light) is made up of a mixture of all colors of light.	2	MC CP
	(3) Describe that light emitted from an object or reflected by an object into an eye is necessary for the object to be seen.	1	MC
6-8 PS3E Electrical Energy Transfor-mations	(1) Describe the transformations of energy in an electric circuit (e.g., a circuit containing a battery, a bulb, and/or a buzzer).	2	MC CP SA

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for items

	Items may ask students to:	***C.C.***	***Format***
6-8 PS3F Wave Energy	(1) Describe that waves (i.e., sound, light, water, seismic) transfer energy.	1	MC CP
	(2) Compare characteristics of light and sound waves (e.g., light waves can travel through a vacuum while sound waves cannot).	1	MC
	(3) Describe that waves move at different speeds in different materials (e.g., sound travels more quickly through water than through air).	1	MC CP
	(4) Describe that sound waves are generated and/or transmitted by a vibrating object.	2	MC CP

EALR 4: Earth and Space Science

Big Idea: Earth in the Universe (ES1)

Core Content: *The Solar System*

Stimulus and Stem Rules

- A stimulus or stem will include an adequate description of an appropriate Earth/space science system.

Item Specifications

	Items may ask students to:	*C.C.*	*Format*
6-8 ES1A Moon Phases & Eclipses	(1) Explain one or more phases of the Moon as observed from Earth in terms of the Moon's changing relative position as the Moon orbits Earth.	1	MC
	(2) Describe an eclipse of the Moon and/or an eclipse of the Sun in terms of the relative positions of Earth, the Sun, and the Moon.	1	MC
	(3) Compare the causes of the phases of the Moon with the causes of an eclipse of the Moon.	2	MC CP
6-8 ES1B The Solar System	(1) Describe or compare characteristics of the Sun, the Moon, Earth, other major planets, moons, asteroids, plutoids, and/or comets (i.e., relative size, composition).	1	MC
	(2) Describe or compare the relative positions and/or distances between the Sun, the Moon, Earth, and/or other major planets.	1	MC CP
6-8 ES1C Relative Motion of the Sun, the Moon, & Earth	(1) Describe the motions of Earth and the Moon relative to the Sun and to each other.	1	MC CP
	(2) Describe how the motions of Earth and the Sun explain the phenomena of day/night and/or the length of a year on Earth.	1	MC CP
	(3) Identify phenomena resulting from the regular and predictable motion of objects in the Solar System (e.g., day/night, rising and setting of the Moon, year, phases of the Moon, eclipses).	1	MC CP
6-8 ES1D Gravity & Orbits	(1) Describe gravity as the force that keeps planets in orbit and governs the motion of objects in the Solar System.	1	MC CP
	(2) Identify gravity as the sole force holding objects to Earth's surface.	1	MC CP
	(3) Predict what would happen to an orbiting object if gravity were increased, decreased, or taken away.	2	MC

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for items

	Items may ask students to:	***C.C.***	***Format***
6-8 ES1E **The Galaxy**	(1) Describe the Sun as one of many billions of stars in the Milky Way galaxy and/or Earth as one of many planets orbiting around a star.	1	MC CP
	(2) Describe Earth's position in the Solar System, the Solar System's position in the Milky Way, and/or the Milky Way's position among other galaxies in the universe.	1	MC

EALR 4: Earth and Space Science

Big Idea: Earth Systems, Structures, and Processes (ES2)

Core Content: *Cycles in Earth Systems*

Stimulus and Stem Rules

- A stimulus or stem will include an adequate description of an appropriate Earth science system.

Item Specifications

	Items may ask students to:	*C.C.*	*Format*
6-8 ES2A Earth's Atmosphere	(1) Describe the composition of the atmosphere (e.g., a mixture of nitrogen, oxygen, and trace gases including water vapor and carbon dioxide).	1	MC
	(2) Describe properties of the atmosphere as altitude increases (e.g., troposphere, stratosphere).	1	MC
6-8 ES2B Uneven Heating of Earth's Surface	(1) Describe how uneven heating of Earth's surface by the Sun causes winds and/or ocean currents.	2	MC
	(2) Describe the role of the Sun in the water cycle.	1	MC
6-8 ES2C Water Cycle	(1) Describe processes involved in the water cycle (i.e., water evaporates from Earth's surface, rises and cools, condenses to form clouds, falls as rain or snow, collects in bodies of water).	1	MC CP SA
	(2) Give examples of where parts of the water cycle can be seen on Earth's surface.	2	MC CP SA
6-8 ES2D Water as a Solvent	(1) Identify water as a solvent (e.g., water dissolves minerals and gases from the environment).	1	MC CP
	(2) Describe that water dissolves minerals (e.g., salt) as the water passes through the water cycle dissolving minerals and carrying them to the oceans.	1	MC
6-8 ES2E Layers of Earth	(1) Compare the relative positions, thicknesses, consistencies, and/or temperatures of Earth's crust, core, and/or mantle.	1	MC CP
6-8 ES2F Crustal Plates	(1) Describe that convection in the upper mantle causes crustal plate movement.	1	MC CP
	(2) Describe what may happen where plate boundaries meet (i.e., earthquakes, volcanoes, tsunamis, faults, mountain building).	2	MC SA
6-8 ES2G Landforms	(1) Describe processes that build up landforms (e.g., uplift, deposition) and/or break down landforms (e.g., erosion, weathering).	2	MC
	(2) Explain that a given landform (e.g., mountain) has been shaped by processes that build up structures (e.g., uplift) and/or by processes that break down and carry away material (e.g., weathering and erosion).	2	MC

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for items

	Items may ask students to:	***C.C.***	***Format***
6-8 ES2H Rock Cycle	(1) Describe the processes involved in the rock cycle, including the formation of igneous, sedimentary, and/or metamorphic rock (e.g., igneous rock forms when magma or lava cools, sedimentary rock forms by the compaction of eroded particles, metamorphic rock forms due to heat and pressure).	1	MC CP SA
	(2) Describe that the properties of different types of rocks (e.g., hardness, particle size) provide evidence of how those rocks were formed.	2	MC
	(3) Explain how one type of rock might become a different type of rock during the rock cycle.	2	MC

EALR 4: Earth and Space Science

Big Idea: **Earth History (ES3)**

Core Content: *Evidence of Change*

Stimulus and Stem Rules

- A stimulus or stem will include an adequate description of an appropriate Earth science system.

Item Specifications

	Items may ask students to:	*C.C.*	*Format*
6-8 ES3A Clues to Earth's Past	(1) Describe that Earth processes which can be observed and measured today provide clues to understanding Earth's past (e.g., rate of sedimentation, movement of crustal plates, changes in composition of the atmosphere).	2	MC
6-8 ES3B Estimating Age of Landforms	(1) Describe that number and thickness of layers in sedimentary rock provide evidence for estimating the age of landforms and/or age of fossils found in rocks.	2	MC
6-8 ES3C Sedimentary Rock Layers	(1) Explain that the oldest horizontal layers in sedimentary rock are usually below newer layers.	1	MC
	(2) Explain how geologic events in the past could have caused layers of sedimentary rock to be tipped, folded, and/or inverted.	2	MC
6-8 ES3D Natural Catastrophes & Landforms	(1) Describe how natural catastrophes have shaped Earth's surface (e.g., earthquakes, volcanic eruptions, glaciers, floods, storms, tsunamis, impacts of asteroids).	2	MC SA
	(2) Describe that current landforms provide evidence of past geologic events (e.g., Crater Lake provides evidence of volcanism; the Channeled Scablands provide evidence of floods).	2	MC CP SA
6-8 ES3E Landforms Shaped by Organisms	(1) Explain the role of living organisms in shaping landforms (e.g., coral reefs/islands, limestone deposits, oil and coal deposits).	2	MC SA

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C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for items

EALR 4: Life Science

Big Idea: Structures and Functions of Living Organisms (LS1)

Core Content: *From Cells to Organisms*

Stimulus and Stem Rules

- A stimulus or stem will include an adequate description of an appropriate life science system.

Item Specifications

	Items may ask students to:	*C.C.*	*Format*
6-8 LS1A Cells	(1) Identify that all organisms are composed of at least one cell.	1	MC CP
	(2) Describe functions performed by cells to sustain an organism (i.e., division to produce more cells, taking in nutrients, using energy, releasing waste, producing materials the cell needs).	1	MC CP
6-8 LS1B Cell Parts	(1) Identify the cell part that carries out a given function in a single-celled organism (i.e., nucleus, cell membrane, mitochondria, chloroplast, cell wall).	1	MC CP
6-8 LS1C Cells, Tissues, & Organs	(1) Describe how the structure of a specialized cell relates to the function that cell, tissue, or organ performs (e.g., a nerve cell is very long to carry signals to other nerve cells; sperm cells have a structure that allows the cells to move).	1	MC
	(2) Describe the relationship(s) among cells, tissues, organs, and/or organ systems (e.g., valves in the heart control blood flow; air sacs in the lungs maximize the surface area for transfer of gases).	2	MC CP
	(3) Describe the components and/or functions of the digestive, circulatory, or respiratory systems in animals.	1	MC CP SA
	(4) Describe interactions among the digestive, circulatory, and/or respiratory systems in animals.	2	MC SA
6-8 LS1D Plant and Animal Cells	(1) Describe whether a given cell structure (i.e., nuclei, cytoplasm, cell membranes, mitochondria, chloroplasts, cell walls) belongs to a plant and/or to an animal.	1	MC CP
	(2) Describe the function of a cell structure (i.e., nuclei, cytoplasm, cell membranes, mitochondria, chloroplasts, cell walls) in a given plant or animal cell.	1	MC CP

	Items may ask students to:	***C.C.***	***Format***
6-8 LS1E Classification	(1) Use a classification key to identify one or more given organisms based on internal and/or external structures and/or behaviors.	2	MC CP
6-8 LS1F Lifestyle Choices	Classroom only: Evaluate how lifestyle choices and environments (e.g., tobacco, drug, and alcohol use; amount of exercise; quality of air; and kinds of food) affect parts of the human body and the organism as a whole.	NA	NA

EALR 4: Life Science

Big Idea: Ecosystems (LS2)

Core Content: *Flow of Energy Through Ecosystems*

Stimulus and Stem Rules

- A stimulus or stem will include an adequate description of an appropriate life science system.

Item Specifications

	Items may ask students to:	*C.C.*	*Format*
6-8 LS2A Ecosystem Factors	(1) Describe an ecosystem as a defined area that contains populations of organisms and nonliving factors.	1	MC
	(2) Describe the boundaries and/or contents of a given ecosystem (e.g., the boundary for a pond ecosystem can be defined as the shoreline, the contents of a pond ecosystem include the water, the living organisms, the earth materials in the pond).	2	MC SA
6-8 LS2B Food Webs and Energy Flow	(1) Describe the flow of energy from producers to consumers to decomposers given a description of an ecosystem or a food web.	2	MC CP SA
	(2) Describe a food web showing the relationships among and between the plants and animals of that ecosystem given a description of an ecosystem.	2	MC SA
6-8 LS2C Photosynthesis	(1) Describe that producers transform light energy from the Sun into chemical energy in food through photosynthesis. **Note:** On the science assessments, the term 'mineral nutrient' will be used to describe the matter plants generally get from soil. Mineral nutrients are not food for plants. Plants make their food (energy-rich molecules) with light energy and matter from air, water, and mineral nutrients.	1	MC CP
	(2) Describe that producers are organisms that make their own chemical energy and/or that animals get chemical energy by eating producers or other animals that eat producers.	1	MC CP
	(3) Explain that chemical energy (food) from producers is used by nearly all organisms to carry on life processes.	2	MC CP
6-8 LS2D Changes in Ecosystems	(1) Predict or describe the effect on an ecosystem of a change in a nonliving factor (e.g., amount of light, range of temperatures, presence of water, habitat destruction, human use of resources).	2	MC SA
	(2) Predict or describe the effect on an ecosystem of a change in a living factor (e.g., changes in a population, introduction of a new species, predation).	2	MC

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for items

	Items may ask students to:	***C.C.***	***Format***
6-8 LS2E Problems in Ecosystems	(1) Describe potential risks and/or benefits of a solution(s) given a common environmental issue, possible causative factors, and a possible solution(s).	2	MC SA
	(2) Identify resource uses that reduce the capacity of an ecosystem to support various populations (e.g., use of pesticides, construction).	2	MC SA

EALR 4: Life Science

Big Idea: Biological Evolution (LS3)

Core Content: *Inheritance, Variation, and Adaptation*

Stimulus and Stem Rules

- A stimulus or stem will include an adequate description of an appropriate life science system.

Item Specifications

	Items may ask students to:	*C.C.*	*Format*
6-8 LS3A Evidence of Evolution	(1) Describe that biological evolution accounts for the diversity of life on Earth.	1	MC CP
	(2) Describe scientific evidence that supports the theory of evolution (e.g., fossil evidence, comparative anatomy, patterns of development, cellular/molecular, distribution in time and space).	2	MC
	(3) Describe how biological evolution accounts for similarities and differences among and between plant and/or animal species (e.g., chemical, cellular, molecular, structural).	2	MC
6-8 LS3B Genes	(1) Describe that location of genes is within chromosomes in the nucleus of a cell.	1	MC CP
	(2) Describe the function of genes in an organism as containing the genetic information to specify the organism's traits.	1	MC CP
	(3) Describe that genes are passed from parent to offspring during reproduction.	1	MC CP
6-8 LS3C Reproduction	(1) Identify reproduction as essential for a species to continue to exist.	1	MC
	(2) Identify characteristics of sexual and/or asexual reproduction (e.g., genes are inherited from both parents in sexual reproduction leading to greater diversity of traits).	1	MC
	(3) Identify most plants and animals as organisms which reproduce sexually while some plants can also reproduce asexually.	1	MC
	(4) Describe that sexual reproduction leads to greater diversity of characteristics in the offspring than does asexual reproduction.	2	MC CP

	Items may ask students to:	*C.C.*	*Format*
6-8 LS3D Mendelian Genetics	(1) Describe that offspring produced during sexual reproduction are similar, but not identical to, either parent because the offspring receive genetic information from both parents.	1	MC
	(2) Describe that offspring produced during asexual reproduction are very nearly identical to the parent because the offspring receives genetic information from a single parent.	1	MC
	(3) Predict the outcome of a given genetic cross involving one characteristic using the principles of Mendelian genetics.	2	MC CP
	(4) Explain how the variation produced by sexual reproduction helps species survive.	2	MC SA
6-8 LS3E Adaptations and Differential Survival	(1) Describe an inherited adaptation which would enhance the ability of an organism to survive and/or reproduce in a particular environment (e.g., feathers similar in color to the organism's surroundings may enable the organisms to be more successful at hiding from predators).	2	MC
	(2) Describe an environment and/or an environmental change in which a given animal and/or plant characteristic could confer a survival and/or reproductive advantage (e.g., during dry weather a snail prevents drying out by sealing itself inside the shell).	2	MC
6-8 LS3F Changes in Ecosystems	(1) Describe a change to the environment that could lead to the extinction of a population given an ecosystem and descriptions of the populations in that ecosystem.	2	MC SA
	(2) Predict which populations and/or organisms might be unable to survive given a change to an ecosystem and given descriptions of the populations and/or organisms in that ecosystem.	2	MC SA
6-8 LS3G Relatedness of Species	(1) Explain how given anatomical structures, cell structures, and/or patterns of development of two or more species provide evidence of their degree of relatedness.	2	MC
	(2) Infer the degree of relatedness given diagrams or descriptions of anatomical features of different species (e.g., chicken wing, whale flipper, human hand, bee leg).	2	MC

Key: ***Format***= Multiple-Choice (MC), Completion (CP), Short-Answer (SA), or Not Assessed (NA)
C.C.= Cognitive Complexity **(#)** = Cognitive Complexity for items

Science Vocabulary Used in Assessment Items at Grade 8

Items use language targeted to the previous grade level or lower readability with the exception of the required science terms in the following list. Appropriate science vocabulary allowed for all earlier grade level science assessments may also be used on the grade 8 MSP. Examples from earlier grade levels are also included in the following list.

a

Used in grade 5:
absorb
air
amount
attract

Used in grade 8:
accuracy
acquired (learned) characteristic
adaptation
asexual reproduction
atmosphere
atom
average speed

b

Used in grade 5:
balance
benefit

Used in grade 8:
balanced forces
bond
boundary

c

Used in grade 5:
career
cause
centimeter (cm)
characteristic
circuit
classify
collect
compost
conclude
conclusion
conditions to be compared
conserve
constellations
consumer
controlled experiment
cycle

Used in grade 8:
cell membrane
cell nucleus
cell wall
cementation
chemical energy
chemical reaction
chloroplast
chromosomes
circulatory system
closed system
composition
compound
condensation
conduction
continental plates
controlled (kept the same) variable
convection
core (of Earth)
crust (of Earth)

d

Used in grade 5:
data
decay
decomposer
decrease
deposition
depth
describe
design
diagram
direction
dissolve

Used in grade 8:
density
digestive system
dominant

e

Used in grade 5:
Earth
ecosystem
electric circuit
electrical energy
electricity
energy
energy of motion
environment
erode
erosion
event
evidence
experiment
experimental question
explain
explanation
explore
extinct

Used in grade 8:
earthquake
eclipse
effective
element

engineer
eruption (of volcanoes)
evolution

f

Used in grade 5:
field study
food web
force
forest
form of energy
fossil
freeze
function

Used in grade 8:
factor
filter
flawed
friction
frictional force

g

Used in grade 5:
gas
gram (g)
graph
gravitational force
gravity

Used in grade 8:
galaxy
gene
genetic
glucose

h

Used in grade 5:
habitat
hardness
heat energy

Used in grade 8:
hypothesis

i

Used in grade 5:
identical
identify
inch (in.)
increase
inherited
input
invent
invention
investigation

Used in grade 8:
igneous rock
impact
infer
insulation
interactions

k

Used in grade 5:
kilogram (kg)
kilometer (km)

Used in grade 8:
kinetic energy

l

Used in grade 5:
lamp
light energy
liquid
liter (L)
living
logical

Used in grade 8:
landslide

m

Used in grade 5:
machine
magnetic
magnetism
mass
material
matter
measure
melt
meter (m)
mile (mi)
milliliter (mL)
millimeter (mm)
mineral nutrient
model
Moon
motion
movement

Used in grade 8:
magma
manipulated (independent) variable
mantle (of Earth)
metamorphic rock
mitochondria
mitochondrion
mixture
molecule

n

Used in grade 5:
newtons (N)
nonliving

o

Used in grade 5:
object
observation
observe
orbit (as a noun)
orbit (as a verb)
organism
organize
output

Used in grade 8:
oceanic plates
offspring

open system

p

Used in grade 5:
part
particle
pattern
pollution
population
pound
predator
predict
prediction
prevent
problem
procedure
process
producer
property
protect
provide

Used in grade 8:
particles
phase (of matter)
phase (of the moon)
photosynthesis
precipitation
prey

q

Used in grade 5:
question

r

Used in grade 5:
recycle
redesign
reduce
reliable
report
research
resource
respond
result
role

Used in grade 8:
radiation
recessive
reflect
reflection
respiratory system
responding (dependent) variable
ribosome
rock cycle

s

Used in grade 5:
scientific
scientist
sediment
soil
Solar System
solid
solution (to a problem)
solve
sound energy
speed
spin (rotate)
spring scale
state of matter
structure
substance
subsystem
summary
Sun
supported
surface
survive
switch
system

Used in grade 8:
sedimentary rock
sexual reproduction
skeletal system
soluble
species
subduction (of tectonic plates)

t

Used in grade 5:
table
technology
temperature
texture
thermometer
transfer
transform
transformation

Used in grade 8:
tectonic plates
thermal (heat) energy
tissue
tsunami

u

Used in grade 8:
universe

v

Used in grade 5:
variable
versus (vs.)
vibration

Used in grade 8:
valid
volcano
volume

w

Used in grade 5:
waste
weather
weathering
weight

Used in grade 8:
wavelength

Progression of Variables Language Used in Assessment Items

Terms for the variables in a controlled experiment that build through the grade levels are listed below.

Grade 5
variable kept the same (controlled)
changed (manipulated) variable
measured (responding) variable

A definition for the term *variable* will be included in a glossary for all grade 5 students to reference during testing as follows: All the parts of a system that could be changed are called variables. In an experiment one variable is changed and another variable is measured. The rest of the variables are kept the same.

Grade 8
controlled (kept the same) variable
manipulated (independent) variable
responding (dependent) variable

Biology
controlled (kept the same) variable
manipulated (independent) variable
responding (dependent) variable

Appendix A: Cognitive Complexity

The cognitive level assigned to an Item Specification is the ceiling for the assessment. Different items written to the same specification can and should be written to different cognitive levels.

Webb's Depth-of-Knowledge (DOK) Levels for Science

Karin K. Hess

According to Norman L. Webb ("Depth-of-Knowledge Levels for Four Content Areas," March 28, 2002), interpreting and assigning depth-of-knowledge levels to both objectives within standards and assessment items is an essential requirement of alignment analysis. Four levels of Depth of Knowledge are used for this analysis.

A general definition for each of the four (Webb) Depth-of-Knowledge levels is followed by Table 1, which provides further specification and examples for each of the DOK levels in science. Generally speaking, large-scale, on-demand assessments should only assess Depth-of-Knowledge Levels 1, 2, and 3. Depth-of-Knowledge at Level 4 should be reserved for local assessment and is included here primarily for illustrative purposes.

Descriptors of DOK Levels for Science (based on Webb, March 2002 and TIMSS Science Assessment framework, 2003)

Level 1 Recall and Reproduction requires recall of information, such as a fact, definition, term, or a simple procedure, as well as performing a **simple** science process or procedure. Level 1 only requires students to demonstrate a rote response, use a well-known formula, follow a set procedure (like a recipe), or perform a clearly defined series of steps. A "simple" procedure is well-defined and typically involves only **one step**. Verbs such as "identify," "recall," "recognize," "use," "calculate," and "measure" generally represent cognitive work at the recall and reproduction level. Simple word problems that can be directly translated into and solved by a formula are considered Level 1. Verbs such as "describe" and "explain" could be classified at different DOK levels, depending on the complexity of what is to be described and explained.

A student answering a Level 1 item either knows the answer or does not: that is, the answer does not need to be "figured out" or "solved." In other words, if the knowledge necessary to answer an item automatically provides the answer to the item, then the item is at Level 1. If the knowledge necessary to answer the item does not automatically provide the answer, the item is at least at Level 2.

Level 2 Skills and Concepts includes the engagement of some mental processing beyond recalling or reproducing a response. The content knowledge or process involved is **more complex** than in Level 1. Items require students to make some decisions as to how to approach the question or problem. Keywords that generally distinguish a Level 2 item include "classify," "organize," "estimate," "make observations," "collect and display data," and "compare data." These actions imply **more than one step**. For example, to compare data requires first identifying characteristics of the objects or phenomenon and then grouping or ordering the

objects. Level 2 activities include making observations and collecting data; classifying, organizing, and comparing data; and organizing and displaying data in tables, graphs, and charts.

Some action verbs, such as "explain," "describe," or "interpret," could be classified at different DOK levels, depending on the complexity of the action. For example, interpreting information from a simple graph, requiring reading information from the graph, is a Level 2. An item that requires interpretation from a complex graph, such as making decisions regarding features of the graph that need to be considered and how information from the graph can be aggregated, is at Level 3.

Level 3 Strategic Thinking requires deep knowledge using reasoning, planning, using evidence, and a higher level of thinking than the previous two levels. The cognitive demands at Level 3 are **complex and abstract**. The complexity does not result only from the fact that there could be multiple answers, a possibility for both Levels 1 and 2, but because the multi-step task requires **more demanding reasoning**. In most instances, requiring students to explain their thinking is at Level 3; requiring a very simple explanation or a word or two should be at Level 2. An activity that has more than one possible answer and requires students to justify the response they give would most likely be a Level 3. Experimental designs in Level 3 typically involve more than one dependent variable. Other Level 3 activities include drawing conclusions from observations; citing evidence and developing a logical argument for concepts; explaining phenomena in terms of concepts; and using concepts to solve non-routine problems.

Level 4 Extended Thinking requires **high cognitive demand** and is **very complex**. Students are required to make several connections—relate ideas *within* the content area or *among* content areas—and have to select or devise one approach among many alternatives on how the situation can be solved. Many on-demand assessment instruments will not include any assessment activities that could be classified as Level 4. However, standards, goals, and objectives can be stated in such a way as to expect students to perform extended thinking. "Develop generalizations of the results obtained and the strategies used and apply them to new problem situations" is an example of a grade 8 objective that is a Level 4. Many, but not all, performance assessments and open-ended assessment activities requiring significant thought will be Level 4.

Level 4 requires complex reasoning, experimental design, and planning and **probably will require an extended period of time** either for the science investigation required by an objective, or for carrying out the multiple steps of an assessment item. However, the extended time period is not a distinguishing factor if the required work is only repetitive and does not require applying significant conceptual understanding and higher-order thinking. For example, if a student has to take the water temperature from a river each day for a month and then construct a graph, this would be classified as a Level 2 activity. However, if the student conducts a river study that requires taking into consideration a number of variables, this would be a Level 4.

Table 1: Examples for each of the DOK Levels in Science, based on Webb (working draft K. Hess, November 2004)

Level 1 **Recall & Reproduction**	**Level 2** **Skills & Concepts**	**Level 3** **Strategic Thinking**	**Level 4** **Extended Thinking**
a) Recall or recognize a fact, term, definition, simple procedure (such as one step), or property b) Demonstrate a rote response c) Use a well-known formula d) Represent in words or diagrams a scientific concept or relationship e) Provide or recognize a standard scientific representation for simple phenomenon f) Perform a routine procedure, such as measuring length g) Perform a **simple** science process or a set procedure (like a recipe) h) Perform a clearly defined set of steps i) Identify, calculate, or measure **NOTE: If the knowledge necessary to answer an item automatically provides the answer, it is a Level 1.**	a) Specify and explain the relationship between facts, terms, properties, or variables b) Describe and explain examples and non-examples of science concepts c) Select a procedure according to specified criteria and perform it d) Formulate a routine problem given data and conditions e) Organize, represent, and compare data f) Make a decision as to how to approach the problem g) Classify, organize, or estimate h) Compare data i) Make observations j) Interpret information from a simple graph k) Collect and display data **NOTE: If the knowledge necessary to answer an item does not automatically provide the answer, then the item is at least a Level 2. Most actions imply more than one step.**	a) Interpret information from a complex graph (such as determining features of the graph or aggregating data in the graph) b) Use reasoning, planning, and evidence c) Explain thinking (beyond a simple explanation or using only a word or two to respond) d) Justify a response e) Identify research questions and design investigations for a scientific problem f) Use concepts to solve non-routine problems/more than one possible answer g) Develop a scientific model for a complex situation h) Form conclusions from experimental or observational data i) Complete a multi-step problem that involves planning and reasoning j) Provide an explanation of a principle k) Justify a response when more than one answer is possible l) Cite evidence and develop a logical argument for concepts m) Conduct a designed investigation n) Research and explain a scientific concept o) Explain phenomena in terms of concepts	a) Select or devise approach among many alternatives to solve problem b) Based on provided data from a complex experiment that is novel to the student, deduct the fundamental relationship between several controlled variables c) Conduct an investigation, from specifying a problem to designing and carrying out an experiment, to analyzing its data and forming conclusions d) Relate ideas *within* the content area or *among* content areas e) Develop generalizations of the results obtained and the strategies used and apply them to new problem situations **NOTE: Level 4 activities often require an extended period of time for carrying out multiple steps; however, time alone is not a distinguishing factor if skills and concepts are simply repetitive over time.**

Depth-of-Knowledge as a "Ceiling" NOT as a "Target"
An important consideration of large-scale assessment design is to use the highest Depth-of-Knowledge (DOK) demand implicit in an assessment limit as the "ceiling" for assessment, not the "target." When considering the highest DOK Level as the ceiling not the target, it has the potential to be assessed at Depth-of-Knowledge Levels at the ceiling, and up to the ceiling, depending upon the cognitive demand of the assessment limit.

Why is this distinction between "ceiling" and "target" important?
If assessed only as the "target" level, all assessment limits with a Level 2 or Level 3 as their highest demand would only be assessed at those highest levels. This would potentially have two negative impacts on the assessment: 1) The assessment as a whole could be too difficult; and 2) important information about student learning along the achievement continuum would be lost. Multiple items covering a range of DOK levels can provide useful instructional information for classroom teachers.

Depth of Knowledge for Science updated 2005
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An updated version is available at: http://www.nciea.org/publications/DOKscience_KH11.pdf