

Oregon High School Science Assessment Specifications





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Science Test Specification

Introduction

The primary purpose of Oregon's Test Specifications and Blueprints is to provide the consistency necessary for the development and administration of the Oregon Assessment of Knowledge and Skills (OAKS). OAKs provide critical data for Oregon's accountability system which meets Peer Review Requirements of the Elementary and Secondary Education Act. All Students in grades 3 through 8 are required to take the Smarter Balanced English Language Arts/Literacy and the Smarter Balanced Mathematics assessments. All students in grades 5 and 8 are required to take the science assessment. In high school, the Smarter Balanced English Language Arts/Literacy, Smarter Balanced Mathematics, and science are required assessments.

OAKS is also one way for students to demonstrate proficiency in the Essential Skills of reading, writing, and mathematics, which are necessary for earning a high school diploma. In addition, English Language Proficiency Assessment (ELPA) is required for non-English speaking students until they acquire sufficient skills in English to exit the program. Social Sciences is an optional assessment.

Test specifications provide guidelines for item writers, who are typically Oregon teachers, on what content may be tested and how items must be written. These specifications lead to test blueprints that outline test design and the

number of questions to be tested in each score reporting category (SRC). The Test Specifications and Blueprints document is an important resource, not only for item writers and reviewers, but for educators administering OAKS and the general public who are interested in understanding the content and format of test items.

Background

The purposes of the Oregon Statewide Assessment Program are (1) to provide information on individual student achievement on performance standards set by the State Board of Education at grade and grade-group levels; (2) to provide information for federal ESSA requirements and for policy decisions by the legislature, the governor, the State Board of Education, and local school districts; (3) to support instructional program improvement efforts; and (4) to inform the public about student achievement in Oregon schools.

The Oregon Statewide Assessment is different from national norm-referenced tests used in many districts and states. The Oregon Statewide Assessment is a criterion-referenced assessment based on the Oregon Content Standards. As a result, the types of scores produced from the Oregon Statewide Assessment are somewhat different from those

produced by national norm-referenced tests.

Oregon educators contribute to the test development and alignment process by serving on advisory committees called Content and Assessment Panels. Stakeholders in these committees are involved in each phase of the development of these specifications to assure that they accurately and clearly explain the overall design of the test and describe the specific content that might appear on the test to measure the knowledge and skills described in the content standards.

Oregon's knowledge and skills test questions use multiple choice and computer scored constructed response formats. Each multiple choice item has only one correct answer while computer scored constructed response items may have many correct answers. A computer electronically collects and scores responses which are scored against the answer key to produce a raw score. The raw score is converted to a scale score called a Rasch unit or RIT score. Students receive a scale score based on the number of questions answered correctly compared to the total number of questions on the form—taking into account the difficulty of the questions. Students are not penalized for guessing.

The content of these specifications reflects the skill expectations outlined in the Content Standards adopted February 2009 by the State Board of Education. These standards were developed, in part, to correlate to the skills assessed on the science portion of the National Assessment of Educational Progress and align with the National Science Standards. As a result, Oregon uses similar terminology in its descriptions of the science subject score reporting categories (listed later in this document).

2018 Embedded Field Test

The 2018 OAKS Science Test will contain field test items aligned to the 2014 Oregon Science Standards (NGSS). These items are being tested for implementation in the 2019 OAKS Science Test and will not be utilized in any of the score reporting categories for 2018 OAKS Science Test. Total time on test is not expected to change.

Statewide and Local Assessments

Statewide assessments are multiple choice and computer scored constructed response tests of knowledge and skills that are developed and scored by the state. Local assessments include performance assessments that may be scored using statewide scoring guides that are administered and scored at the local level. Local assessments are not included in state accountability reports, e.g. Oregon Department of Education School and District Report Cards.

Electronic Administration

On the science knowledge and skills OAKS online tests, there are three opportunities to participate in fully-adaptive testing. In this format, the accuracy of the student responses to questions determines the next item or set of items the student will see. Students are allowed to preview test questions if a set of questions link to a specific graphic or stimulus. Having the tests fully adaptive allows for more precision in measurement and less frustration for the students.

Electronic administration of the science test for each grade tested includes up to three test opportunities in English or English-Spanish formats. Students who need to have the test

read to them may access the text to speech function of each test. The OAKS Online test delivery system allows students with visual impairments, who use Braille, to access the OAKS Online testing system. These students will have the same number of testing opportunities as other students and have

access to the adaptive OAKS online test. Paper-based Braille assessments will no longer be available. An online practice test of sample items is available for students who may need practice using a scrollbar, or who need practice with new item types.

The following pages contain a more detailed examination of the test content for science. The first column lists the content standard assessed for that particular score reporting category and academic vocabulary sometimes linked to that standard. The second column provides a description of the testable content and gives a more detailed explanation of how the standard will be assessed. Finally, the third column provides sample items that are very similar to the type of questions asked on a test related to that eligible content.

Core Standard H.1 Structure and Function, Score Reporting Category 1/5

A system's characteristics, form, and function are attributed to the quantity, type, and nature of its components
It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

Content Standard

H.1P.1 Explain how atomic structure is related to the properties of elements and their position in the Periodic Table. Explain how the composition of the nucleus is related to isotopes and radioactivity.

Academic Vocabulary*

- atomic mass
- atomic number
- charge
- half-life
- ion
- reactive/non-reactive
- valence electrons

Links to National Science Standards

2009 NAEP Framework: P12.2, P12.3, P12.4, P12.6, P12.11, P12.15

National Science Education Standards: Physical Science Content Standard B, pgs.176-181.

AAAS Science Literacy Benchmarks

Explanation

Atomic Structure

- The atom is made of protons, electrons, and neutrons.
- The number of protons defines an element.
- Isotopes are atoms of the same element with different numbers of neutrons.
- Ions are formed when the number of electrons differs from the number of protons.

The Periodic Table

- The Periodic table organizes the elements into groups/regions with common characteristics.
- Each group has unique chemical properties (similarities and trends within groups)
- The groups/regions are: Alkali metals, Alkaline Earth Metals, Transition Metals, Halogens, and Noble gases.
- The regions are metals, non-metals, semi-metals (metalloids).

Isotopes and Radioactivity

- Some isotopes are stable and others are radioactive.
- When radioactive isotope decays, it degrades into a different isotope, this continues until a stable element occurs.
- Nuclear fusion is when two isotopes combine (as they do in the sun).
- Nuclear fission is when a single isotope is split in half (as in nuclear power plants).

Content Connections from Previous Grades

7.1P.1, 8.1P.1, 8.1P.2

Sample Items

Based on its location on the periodic table, which of the following elements will gain two electrons to achieve a stable atom?

- A. Sodium (Na)
- B. Calcium (Ca)
- C. Oxygen (O)
- D. Bromine (Br)

Answer Key: C

Based on its position on the periodic table, which of the following elements is MOST reactive?

- A. Helium (He)
- B. Fluorine (F)
- C. Sulfur (S)
- D. Carbon (C)

Answer Key: B

**Academic Vocabulary is a list of terms related to the content standard and may be used in test items without explanation. Vocabulary and concepts within the Explanation are assessable and not exclusive.*

Core Standard H.1 Structure and Function, Score Reporting Category 1/5

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Content Standard

H.1P.2 Describe how different types and strengths of bonds affect the physical and chemical properties of compounds.

Academic Vocabulary*

- hydrogen bonds

Links to National Science Standards

2009 NAEP Framework: P12.1, P12.6, P12.7

National Science Education Standards: Physical Science Content Standard B, pgs. 176-181.

AAAS Science Literacy Benchmarks

Explanation

Ionic Bonds

- An ionic bond occurs when a metal atom transfers electron(s) to a non-metal atom (e.g. to form salt).
- Ionic bonds are stronger than covalent bonds
- Dissolve in water
- Conduct electricity when dissolved in water
- Solid at room temperature

Polar Covalent Bonds

- A polar covalent bond occurs when the electrons are shared unequally between two atoms (e.g. water).
- Dissolves in water
- Does not conduct electricity when dissolved in water
- Usually liquid or gas at room temperature

Nonpolar Covalent Bonds

- A nonpolar covalent bond occurs when the electrons are shared equally between two atoms (e.g. O₂)
- Solid or liquid forms do not dissolve in water

Content Connections from Previous Grades

8.1P.3, H1P.1

Sample Items

If at room temperature, a solid compound is placed in water, dissolves and conducts electricity it is MOST LIKELY held together with?

- A. Ionic bonds
- B. Polar covalent bonds
- C. Hydrogen bonds
- D. Nonpolar covalent bonds

Answer Key: A

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Core Standard H.1 Structure and Function, Score Reporting Category 1/6

A system's characteristics, form, and function are attributed to the quantity, type, and nature of its components
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Content Standard

H.1L.1 Compare and contrast the four types of organic macromolecules. Explain how they compose the cellular structures of organisms and are involved in critical cellular processes

Academic Vocabulary*

- cholesterol
- enzymes
- macromolecule
- metabolism
- mon/polysaccharides
- organic
- phospholipid
- active transport
- diffusion/osmosis

Links to National Science Standards

2009 NAEP Framework: L12.1, L12.2, L12.4

National Science Education Standards: Physical Science Content Standard B, pgs. 155-158.

AAAS Science Literacy Benchmarks

Explanation

Four Organic Macromolecules

- proteins (e.g. enzymes)
- lipids (fats, oils, waxes)
- carbohydrates (sugar/starch/cellulose)
- nucleic acids (DNA/RNA)
- all composed of the elements CHNOPS

Critical Cellular Processes**

- Respiration
- Protein Synthesis
- Photosynthesis
- Active Transport

- Diffusion/osmosis

****limited to basic chemical equations, general knowledge of cycles and processes involved, inputs and outputs.**

Cellular Structures

- mitochondrion, lysosomes
- nucleus, DNA/RNA, endoplasmic reticulum, golgi apparatus, ribosomes
- chloroplast
- plasma membrane, cell wall

Content Connections from Previous Grades

7.2L.1, 7.2L.2

Sample Items

Which of the following statements about cell membranes is NOT true?

- A. They are barriers between the inside and outside of the cell.
- B. They contain proteins which perform a variety of transport functions.
- C. They are composed of phospholipids
- D. They allow DNA to move in and out of the cell

Answer Key: D

Cellular respiration generates

- A. energy to support cell processes.
- B. oxygen and CO₂.
- C. chemical elements to support cell growth.
- D. proteins used in cell division.

Answer Key: A

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Core Standard H.1 Structure and Function, Score Reporting Category 1/6

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Content Standard

H.1L.2 Describe the chemical structure of DNA and its relationship to chromosomes. Explain the role of DNA in protein synthesis.

Academic Vocabulary*

- Amino acid
- adenine
- complementary
- cytosine
- guanine
- thymine

Links to National Science Standards

2009 NAEP Framework: L12.8, L12.9

National Science Education Standards: Physical Science Content Standard B, pgs.155-158.

AAAS Science Literacy Benchmarks

Explanation

DNA structure

- double helix
- four bases (ATGC)
- phosphate and sugar backbone
- base pairing A-T and G-C
- Coiled tightly to form chromosomes

Differences between DNA and RNA

- DNA double stranded/ RNA single stranded
- Thymine in DNA/uracil in RNA
- Deoxyribose in DNA/Ribose in RNA
- One type of DNA/Three types of RNA (messenger RNA, ribosomal RNA, transfer RNA)

Protein Synthesis

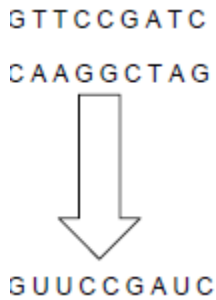
- DNA carries the instructions/blueprints for making proteins
- mRNA leaves the nucleus
- rRNA (ribosome) reads mRNA
- tRNA brings amino acids that connect to make protein

Content Connections from Previous Grades

7.2L.1

Sample Items

The diagram below represents the beginning and end products of a process that occurs in the nucleus of a cell.



What process does the diagram represent?

- A. Recombination
- B. Replication
- C. Transcription
- D. Translation

Answer Key: C

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Core Standard H.1 Structure and Function, Score Reporting Category 1/5

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Content Standard

H.1L.3 Explain and apply laws of heredity and their relationship to the structure and function of DNA

Academic Vocabulary*

- carrier
- color-blindness
- crossover
- genetic expression
- generation (P_1 , F_1 , F_2)
- hemophilia
- karyotype
- mutation
- non-disjunction
- pedigree
- polygenic
- sequence
- sex-linked

Links to National Science Standards

2009 NAEP Framework: L12.10

National Science Education Standards: Physical Science Content Standard B, pgs.155-158.

AAAS Science Literacy Benchmarks

Explanation

Mendelian Genetics

- Dominant/recessive inheritance
- X-linked inheritance
- Codominant/Incomplete dominance
- Polygenic inheritance
- Punnett Squares (monohybrid)
- Homozygous/Heterozygous

DNA and Heredity

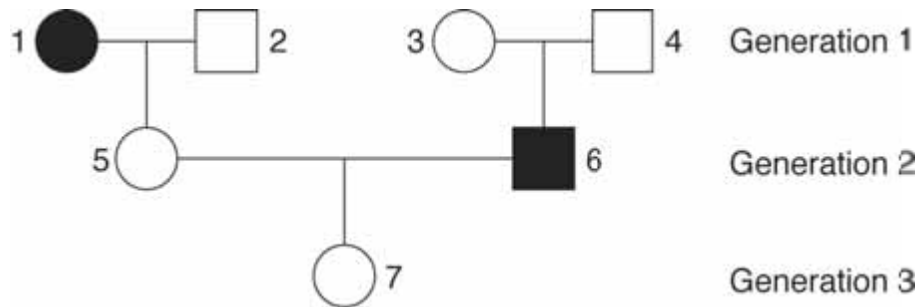
- DNA makes up chromosomes
- Chromosomes are organized into segments called genes
- Genes code for proteins
- Proteins produce traits of an organism
- Genotype/phenotype

Content Connections from Previous Grades

7.1L.2

Sample Items

The pedigree shows individuals that have a genetic disorder. Only individuals that have the disorder are shaded.



Which of the following terms best describes the genetic disorder?

- A. Dominant
- B. Incomplete Dominance
- C. Recessive
- D. Sex-linked

Answer Key: C

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Core Standard H.1 Structure and Function, Score Reporting Category 1/6

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Content Standard

H.1L.4 Explain how cellular processes and cellular differentiation are regulated both internally and externally in response to the environments in which they exist.

Academic Vocabulary*

- anaphase
- concentration gradient
- isotonic/hypertonic/hypotonic
- interphase
- metaphase
- permeability
- prophase
- telophase
- transport proteins

Links to National Science Standards

2009 NAEP Framework: L12.3

National Science Education Standards: Physical Science Content Standard B, pgs.155-158.

AAAS Science Literacy Benchmarks

Explanation

Homeostasis

- Organisms attempt to maintain a balance (steady-state) in their internal environment.
- Examples include pressure, salinity, nutrient level, temperature, and metabolic rate.

Cell Processes

- Factors affect the processes cells perform.
- These factors include temperature, light, nutrients, humidity, altitude, availability of energy and salinity.
- Organisms have chemical and physical reactions to these factors.
- Diffusion/Osmosis/Active transport

Cell Differentiation

- Multicellular organisms have different types of cells and tissues.
- Differentiation is affected by gene expression and may also be affected by environmental factors.

Content Connections from Previous Grades

6.1L.1, 6.2L.1, 7.2L.1, H.1L.1

Sample Items

The process of diffusion occurs when

- A. all molecular movement stops.
- B. molecules move from areas of lesser concentration to areas of greater concentration.
- C. sugar molecules move into a cell.
- D. molecules move from areas of greater concentration to areas of lesser concentration.

Answer Key: D

If an animal cell is placed in distilled water, it will swell and burst. The bursting of the cell is a result of which biological process?

- A. Active transport
- B. Enzyme activity
- C. Osmosis
- D. Respiration

Answer Key: C

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Core Standard H.1 Structure and Function, Score Reporting Category 1/7

A system's characteristics, form, and function are attributed to the quantity, type, and nature of its components
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Content Standard

H.1E.1 Classify the bodies in our solar system based on properties and composition. Describe attributes of our galaxy and evidence for multiple galaxies in the universe.

Academic Vocabulary*

- black hole
- nebula
- red shift
- dwarf stars
- orbital path
- spiral galaxy

Links to National Science Standards

2009 NAEP Framework: E12.2, E12.3

National Science Education Standards: Physical Science Content Standard D, pgs.187-190.

AAAS Science Literacy Benchmarks

Explanation

Solar System Bodies

- Sun
- Inner/rocky planets and out/gaseous planets
- Asteroids, meteors, and comets
- Moons and other satellites

Properties and Composition

- Physical: size, relative location, orbital path/plane
- Chemical: atmosphere, primary elements, % composition

Galaxy (Milky Way)

- Relative stellar mass
- General size/shape of our galaxy

Content Connections from Previous Grades

5.E1.1, 6.1E.1, 6.1E.2

Sample Items

Which of the following observations is a result of the Doppler effect?

- A. Noise from across a lake is louder at night than during the day.
- B. A person walking notices that the pitch of a car's engine decreases as the car passes by.
- C. Beats are produced when two tuning forks with different frequencies are heard together.
- D. A person hears the sound from a radio more clearly in certain areas of a room than in others.

Answer Key: B

Electromagnetic waves of various frequencies reach Earth from distant parts of the universe. Which of the following can be inferred from this?

- A. The wavelengths must be very short.
- B. A single material must fill all of space.
- C. These waves can travel without a medium.
- D. The speed of these waves is 300,000,000 m/s.

Massachusetts Released item #11, pg. 294

Answer Key: C

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Core Standard H.1 Structure and Function, Score Reporting Category 1/7

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It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

Content Standard

H.1E.2 Describe the structure, function, and composition of Earth's atmosphere, geosphere, and hydrosphere.

Academic Vocabulary*

- infrared
- ozone
- petroleum
- Plate Tectonics
- stratosphere
- ultra-violet
- vertical/horizontal circulation

Links to National Science Standards

2009 NAEP Framework: E8.7, E8.8, E8.14

National Science Education Standards: Physical Science Content Standard D, pgs.187-190.

AAAS Science Literacy Benchmarks

Explanation

Structure and Composition of Atmosphere

- Gas content and percentage
- Physical and chemical properties as they relate to elevation (pressure and temperature patters)
- Specific composition (layers)

Structure and Composition of Geosphere

- Relative thickness
- Consistency and composition of crust, mantle and core.
- Tectonic plates and related surface features

Structure and Composition of Hydrosphere

- Percentage of fresh water in usable and unusable supplies
- Composition of fresh water/salt water
- Interfaces of fresh and salt water

Content Connections from Previous Grades

6.1E.1, 7.2E.2, 8.2E.2, 8.2E.3

Sample Items

Which of these is an example of the geosphere effecting the composition of the atmosphere?

- A. Tectonic plates moving against each other causing earthquakes.
- B. A volcanic eruption releasing rock, water and gas.
- C. A landslide forming a dam on a large river.
- D. Forest fires burning release material and heat.

Answer Key: B

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Core Standard H.2 Interaction and Change, Score Reporting Category 2/5

The components in a system can interact in dynamic ways that may result in change. In systems, changes occur with a flow of energy and/or transfer of matter.

It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

Content Standard

H.2P.1 Explain how chemical reactions result from the making and breaking of bonds in a process that absorbs or releases energy. Explain how different factors can affect the rate of a chemical reaction.

Academic Vocabulary*

- activation energy
- combustion
- dilution
- enzyme

Links to National Science Standards

2009 NAEP Framework: 8.2P.2, H1P.2

National Science Education Standards: Physical Science Content Standard B, pgs. 176-181.

AAAS Science Literacy Benchmarks

Explanation

A chemical reaction must break a bond(s) and/or form a new bond(s).

- Synthesis reactions make new bonds.
- Decomposition reactions break existing bonds
- Combustion reactions break existing bonds.

Reactions involve energy

- Exothermic reactions release energy during the chemical reaction.
- Endothermic reactions absorb energy during the chemical reaction.

Factors that can effect rates of reaction

- Catalysts
- Surface area
- Concentration
- Pressure
- Temperature
- time

Content Connections from Previous Grades

8.2P.2, H.1P.2

Sample Items

Sam and Jordan are studying the reaction between vinegar and baking soda. They already know what when vinegar and baking soda re mixed, a vigorous reaction produces a lot of bubbles and that the baking soda seems to disappear during the reaction. During a class discussion, the students figured out that the equation for the reaction is:

Vinegar + Baking Soda → Carbon Dioxide + Water + Sodium Acetate

$CH_3OOH + NaHCO_3 \rightarrow CO_2 + H_2O + NA(CH_3COO)$

Sam and Jordan measure 50 mL of vinegar and pour it into a flask. Then they weigh out 10g of baking soda. Same starts the stopwatch when Jordan dumps the baking soda into the flask, than Jordan gently swirls the flask while Sam watches to see when the last bubbles are given off by the reaction. They have determined that the reaction takes 30 sec. under these conditions.

If Sam adds 5 g of baking soda, rather than the 10g that was used in the first trial, the change in the experiment will

- A. decrease the reaction time, and the bubbles will stop in less than 30 seconds.
- B. Increase the reaction time, and the bubbles will continue for more than 30 seconds.
- C. have no effect on the speed of the reaction, and the bubbles will stop in 30 seconds.
- D. be impossible to be predicted, given this information

Answer Key: A

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Core Standard H.2 Interaction and Change, Score Reporting Category 2/5

The components in a system can interact in dynamic ways that may result in change. In systems, changes occur with a flow of energy and/or transfer of matter.

It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

Content Standard

H.2P.2 Explain how physical and chemical changes demonstrate the law of conservation of mass.

Academic Vocabulary*

- emission
- evaporation

Links to National Science Standards

2009 NAEP Framework: P8.6, P8.7

National Science Education Standards: Physical Science Content Standard B, pgs.176-181.

AAAS Science Literacy Benchmarks

Explanation

During both physical and chemical changes the total mass of the system will not change.

- Phase changes (boiling, condensing, melting, freezing, sublimation)
- Temperature change (without a phase change)
- Dissolving (solvent/solute/solution)
- Physical manipulation (separation, grinding, mixing, collecting)

During chemical reactions the total mass before and after must be equal

- During chemical reactions, the number of atoms of each element before the reaction must be equal to the number of atoms of each element after the reaction (therefore, the need for coefficients in a balanced chemical reaction).

Content Connections from Previous Grades

8.2P.1

Sample Items

A student fills a beaker with 200mL of water. The beaker and water have a combined mass of 360g. The student then adds 10grams of salt to the water. He stirs until the salt dissolves.

What is the mass of the salt-water-beaker system after the salt has dissolved?

- A. 350.0g
- B. 360.0g
- C. 370.0g
- D. 380.0g

Answer Key: C

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Core Standard H.2 Interaction and Change, Score Reporting Category 2/5

The components in a system can interact in dynamic ways that may result in change. In systems, changes occur with a flow of energy and/or transfer of matter.

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Content Standard

H.2P.3 Describe the interactions of energy and matter including the law of conservation of energy

Academic Vocabulary*

- amplitude
- entropy
- frequency
- hertz
- thermal equilibrium
- transformation
- wavelength

Links to National Science Standards

2009 NAEP Framework: P12.5, P12.8-12.10, P12.12, P12.13, P12.16, P12.18, and P12.23

National Science Education Standards: Physical Science Content Standard B, pgs.176-181

AAAS Science Literacy Benchmarks

Explanation

Kinetic Energy

- Heat energy
- Thermal equilibrium
- Magnetic field
- Sound energy
- Seismic energy
- Electrical energy
- Mechanical energy

Potential Energy

- Gravitational energy
- Elastic energy
- Chemical energy

Radiant Energy

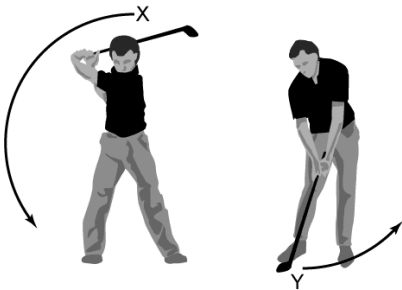
- Percentage of fresh water in usable and unusable supplies
- Composition of fresh water/salt water
- Interfaces of fresh and salt water

Content Connections from Previous Grades

8.2P.2, H.2P.1

Sample Items

The diagrams below show a man swinging a golf club



The kinetic energy of the golf club at point Y is more than the potential energy of the club at point x. Which of the following statements best explains why this fact does not violate the law of conservation of energy?

- A. Gravity is constant from point x to point y.
- B. Air resistance is greater at point y than at point x.
- C. Acceleration due to gravity is greater at point y than at point x.
- D. Energy is added by the man to the golf club from point x to point y.

Massachusetts Release item pg. 297 #15

Answer Key: D

A surfer paddles out from shore in search of the perfect wave. The surfer has a weight of 500N and the surfboard weighs 100N.

As the surf gets rougher, the surfer estimates that she is bobbing up and down once every two seconds. What is the frequency of the water waves that are passing her?

- A. 0.5 Hertz
- B. 1.0 Hertz
- C. 2.0 Hertz
- D. 3.0 Hertz

Answer key: A

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Core Standard H.2 Interaction and change, Score Reporting Category 2/5

The components in a system can interact in dynamic ways that may result in change. In systems, changes occur with a flow of energy and/or transfer of matter.

It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

Content Standard

H.2P.4 Apply the laws of motion and gravitation to describe the interaction of forces acting on an object and resultant motion.

Academic Vocabulary*

- acceleration
- momentum
- Newton (force unit)

Links to National Science Standards

2009 NAEP Framework: P12.13, P12.17
P12.19, and P12.20-12.22

National Science Education Standards: Physical
Science Content Standard B, pgs. 176-181.

AAAS Science Literacy Benchmarks

Explanation

Newton's Laws

- Objects change their motion only when a net force is applied
- Newton's First Law of Motion (inertia)
- Newton's Second Law of Motion ($F=ma$)
- Newton's Third Law of Motion (cause/effect)
- Newton's Law of Universal Gravitation

Force

- Equation calculations
- Units of force
- Force Vectors
- Balanced vs. unbalanced forces

Content Connections from Previous Grades

5.2P.1, 7.2P.1, 8.2E.1

Sample Items

The force exerted on a cart is constant. On a frictionless surface, if the cart's mass is increased, the acceleration will

- A. Increase only.
- B. Decrease only.
- C. Increase, then decrease.
- D. Decrease, then increase.

Answer Key: B

A surfer paddles out from shore in search of the perfect wave. The surfer has a weight of 500N and the surfboard weighs 100N.

When the surfer is on a surfboard floating on calm water, what is the buoyant force pushing up on the board?

- A. 100 Newtons
- B. 400 Newtons
- C. 500 Newtons
- D. 600 Newtons

Answer Key: D

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Core Standard H.2 Interaction and Change, Score Reporting Category 2/5

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Content Standard

H.2L.1 Explain how energy and chemical elements pass through systems. Describe how chemical elements are combined and recombined in different ways as they cycle through the various levels of organization in biological systems.

Academic Vocabulary*

- Autotroph/heterotroph
- chemosynthesis
- food chain/food web
- photosynthesis
- phytoplankton/zooplankton
- producer/consumer
- respiration
- trophic level

Links to National Science Standards

2009 NAEP Framework: P12.4-12.6

National Science Education Standards: Physical Science Content Standard C, pgs. 155-158

AAAS Science Literacy Benchmarks

Explanation

Energy

- continually provided by sunlight
- most is dissipated as heat, some is used by organisms to support life.
- Energy needs to be continually supplied.

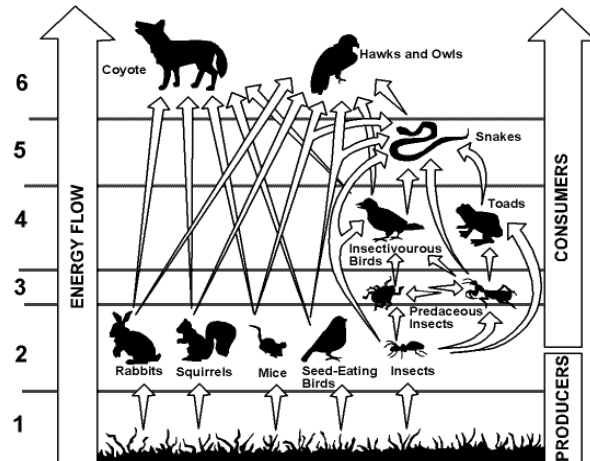
Chemical Elements

- Limited amount available.
- Cycled through the environment (Carbon cycle, nitrogen cycle, water cycle)
- Cell→Organism→Ecosystem→Biosphere

Content Connections from Previous Grades

7.2L.1, 7.2L.2, H.1L.1, H.1L.4

Sample Items



The greatest total amount of food energy is found in the organisms at level

- A. 1
- B. 2
- C. 4
- D. 6

Answer Key: A

In which of the following ways do producers in an ecosystem obtain energy?

- A. By consuming other producers
- B. By living parasitically on animals
- C. By using sunlight to make sugars
- D. By breaking down dead organisms

Answer key: C

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Core Standard H.2 Interaction and change, Score Reporting Category 2/6

The components in a system can interact in dynamic ways that may result in change. In systems, changes occur with a flow of energy and/or transfer of matter.

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Content Standard

H.2L.2 Explain how ecosystems change in response to disturbance and interactions. Analyze the relationships among biotic and abiotic factors in ecosystems.

Academic Vocabulary*

- biotic/abiotic
- biome
- biodiversity
- biosphere
- carrying capacity
- community
- symbiotic
- population
- primary
- secondary
- tertiary
- limiting factors

Links to National Science Standards

2009 NAEP Framework: P12.7

National Science Education Standards: Physical Science Content Standard C, pgs. 155-158.

AAAS Science Literacy Benchmarks

Explanation

Ecosystems

- Dynamic, not static
- All ecosystems are interconnected
- All aspects of ecosystems are interconnected
- Invasive species and ecosystem changes can produce instability

Biotic and Abiotic Factors

- Can be limiting
- Can affect population growth
- Succession
- Niche

Types of Symbiotic Relationship

- Commensalism
- Mutualism
- Parasitism

Content Connections from Previous Grades

4.2L.1, 5.2L.1, 6.2L.2

Sample Items

Which of the following are important biotic factors that can affect the structure and organization of biological communities?

- A. Precipitation, wind
- B. Nutrient availability, soil PH
- C. Predation, competition
- D. Temperature, water

Answer Key: C

Athlete's Foot is a disease caused by a fungus feeding on the skin between your toes, causing itching and redness. Which of these terms BEST describes this interaction?

- A. Predation
- B. Mutualism
- C. Parasitism
- D. Commensalism

Answer Key: C

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Core Standard H.2 Interaction and change, Score Reporting Category 2/6

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Content Standard

H.2L.3 Describe how asexual and sexual reproduction affect genetic diversity.

Academic Vocabulary*

- chromatids
- daughter cells
- haploid/diploid
- homologous (chromosomes)
- mutation
- non-disjunction
- parent cell
- replication
- spindle
- translocation

Links to National Science Standards

2009 NAEP Framework: L12.10

National Science Education Standards: Physical Science Content Standard C, pgs.155-158.

AAAS Science Literacy Benchmarks

Explanation

Asexual Reproduction

- Mitosis produces clones, offspring genetically identical to parents, same number of chromosomes in parental and offspring cell.
- Mutation is the only source of variation.
- Explain the generalized process of mitosis

Sexual Reproduction

- Meiosis is the process that produces sperm and eggs (gametes).
- Recombination of genes in meiosis produce a large amount of variation
- This variation in the reproductive cells of parents results in great variety of possible gene combinations in offspring.

Content Connections from Previous Grades

7.1L.1, 8.1L.1, H.1L.3

Sample Items

What is an advantage of reproducing by mitosis instead of meiosis?

- A. Mitosis provides increased variation in offspring
- B. Mitosis blends the traits of both parents
- C. Mitosis needs only one parent
- D. Mitosis increases the chance of advantageous mutation.

Answer Key: C

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Core Standard H.2 Interaction and change, Score Reporting Category 2/6

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Content Standard

H.2L.4 Explain how biological evolution is the consequence of the interactions of genetic variation, reproduction and inheritance, natural selection, and time.

Academic Vocabulary*

- barrier
- co-evolution
- embryonic
- gradualism
- hybridization
- immunity
- interbreeding
- mutation
- punctuated (equilibrium)

Links to National Science Standards

2009 NAEP Framework: P12.13

National Science Education Standards: Physical Science Content Standard C, pgs.155-158.

AAAS Science Literacy Benchmarks

Explanation

Evolution

- Natural selection is the mechanism for evolution.
- Species change over long period of time.
- Mutation and genetic recombination create diversity.

Natural Selection

- More organisms are born than can possibly survive.
- Variation occurs in organisms due to mutation and recombination of genes.
- Genetic vs. biological diversity
- The availability of resources in the environment is limited.
- Organisms best adapted to their environment survive longer and are more likely to reproduce.

Content Connections from Previous Grades

7.1L.2, 8.2L.1, H.1L.3, H.2L.3

Sample Items

In which population would you expect the most rapid evolutionary change?

- A. A small population with a high mutation rate in a changing environment
- B. A small population with a low mutation rate in a stable environment
- C. A large population with a high mutation rate in a changing environment
- D. A large population with a low mutation rate in a stable environment

Answer Key: A

Hemophilia is a sex-linked recessive disease. People with hemophilia have blood that doesn't clot. Queen Victoria of England had one allele for hemophilia. Which of the following statements describes the most likely pattern for the occurrence of hemophilia in her children?

- A. All of Queen Victoria's children had hemophilia.
- B. All of Queen Victoria's children were carriers for hemophilia.
- C. Female descendents of Queen Victoria could not pass on the gene for hemophilia.
- D. More male descendents of Queen Victoria had hemophilia

Answer Key: D

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Core Standard H.2 Interaction and change, Score Reporting Category 2/6

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Content Standard

H.2L.5 Explain how multiple lines of scientific evidence support biological evolution.

Academic Vocabulary*

- Cladogram (cladistics diagram)
- Divergent evolution
- phylogenetic
- Convergent evolution
- Mitochondrial DNA

Links to National Science Standards

2009 NAEP Framework: P12.11-12.12

National Science Education Standards: Physical Science Content Standard C, pgs.155-158.

AAAS Science Literacy Benchmarks

Explanation

Lines of Evidence

- Homologous structures
- Analogous structures
- Vestigial structures
- Fossils
- Embryology
- Geographic isolation
- Reproductive isolation
- Geology (plate tectonics)
- Genetic (DNA)
- Biochemical (Amino Acid Sequence)

Content Connections from Previous Grades

7.1L.2, 8.2L.1, H.1L.3, H.2L.3, H.2L.4

Sample Items

A researcher is comparing amino acid sequences for protein hemoglobin from several primate species. What does the degree of similarity in sequences among the primate species indicate about these species?

- A. How closely related they are
- B. How frequently they interbreed
- C. How rapidly they can evolve in the future
- D. How efficient their circulatory systems are

Answer Key: A

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Core Standard H.2 Interaction and change, Score Reporting Category 2/7

The components in a system can interact in dynamic ways that may result in change. In systems, changes occur with a flow of energy and/or transfer of matter.

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Content Standard

H.2E.1. Identify and predict the effect of energy sources, physical forces, and transfer processes that occur in the Earth system. Describe how matter and energy are cycled between system components over time.

Academic Vocabulary*

- asteroid
- fluctuation
- radiant
- radioactivity
- ultraviolet/infrared

Links to National Science Standards

2009 NAEP Framework: E12.9, E12.11-12.12

National Science Education Standards: Physical Science Content Standard D, pgs.187-190.

AAAS Science Literacy Benchmarks

Explanation

Energy Source

- The Sun is the source of all external energy
- Radioactive elements (decay)
- Remnants of primordial formation
- Hydro, geothermal, wind, biomass

Physical forces

- Volcanic and earthquake activity (e.g. eruption of St. Helens)
- Glacial movement
- Weather phenomena
- Tectonic plate movement

Transfer processes

- The effects of differential heating/cooling of matter on Earth's systems
- The transfer of energy within and between systems leads to a change in those systems
- Climate changes, convection currents and weather patterns are examples.

Matter and Energy

- Matter and energy are cycled within a singular system.
- Systems can interact and influence each other in predictable ways.

Content Connections from Previous Grades

7.2E.4, 8.2E.1, 8.2E.2, 8.2E.3, 8.2E.4

Sample Items

Some scientists have suggested that growing more trees will help to slow down the process of global warming. Why might this be TRUE?

- A. Trees remove excess carbon from the soil.
- B. Trees absorb excess carbon dioxide (CO₂) from the atmosphere.
- C. Trees remove excess water from the soil.
- D. Trees stabilize soil and prevent erosion

Answer Key: B

Which of the following statements BEST explains why drops of liquid form on the outside of a glass of ice water on a hot day?

- A. Water molecules in the air are attracted to the surface of the glass.
- B. Water molecules in the ice water lose energy as they transfer heat to the air from the atmosphere.
- C. Water molecules in the air lose energy as they transfer heat to the cold glass.
- D. Water molecules in the ice water move through the glass pores to the outside of the glass.

Answer Key: C

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Core Standard H.2 Interaction and change, Score Reporting Category 2/7

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Content Standard

H.2E.2 Explain how Earth's atmosphere, geosphere, and hydrosphere change over time and at varying rates. Explain techniques used to elucidate the history of events on Earth.

Academic Vocabulary*

- ozone
- radiometric (dating)
- relative (dating)
- unconformity

Links to National Science Standards

2009 NAEP Framework: E12.4, E12.6-12.8, E12.10-12.11

National Science Education Standards: Physical Science Content Standard D, pgs.187-190.

AAAS Science Literacy Benchmarks

Explanation

Atmosphere

- Long term: climate, jet stream fluctuations
- Short term: weather events, greenhouse gasses.
- The atmosphere has been dramatically influenced by life on Earth.

Geosphere

- Long term: tectonic plate movement, interactions between plates.
- Short term: earthquakes, volcanoes, deposition and erosion.
- Convection currents in the mantle create movement in the crust.

Hydrosphere

- Long term: glaciation, weathering
- Short term: weather, tides
- Water movement has a direct impact on geosphere

Techniques for investigating Earth history

- Radioactive dating (e.g. Carbon-14)
- Magnetic pole reversals
- Index fossils
- Tree rings
- Ice cores

Content Connections from Previous Grades

8.2E.4, H.1E.2

Sample Items

Mountains occur MOSTLY where

- A. there is a lot of water erosion.
- B. glaciers move boulders into piles.
- C. sinkholes cause surrounding land to collapse
- D. two plates collide causing land to fold or rise.

Answer Key: D

Which of the following is a scientifically accepted theory of Earth's origin?

- A. Solid pieces of debris from the Big Bang became rounded due to wind erosion.
- B. The sun and planets were condensed from parts of the same spinning cloud of dust and gas.
- C. The planets were large asteroids captured by the sun and pulled into its orbit.
- D. Cooling debris from the sun was thrown off and began to orbit the sun.

Answer Key: B

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Core Standard H.2 Interaction and change, Score Reporting Category 2/7

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Content Standard

H.2E.3 Describe how the universe, galaxies, stars, and planets evolve over time.

Academic Vocabulary*

- Black hole
- Red giant (star)
- Supernova
- White dwarf star

Links to National Science Standards

2009 NAEP Framework: E12.1-12.3, E12.5

National Science Education Standards: Physical Science Content Standard D, pgs.187-190.

AAAS Science Literacy Benchmarks

Explanation

Universe

- Evidence indicates that it began in hot, dense state.
- Has been expanding continually.
- Light elements (H, He) formed first

Galaxies and Stars

- Gas and dust of lightest elements “clumped” together (accretion)
- Stars have a life cycle.
- Within a star, the fusion of Hydrogen results in Helium, and consequently heavier elements.

Planets

- Sun, Earth and the rest of the Solar System formed from a rotating nebular cloud of gas and dust.
- Evidence from meteorites and lunar rocks has helped formulate our understanding of the origin of the Solar System.

Content Connections from Previous Grades

8.2E.1, H.1E.1

Sample Items

Within a star fusion of hydrogen results in the formation of

- A. oxygen
- B. lead
- C. helium
- D. hydrogen

Answer Key: C

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Core Standard H.2 Interaction and change, Score Reporting Category 2/7

The components in a system can interact in dynamic ways that may result in change. In systems, changes occur with a flow of energy and/or transfer of matter.

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Content Standard

H.2E.4 Evaluate the impact of human activities on environmental quality

Academic Vocabulary*

- Aerosol
- Carbon dioxide
- Deforestation
- Desertification
- Fossil-fuel
- Ozone
- Petroleum
- Renewable/non-renewable

Links to National Science Standards

2009 NAEP Framework: E12.13

National Science Education Standards: Physical Science Content Standard D, pgs.187-190.

AAAS Science Literacy Benchmarks

Explanation

Human activities have an environmental impact which affects resource management.

- Increased consumption of fossil fuels impact habitats, contributes to climate change, stresses natural processes that renew some renewable resource and depletes resources that are non-renewable.
- Human activities, such as pesticide use and strip mining, change resources and environment. This may lead to habitat change, landscape changes, resource depletion.
- Sustainable systems require replenishment. Humans have a responsibility to continue exploring ways to conserve or replace resources.
- Human activities and their effects have an economic impact that should include a cost/benefit analysis.

Content Connections from Previous Grades

4.4D.3, 7.2E.1, 7.2E.3, 8.2E.4, H.2L.2

Sample Items

Which of these lessens the impact humans have on their environment?

- A. Using natural insect predators to replace pesticides.
- B. Doubling the number of people harvesting fruit in an orchard.
- C. Planting tomatoes that have a better flavor.
- D. Driving to the store twice in the same day, instead of once.

Answer Key: A

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Core Standard H.3 Scientific Inquiry, Score Reporting Category 3/8

Scientific inquiry is the investigation of the natural world by a systematic process that includes proposing a testable question or hypothesis and developing procedures for questioning, collecting, analyzing, and interpreting multiple forms of accurate and relevant data to produce justifiable evidence-based explanations and new explorations..

It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

Content Standard

H.3S.1. Based on observations and science principles, formulate a question or hypothesis that can be investigated through the collection and analysis of relevant information.

Academic Vocabulary*

- claim
- evidence
- relevant

Links to National Science Standards

2009 NAEP Framework:

National Science Education Standards: Physical Science Content Standard D, pgs.173-176.

AAAS Science Literacy Benchmarks

Explanation

Form a question

- General topics of research can be given by teacher, but students should at minimum pick their own specific question.
- Observations leading to the question may be from student experience or prior knowledge.
- Pseudoscientific (or fanciful) questions are not appropriate

Question will be answerable within classroom constraints

- “How does gravity work to make a pendulum swing” is not answerable, but “Can I build a pendulum clock to accurately measure a 1 minute time interval” is answerable.
- Questions can be direct, “Does soil temperature affect the germination rate of radish seeds?”
- Questions can be in the form of a hypothesis, “Colder soil temperature will decrease germination rate of radish seeds.”

Practical limits (boundaries) to the study should be noted by the student.

- Example: “I could collect better data to answer this question if I had access to a larger vacuum chamber, but the small bell-jar chamber in my classroom only allowed me to look at small samples.

Content Connections from Previous Grades

7.3S.1, 8.3S.1

Sample Items

A hypothesis is best described as

- A. A conceptual scheme supported by many experiments
- B. A result of deductive reasoning
- C. A tentative explanation of the results
- D. A tentative explanation of observed phenomena

Answer Key: D

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Core Standard H.3 Scientific Inquiry, Score Reporting Category 3/8

Scientific inquiry is the investigation of the natural world by a systematic process that includes proposing a testable question or hypothesis and developing procedures for questioning, collecting, analyzing, and interpreting multiple forms of accurate and relevant data to produce justifiable evidence-based explanations and new explorations.

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Content Standard

H.3S.2 Design and conduct a controlled experiment, field study, or other investigation to make systematic observations about the natural world, including the collection of sufficient and appropriate data.

Academic Vocabulary*

- controls
- dependent variable
- independent variable
- replication (of observations)
- sufficient

Links to National Science Standards

2009 NAEP Framework:

National Science Education Standards: Physical Science Content Standard D, pgs. 173-176.

AAAS Science Literacy Benchmarks

Explanation

Design the Study

- Controlled studies must include control and experimental treatments and replicates.
- Field studies may be observations of aspects of the natural world. Observations should be repeated over space and/or time.
- Novel analysis studies use previously collected data that the student is looking at in a new way. NASA data and photography, for example is open-source, and can be looked at in many ways.

Ability to Replicate the Study

- All studies must include some consideration of the importance of replicate observations.
- The more complex the study, the smaller the observed changes, the more replicates may be needed.
- Field study replications may be impractical, depending on the question, but should be addressed by the student in discussion.

Content Connections from Previous Grades

7.3S.1, 8.3S.1

Sample Items

A student hypothesized that the mass of a substance affects how the temperature of the substance changes when it is heated. The student uses the following procedure to test the hypothesis.

- Each sample is initially at room temperature before heating.
- Each sample is heated for the same amount of time with the same heat source.
- The final temperature is measured for each sample.

Which of the following would be the best way to select the samples for testing the student's hypothesis?

- A. Obtain samples of one substance, each with the same mass.
- B. Obtain samples of one substance, each with a different mass.
- C. Obtain samples of different substances, each with the same mass.
- D. Obtain samples of different substances, each with a different mass.

Massachusetts Released item #35 pg. 523

Answer Key: B

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Core Standard H.3 Scientific Inquiry, Score Reporting Category 3/8

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Content Standard

H.3S.3 Analyze data and identify uncertainties. Draw a valid conclusion, explain how it is supported by the evidence, and communicate the findings of a scientific investigation.

Academic Vocabulary*

- limits
- reliability
- validity
- tange
- uncertainty

Links to National Science Standards

2009 NAEP Framework:

National Science Education Standards: Physical Science Content Standard D, pgs. 173-176.

AAAS Science Literacy Benchmarks

Explanation

Analyzing the Data

- Clearly use the data to support a conclusion/answer the question.
- The data can be analyzed using graphics and descriptive statistics
- Explicitly answer the question/reach a conclusion. If an answer isn't possible, the student should explain why, referring to the data they did collect in their explanation.
- An investigation that yielded no data could not be scored.
- Provide a confidence statement. How confident is the student that the conclusion reached is valid and reliable? The student should be able to discuss and justify their confidence level.
- Writing in any report should both be grammatically correct and follow all writing conventions.

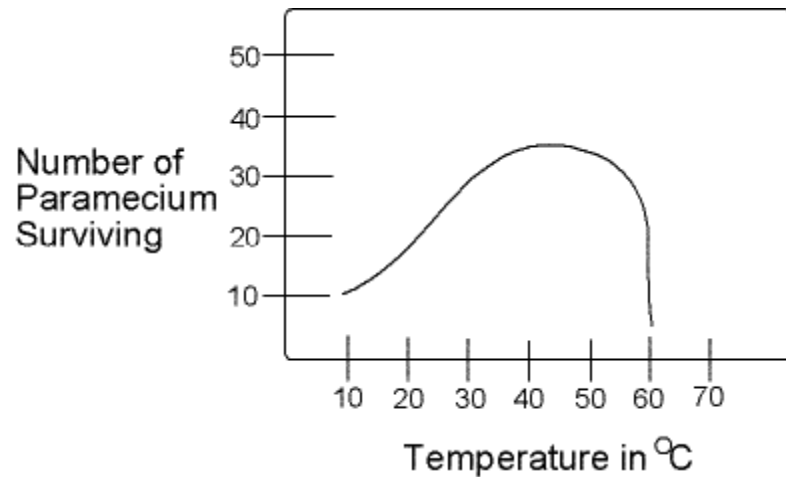
Content Connections from Previous Grades

7.3S.2, 8.3S.2

Sample Items

As a biologist, you are conducting research on temperature effects on the one-celled organism *Paramecium*.

Your results are shown in the graph below.



You conclude that :

- A. Temperature increases are harmful to *Paramecia*.
- B. Temperature increases are beneficial to *Paramecia*.
- C. *Paramecia* have an optimal temperature range.
- D. *Paramecia* are not affected by temperature change.

Answer Key C

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Core Standard H.3 Scientific Inquiry, Score Reporting Category 3/8

Scientific inquiry is the investigation of the natural world by a systematic process that includes proposing a testable question or hypothesis and developing procedures for questioning, collecting, analyzing, and interpreting multiple forms of accurate and relevant data to produce justifiable evidence-based explanations and new explorations..

It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

Content Standard

H.3S.4 Identify examples from the history of science that illustrate modification of scientific knowledge in light of challenges to prevailing explanations.

Academic Vocabulary*

- modification
- revolutionary

Links to National Science Standards

2009 NAEP Framework:

National Science Education Standards: Physical Science Content Standard D, pgs.173-176.

AAAS Science Literacy Benchmarks

Explanation

Science is Changeable

- An important characteristic of science that sets it apart from other areas of human activity is that science advances by challenging prevailing ideas.
- Students should recognize examples from the history of science that illustrate this important concept.
- Every area of science has such examples appropriate for use in high school.

Examples of Modification might include

- Old idea: Species are stable over time. Modern idea: Species change over time under the influence of natural selection.
- Old idea: Fire is a substance contained within many kinds of solid matter. Burning this matter releases the substance (phlogiston). Modern idea: Combustion is the release of chemical bond energy. The energy release can be large enough to cause the formation of temporary pockets of plasma (flames).
- Old idea: Material objects are solid. Modern idea: Material objects are primarily empty space.

Content Connections from Previous Grades

7.3S.3, 8.3S.3

Sample Items

Since Charles Darwin formed his theories of natural selection, which of the following has been the most significant discovery in improving our understanding of the process of evolution?

- A. Radioactivity
- B. Microscopes
- C. Penicillin
- D. DNA

Answer Key: D

Darwin proposed that species change over time because of the process of natural selection. One piece of evidence Darwin used to support this was

- A. DNA differences between species.
- B. Changes in cell structure over time.
- C. Discovery of ancient human tool use.
- D. Existence of fossils of extinct species

Answer Key: D

**Academic Vocabulary is a list of terms related to the content standard and may be used in test items without explanation. Vocabulary and concepts within the Explanation are assessable and not exclusive.*

Core Standard H.3 Scientific Inquiry, Score Reporting Category 3/8

Scientific inquiry is the investigation of the natural world by a systematic process that includes proposing a testable question or hypothesis and developing procedures for questioning, collecting, analyzing, and interpreting multiple forms of accurate and relevant data to produce justifiable evidence-based explanations and new explorations..

It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

Content Standard

H.3S.5 Explain how technological problems and advances create a demand for new scientific knowledge and how new knowledge enables the creation of new technologies.

Academic Vocabulary*

- innovation
- prediction
- societal demand
- spin-off

Links to National Science Standards

2009 NAEP Framework:

National Science Education Standards: Physical Science Content Standard D, pgs.173-176.

AAAS Science Literacy Benchmarks

Explanation

Form a question

- New scientific discoveries lead to new questions.
- New technologies lead to new scientific questions.
- Together these can lead to new technologies in a pattern of discovery without apparent limit.
- Students should be familiar with appropriate examples in life, earth/space, and physical science.

Examples of such science/technology interactions might include:

- Discoveries of atomic structure leading to the invention of electron microscopes leading to a detailed understanding of the structure of viruses leading to the invention of antiviral chemicals.
- A theoretical prediction of the greenhouse effect leading to the invention of CO₂ detectors leading to the detection of global warming leading eventually to the invention of CO₂ mitigation technologies.
- Invention of telescopes leads to discovery of seasonal changes on the Martian surface leading to the invention of Mars robotic landers leading to discovery of the warm, wet ancient Martian past, leading to the invention of the next generation of Mars robotic lander to be launched.

Content Connections from Previous Grades

7.4D.3, H.4D.5

Sample Items

A hypothesis is best described as

- E. A conceptual scheme supported by many experiments
- F. A result of deductive reasoning
- G. A tentative explanation of the results
- H. A tentative explanation of observed phenomena

Answer Key: D

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Core Standard H.4 Engineering Design, Score Reporting Category 4/8

Engineering design is a process of formulating problem statements, identifying criteria and constraints, proposing and testing possible solutions, incorporating modifications based on test data, and communicating the recommendations.

It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

Content Standard

H.4D.1 Define a problem and specify criteria for a solution within specific constraints or limits based on science principles. Generate several possible solutions to a problem and use the concept of trade-offs to compare them in terms of criteria and constraints.

Academic Vocabulary*

- limits
- trade-offs

Links to National Science Standards

2009 NAEP Framework:

National Science Education Standards: Physical Science Content Standard D, pgs. 190-193.

AAAS Science Literacy Benchmarks

Explanation

Practical problems in need of a solution

- Define a general problem or opportunity for improvement.
- Identify a specific problem for which a solution seems possible.
- Identify appropriate criteria and constraints: cost, materials, timing, environmental concerns, scientific knowledge and principles, etc.
- Propose multiple solutions to a problem.

Examples

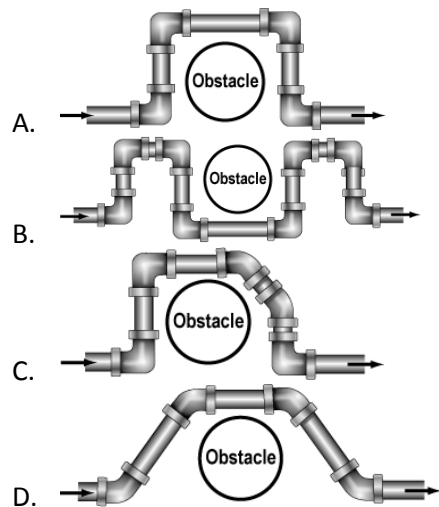
- Create a frame in a hole in the ground and design a cover that fits the frame such that the cover will not accidentally fall through the frame when the cover is being installed. What is a good shape for the frame and the cover? Concepts: Gravity (science), geometry of two dimension shapes (math).
- Consider a building and its use of energy. Propose a way to reduce the amount of energy it uses. Concepts: Energy, heat conductivity, properties of materials.
- How can a public place be made safer and more accessible to someone with physical limitations? Concepts: the five senses and how one can be used in place of another.

Content Connections from Previous Grades

8.4D.1, 8.4D.2

Sample Items

A plumber needs to modify a water pipe to go around an obstacle. Which of the following designs should be used in order to minimize the resistance to the flow of water?



Massachusetts Release Item #7 pg. 537

Answer Key: D

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Core Standard H.4 Engineering Design, Score Reporting Category 4/8

Engineering design is a process of formulating problem statements, identifying criteria and constraints, proposing and testing possible solutions, incorporating modifications based on test data, and communicating the recommendations.

It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

Content Standard

H.4D.2 Create and test or otherwise analyze at least one of the more promising solutions. Collect and process relevant data. Incorporate modifications based on data from testing or other analysis.

Academic Vocabulary*

- model
- prototype
- redesign

Links to National Science Standards

2009 NAEP Framework:

National Science Education Standards: Physical Science Content Standard D, pgs.190-193.

AAAS Science Literacy Benchmarks

Explanation

Test or Analyze:

- How can you create and test a solution?
- How can you obtain data to analyze and from where?

Collect and transform the data

- Data must be appropriate to solution of the problem.
- Make a preliminary assessment of proposed solutions and possible models.

Examples

- A comparison of the nutritional value of average meal in a fast food restaurant, conventional restaurant and a hybrid. What changes could be made to improve the menus? Concepts: Calorie, Nutrition, Cost
- Egg drop (or something of specific weight) with various parachute designs. Drop from specific heights. Concepts; Gravity, mass and wind resistance.
- Build a bridge from soda straws and place it between two tables. Stack pennies on it until it fails. Calculate failure weight based on number of pennies and weight per penny. Concepts: Gravity, mass, strength of materials, forces.

Content Connections from Previous Grades

7.4D.2, 8.4D.2, 8.3S.2

Sample Items

A manufacturer has developed a textured surface for plastic cups. Their cups are designed for small children. The manufacturer has produced prototypes.

Which of the following is the next step in the engineering design process?

- A. Marketing the new textured cups
- B. Developing new textures for cup surfaces
- C. Testing and evaluating the textured prototypes
- D. Redesigning the textured surface on the prototypes

Massachusetts Released Item #1 pg. 535

Answer Key: C

The owners of a grocery store chain have decided to try a hand-held bar code scanner for customers to use as they shop. After developing the prototype of the hand-held bar code scanner, what is the next step in the new product development?

- A. Refining the scanner for production
- B. Advertising the scanner in all stores
- C. Field testing the scanner in selected stores
- D. Mass-producing the scanner for all stores

Massachusetts Released Item #32 pg. 552

Answer Key: C

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Core Standard H.4 Engineering Design, Score Reporting Category 4/8

Engineering design is a process of formulating statements, identifying criteria and constraints, proposing and testing possible solutions, incorporating modifications based on test data, and communicating the recommendations.

It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

Content Standard

H.4D.3 Analyze data, identify uncertainties, and display data so that the implications for the solution being tested are clear.

Academic Vocabulary*

- uncertainty

Links to National Science Standards

2009 NAEP Framework:

National Science Education Standards: Physical Science Content Standard C, pgs. 190-193

AAAS Science Literacy Benchmarks

Explanation

Data analysis can include

- simple descriptive statistics
- graphical analyses
- tables and charts
- pro and con analyses

Measured variables must include

- replicate data
- consideration of outliers

Examples

- Wind farm data can be used to select wind energy sites and to determine potential cost/benefit. Concepts: Gathering of data, presenting data with tables and graphs.
- Measure the time it takes for various parachute designs take to fall and produce a graph that shows several trials for each of the designs. Concepts: Gathering of data, presenting data with tables and graphs.

Content Connections from Previous Grades

8.3S.2, H.3S.3

Sample Items

In order to analyze data effectively, an engineer must be able to

- A. Identify the problem
- B. Develop an effective solution
- C. Display data so it shows trends or patterns
- D. Modify prototypes

Answer Key: C

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Core Standard H.4 Engineering Design, Score Reporting Category 4/8

Engineering design is a process of formulating statements, identifying criteria and constraints, proposing and testing possible solutions, incorporating modifications based on test data, and communicating the recommendations.

It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

Content Standard

H.4D.5 Describe how new technologies enable new lines of scientific inquiry and are largely responsible for changes in how people live and work.

Academic Vocabulary*

- sustainability

Links to National Science Standards

2009 NAEP Framework:

National Science Education Standards: Physical Science Content Standard C, pgs.190-193

AAAS Science Literacy Benchmarks

Explanation

Scientific Inquiry and Engineering Design

- Have enabled new lines of scientific inquiry
- Have led to important changes in human lives

Examples

- Changing standards of living: Food and energy production
- Enhancing health and longevity: Medical technology including both diagnostic equipment and development of vaccines
- Enable new science inquiry: Invention of telescope and microscope changed the scale (macro to micro) and nature of scientific questions

Content Connections from Previous Grades

7.4D.3, H.3S.5

Sample Items

Advances in military technologies have often led to the development of everyday applications. Early radar systems operators noticed that objects near the radar were often heated when the radar was in use.

This observation led to the development of which of the following everyday applications?

- A. microwave ovens
- B. motion detectors
- C. nuclear reactors
- D. solar collector panels

Massachusetts Released Item #8, pg. 538

Answer Key: B

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Core Standard H.4 Engineering Design, Score Reporting Category 4/8

Engineering design is a process of formulating statements, identifying criteria and constraints, proposing and testing possible solutions, incorporating modifications based on test data, and communicating the recommendations.

It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

Content Standard

H.4D.6 Evaluate ways that ethics, public opinion, and government policy influence the world of engineers and scientists, and how the results of their work impact human society and the environment.

Academic Vocabulary*

- Byproduct
- Impact statement
- Oversight
- regulation

Links to National Science Standards

2009 NAEP Framework:

National Science Education Standards: Physical Science Content Standard C, pgs.190-193

AAAS Science Literacy Benchmarks

Explanation

Engineering Design Considerations

- Environmental impact
- Economic cost
- Public opinion
- Government policy
- Constraints/criteria
- Unintended or unanticipated consequences

Examples

- Production of ethanol from corn has advantages and disadvantages, including unanticipated consequences.
- DDT as a way to control insects and reduce diseases like malaria but over time science discovered unanticipated consequences.
- Nuclear generation of electrical power: (knowledge of consequences and risks changed public opinion over time).
- Carbon emissions: growing understanding and knowledge of consequences has begun to change public policy.

Content Connections from Previous Grades

8.4D.2, 8.4D.3, H3S.3

Sample Items

Which of the following would be evidence that public opinion about carbon emissions has an influence on the work of engineers?

- A. More students are riding their bikes to school.
- B. Teachers spend more time discussing carbon emissions in class.
- C. More solar panels appear on the roofs of buildings.
- D. More bridges are built across local rivers

Answer Key: C

**Academic Vocabulary is a list of terms related to the content standard and may be used in test items without explanation. Vocabulary and concepts within the Explanation are assessable and not exclusive.*

Item Specifications

Oregon Assessment of Knowledge and Skills (OAKS) is a multiple choice and computer scored constructed response statewide assessment. It is a required assessment that provides the base for the state accountability system.

Criteria for All OAKS Test Questions

Test items must

- be appropriate for students in terms of grade-level difficulty, cognitive complexity, reading level, interests and experience.
- be free of age, gender, ethnic, religious, socioeconomic, or disability stereotypes or bias.
- provide clear and complete instructions to students.
- ensure each Score Reporting Category will have items with a range of difficulty and complexity levels.
- ensure each multiple choice test item will measure only one Score Reporting Category.

Graphics Criteria

Graphics are used in OAKS to provide both necessary and supplemental information. Some graphics contain information that is necessary for answering the question, while other graphics illustrate or support the context of the question.

- Graphic displays, their corresponding items and answer choices will appear on the same screen for online items.
- Shading and color will be minimized. It will be used to make a figure's size, shape or dimensions clear, and not solely for artistic effect.

- Graphics used for computer scored constructed response items are displayed within a work space and allow students to manipulate answer graphics and answer choices.

Item Style and Format Criteria for Multiple Choice Items

- Test items will be in the form of questions or sentences that require completion.
- Each item will have three, four or five answer choices. Students will be told in the test directions to choose the best answer from among the choices.
- Answer choices will be arranged one of three ways beneath the test item: vertically, horizontally, or in two columns (i.e., A and B in the left column, C and D in the right column).
- Neither "None of the above" nor "All of the above" will be used as one of the answer choices. "There is not enough information" is an allowed answer choice, but infrequently used.
- Test items may be worded in the negative ("Which of these is NOT ..."), but this structure will be used only when it offers substantial advantages for the item construction.
- Items should be free of absolute wording, such as "always" and "never," and have qualifying words (e.g., least, most, except) printed in small caps for emphasis.
- Masculine pronouns should NOT be used to refer to both sexes. Plural forms should be used whenever possible to avoid gender-specific pronouns (For example, instead of "The student will make changes so that he ..," it is best to use "The students will make changes so that they...").

- An equal balance of male and female names should be used including names representing different ethnic groups.
- Test items aligned to standards may contain extraneous information.
- Stacked English-Spanish test items are used on electronic tests for the English-Spanish OAKS.

Item Style and Format Criteria for Computer Scored Constructed Response

- Test items will be in the form of questions or instructions that require at least one object to be created or matched to an existing picture,
- Each item may have many correct answer choices.
- Test items may be worded so that not all answer choices are used to construct the correct response.
- An equal balance of male and female names should be used including names representing different ethnic groups.
- Test items aligned to standards may contain extraneous information but only to enhance the students' understanding of the question.
- Students using Braille will not receive constructed response items but will receive similar content items appropriate for students using Braille.

Criteria for SCIENCE OAKS Test Reporting

Student information from 2017-18 OAKS Online Science will be reported through six Score Reporting Categories (SRC) including three Science Core Standards and three Science subjects as sub categories. Scientific Inquiry (SRC 3) and Engineering Design (SRC 4) scores will be combined

and reported together as SRC 8 (Science Processes) for 2017-18.

- **Structure and Function (SRC 1):** Understand living and non-living things have characteristics, form and function, and are composed of components that function together to form systems.
- **Interaction and Change (SRC 2):** Understand components in a system can interact in dynamic ways, within or without that system, and may result in change.
- **Physical Science (SRC 5):** Understand structures and properties of matter, forms of energy, and changes that occur in the physical world.
- **Life Science (SRC 6):** Understand structures, functions, and interactions of living organisms and the environment.
- **Earth and Space Science (SRC 7):** Understand physical properties of the Earth and how those properties change. Understand Earth's relationship to other objects in the Universe.
- **Scientific Inquiry (SRC 3) and Engineering Design (SRC 4) reported as (SRC 8):** Understand science process concepts and skills that characterize the nature and practice of science. Scientific Inquiry is a systematic process that includes proposing testable hypotheses, collecting, analyzing, and interpreting data to produce evidence-based explanations and new explorations. Engineering Design is a process of formulating problem statements, identifying criteria and constraints, testing solutions, and incorporating modifications based on test data and communicating the recommendations.

The Test Items

- Each Structure and Function or Interaction and Change test item will also report out to one subject Score Reporting Category but only count once for a student's total score.
- Each Core Score Reporting Category will have items with a range of difficulty levels. This range of difficulty will be approximately the same across the Core reporting categories.
- Test items are designed to be appropriate for students in the assigned test grade in terms of reading level, interests, and experience.
- Test items will be stated in the clearest manner possible.

Criteria for SCIENCE OAKS Modules

A portion of each test will be incorporated into modules. A module is defined as a stimulus containing scientific information, accompanied by two to five knowledge and skills questions. The remaining test items on each test will be discrete/stand-alone knowledge and skills items. Students will not refer to a stimulus when answering those questions.

- The stimulus for each module will vary in length, format and character. It could be one or a combination of any of the following: data table, diagram, chart, drawing, photo or reading text.
- Each Knowledge and Skills test item within a module measures one Core Score Reporting Category (SRC). Within a module, though, items may measure different SRCs.

- Each stimulus will be free of age, gender, and other bias, as evaluated by the Oregon Assessment Sensitivity Panel.
- Although the stimulus for each module will provide scientific information, students will be required to draw on prior knowledge to answer many of the items. In other words, there may not be sufficient information in the stimulus to answer all associated test questions. The stimulus may simply provide a context for some test questions.
- Each module will often include a title, which will serve to identify the accompanying items as a set.

Science Test Blueprint

Introduction

The blueprints used to construct Knowledge and Skills Tests for Science prescribe:

- the Score Reporting Categories (SRC) included on each test,
- the cognitive demand and difficulty level of items as distributed on a test form,
- the number and percentages of test items from each SRC included on each test, and
- the total number and percentages of operational and field test items included for each test.

Teachers and other educators have historically played a vital role in the development of these specifications and blueprints by serving on Content and Assessment Panels and other review groups. These groups have advised the Department as content standards have been developed, and have helped establish priorities on which standards to assess and the weighting of the strands within each content area assessment.

Alignment of Test Items to Content Standards

Test items are carefully aligned to content standards at the appropriate grade level through a rigorous process at two points in the test item development process:

1. At item development workshops, item writers are provided with adopted content standards to which they must write test items; during a peer review process, this alignment is verified by another grade level item

developer.

2. Alignment of items to the content standards is further verified during a review by members of a Content and Assessment Panel, who ensure items not only match the content standards, but also verify overall quality and appropriateness. Reviewers either accept items as a strong match to the targeted standards, edit items to achieve a strong match, or reject items which do not strongly match the standards.

The Appendix to this document includes additional evidence describing procedures ensuring alignment during item development, including descriptions of the Item Development Process and the Life of an Item.

Content Coverage

Prior to item writing activities, item databases are reviewed to determine the extent that the available items represent the emphasis and content in the standards. If any grade level standards are underrepresented in the item pool, they are identified and targeted specifically for additional item development. This assures that every year, the proportion of items in the item pool is comparable in both emphasis and content to the content standards. The table on the following page describes the emphasis given to each content strand; this emphasis is reflected in both the item pool and administered tests.

All tests and the item pool from which they are constructed follow the weighting of each content strand as reflected in the tables on the following pages. Items within a strand, or SRC, are selected to provide

a range of difficulty so that the progressive nature of the test is maintained as students of varied ability levels are presented with items most appropriate to their ability from that pool. Although a student may not see an item addressing every one of the assessable standards in a single test event, the item pool contains multiple items for each content standard at a variety of difficulty levels.

In addition, the adaptive algorithm specifically considers alignment criteria when drawing test items. As a result, we accomplish the dual purpose of creating a test form that is appropriately developed for each student and meets the criteria set forth for alignment (e.g., balance of representation, depth of knowledge). Online tests report total test scores called a summary score.

The English test blueprints provide the criteria for all English-Spanish tests. Each Spanish test pool has the same items as the English test pool.

Additional Test Design Criteria

Each item assesses content aligned at one grade within the grade level standards.

Online-adaptive test opportunities provide a range and breadth of items within each Core SRC and Subject SRC. Each grade level test pool has approximately 900 items available for testing.

Key placement cannot be controlled for online-adaptive assessments, so to ensure more random correct keys, item writers are instructed to rotate the correct key for their items during item authoring.

Modules, or items that have a stimulus and have 1-6 questions, are designed to be presented together on the same test. Between one third and one half of the items from each SRC in each test pool are Modules.

Science Score Reporting Categories- High School test (OAKS online)

This table diagrams the science unifying concepts and processes to be reported in 2017-18.

Score Reporting Categories		Unifying Concepts and Processes			
		Big Ideas		Science Processes	
		*Structure and Function (SRC 1)	*Interaction and Change (SRC 2)	**Scientific Inquiry (SRC 3)	**Engineering Design (SRC 4)
				**Scientific Inquiry and Engineering Design (SRC 8)	
Science Disciplines or Subjects	*Physical Science (SRC 5)	<i>Structure and Function in Physical Science</i>	<i>Interaction and Change in Physical Science</i>		
	*Life Science (SRC 6)	<i>Structure and Function in Life Science</i>	<i>Interaction and Change in Life Science</i>		
	*Earth and Space Science (SRC 7)	<i>Structure and Function in Earth and Space Science</i>	<i>Interaction and Change in Earth and Space Science</i>		

*Test items aligned to SRC 1 and SRC 2 will also be reported to a subject SRC of Physical Science, Life Science, or Earth and Space Science. But, each test item in SRC 2 will only be counted once toward a student's summary science score.

**In 2017-18 test items aligned to SRC 3 and SRC 4 will be reported only once as SRC 8. Item development will continue so that Scientific Inquiry (SRC 3) and Engineering Design (SRC 4) can be independently reported.

Weighting of Score Reporting Categories

The 2009 science content standards are organized under four Core Standards. The Core Standard statements describe the unifying concepts and processes in science. Core Standards One, **Structure and Function**, and Two, **Interaction and Change**, describe the big ideas in the three science disciplines or subjects of **Physical, Life, and Earth and Space**. Core Standards Three, **Scientific Inquiry**, and Four, **Engineering Design**, describe the science process skills and understandings that characterize the nature and practice of science and engineering.

The chart below shows the score reporting categories (SRC) for each grade tested and the percentage of questions on a given test administration that would assess that category. Test items aligned to SRC 1 and SRC 2 will also be reported to a subject SRC of Physical Science, Life Science, or Earth and Space Science. But, each test item in SRC 1 or SRC 2 will only be counted once toward a student's summary science score. In 2017-18, test items aligned to SRC 3 and SRC 4 will be reported only once as SRC 8.

For example, at grade 5, 25% of the items on a test will assess Structure and Function, which equals about 11 items on a 45-item test. Those 11 items will also be reported as they align to a Subject SRC, for reporting purposes only.

Targeted Percent of Questions by Core SRC					Targeted Percent of Questions by Subject SRC			
	SRC 1	SRC 2	SRC 3*	SRC 4*	SRC 5	SRC 6	SRC 7	SRC 8*
	Structure and Function	Interaction and Change	Scientific Inquiry	Engineering Design	Physical Science	Life Science	Earth and Space Science	Science Processes
Grade 5	25%	50%	13%	12%	25%	25%	25%	25%
Grade 8	30%	45%	13%	12%	25%	25%	25%	25%
High School	30%	45%	13%	12%	24%	27%	24%	25%
* Scores from SRC 3 and SRC 4 are combined and reported as SRC 8 for 2017-18								

Science Test Blueprint- High School Content Coverage and Weighting

Score Reporting Categories		Testable content codes	Target % of Questions Assessed per Test*		Online-Test Pool Size
Structure and Function	Physical Science	H.1P.1, H.1P.2	25%		320+
	Life Science	H.1L.1, H.1L.2, H.1L.3, H.1L.4			
	Earth and Space Science	H.1E.1, H.1E.2			
Interaction and Change	Physical Science	H.2P.1, H.2P.2, H.2P.3, H.2P.4	50%		750+
	Life Science	H.2L.1, H.2L.2, H.2L.3, H.2L.4, H.2L.5			
	Earth and Space Science	H.2E.1, H.2E.2, H.2E.3, H.2E.4			
Science Processes (SI and ED)	Scientific Inquiry	H.3S.1, H.3S.2, H.3S.3, H.3S.4, H.3S.5	25%		265+
	Engineering Design	H.4D.1, H.4D.2, H.4D.3, H.4D.4, H.4D.5, H.4D.6			
Operational Item Total					Approx. 1335
Field Test Item Total					300
Total items on Test			100%		

*During an individual student testing session, the test algorithm selects items from each SRC, targeting the percentages indicated. Furthermore, items are selected to match the target item difficulty level, determined by the student's performance on previous items, and also to match the Cognitive Demand Distribution Goals for the test. The numbers of items available in the item pool for each SRC are sufficient to allow three tests per student each year, without the student seeing any item more than once.

Target Cognitive Demand and Item Pool Distribution by Difficulty

The science test pools are designed so that a range of difficult items are included for each student’s test opportunity. The target item pool difficulty distribution for the High School test is outlined in the chart. A target range of cognitive demand item delivery is also included. (See Appendix A, Cognitive Demand and Target Item Pool Difficulty Distribution for all grades).

The three Cognitive Demand levels used to qualify Oregon’s test items are:

- Recall: Item requires a student to recall a fact, information or procedure.
- Skill/Concept: Item requires a student to use skill or concept, including thinking that requires two or more steps.
- Strategic Thinking: Item requires a student to use reason, develop a plan or use a sequence of steps.

Online adaptive tests provide students with questions at the beginning of the test at or about the mean RIT level and as the student responds, the test item delivery system makes adjustments by selecting appropriate items for each student based upon their correct and incorrect responses. Student scores on each test will vary due to performance and the set of unique test items issued to the student. Generally, students will earn scores between the maximum high and minimum low range. The following are the possible high and low RIT student scores for high school tests, within one or two points, based on a given year’s item pool.

High RIT	300
Low RIT	175

Difficulty Criteria for High School level

HS Science	Target Item Pool Difficulty Distribution
RIT by Difficulty	
213-233	33%
234-241	33%
242-258	33%
RIT Range	213-258
Mean RIT	237
Cognitive Demand	Target for Item Delivery
Recall	20%
Skill/Concept	50%
Strategic Thinking	30%

Achievement Level Descriptors

Achievement Level Descriptors describe what students know and can do based on their performance on statewide knowledge and skills tests in the various content areas. These may be used by educators to target instruction and inform parents and student of the expectations for students to be considered proficient at a particular grade level.

The achievement Level Descriptors are based on a sampling of a larger set of testable content outlined in the Oregon Content Standards. Results for individual students are only one indicator of student ability as measured at the time of testing. These statements give a general description of what most students know and can do within a particular band of achievement and are presented in the order of the way they are reported rather than by importance or test emphasis.

Students who score at or within a particular level of achievement possess the bulk of the abilities described at that level and generally have mastered the skills described in the preceding achievement levels.

Achievement Level Descriptors for each subject area were developed by groups of parents, educators, and business people who worked with state officials to establish the minimum scores required for Exceeds, Meets, Nearly Meets and Does Not Yet Meet.

Science Achievement Level Descriptors

STRUCTURE AND FUNCTION- High School

	Does Not Yet Meet	Nearly Meets	Meets	Exceeds
General Policy Definitions (apply to all grades and all subjects)	Students do not demonstrate mastery of grade-level knowledge and skills required for proficiency.	Students demonstrate mastery of grade-level knowledge and skills required for proficiency.	Students demonstrate mastery of grade-level knowledge and skills required for proficiency.	Students demonstrate mastery of grade-level knowledge and skills exceeding the requirement for proficiency.
Science Policy Definitions (apply to all grade groups)	Students demonstrate limited mastery of science, scientific inquiry and engineering design knowledge and skills, through the application of basic concepts with occasional success.	Students demonstrate partial mastery of science, scientific inquiry and engineering design knowledge and skills, through the application of basic concepts with regular success.	Students demonstrate mastery of science, scientific inquiry and engineering design knowledge and skills, through the interpretation and application of grad-level concepts with consistent success.	Students demonstrate mastery of science, scientific inquiry and engineering design knowledge and skills, through the interpretation and application of advanced concepts with consistent success.
Physical Science	<p>Recognize that atoms have different parts and elements have specific properties and can be found on the Periodic Table.</p> <p>Recognize that atoms are connected by different types of bonds to form compounds</p>	<p>Identify the parts of atoms and find properties of elements using a Periodic Table.</p> <p>Distinguish between different types of chemical bonds that form between compounds.</p>	<p>Explain how atomic structure is related to the properties of elements and their position in the Periodic Table.</p> <p>Describe how different types and strengths of bonds affect the physical and chemical properties of compounds.</p>	<p>Predict physical, chemical, and nuclear properties of elements based on their position on the Periodic Table.</p> <p>Explain how the physical and chemical properties of compounds are based on the types and strengths of chemical bonds.</p>

Adopted by the Oregon State Board of Education on October 20, 2011

	Does Not Yet Meet	Nearly Meets	Meets	Exceeds
Life Science	<p>Recognize that there are different types of organic macromolecules and that they are used in cells in different ways.</p> <p>Recognize that physical structure of DNA and DNA stores chemical messages.</p> <p>Recognize that characteristics of organisms are related to DNA and are passed from one generation to the next.</p> <p>Recognize that cell processes and differentiation can be changed.</p>	<p>List the four types of organic macromolecules and state where they can be found in the cell.</p> <p>Recognize that chromosomes are made of DNA and that DNA contains codes for proteins.</p> <p>Recognize that there are laws of heredity and that heredity is controlled by the structure of DNA.</p> <p>Recognize that environmental factors influence cellular processes and differentiation.</p>	<p>Compare and contrast the four types of organic macromolecules (proteins, carbohydrates, lipids and nucleic acids) and explain how they are used in cell composition and processes.</p> <p>Describe the chemical structure of DNA and its relationship to the structure and function of DNA.</p> <p>Explain how cellular processes and differentiation are regulated internally and externally in response to their environment.</p>	<p>Explain how changes in four organic macromolecules would affect cell composition and cell processes.</p> <p>Explain how the chemical structure of DNA directs the production of proteins.</p> <p>Explain how changes in DNA sequence change the expressed traits of organisms in subsequent generations.</p> <p>Predict how cellular processes and differentiation will respond to changes in the environment.</p>
Earth and Space Science	<p>Identify the different types of bodies found in our solar system.</p> <p>Recognize that the Earth has different regions that are based on their composition.</p>	<p>Recognize that bodies in our solar system are classified by their properties and composition and that multiple galaxies exist.</p> <p>State the differences between the Earth's atmosphere, geosphere, and hydrosphere.</p>	<p>Classify the bodies in our solar system based on properties and composition and describe attributes of our galaxy and the evidence for multiple galaxies.</p> <p>Describe the structure, function, and composition of Earth's atmosphere, geosphere, and hydrosphere.</p>	<p>Predict the properties and composition of bodies in other galaxies based on attributes of our own galaxy.</p> <p>Explain the relationships among the Earth's atmosphere, geosphere, and hydrosphere.</p>

Adopted by the Oregon State Board of Education on October 20, 2011

Science Achievement Level Descriptors

INTERACTION AND CHANGE- High School

	Does Not Yet Meet	Nearly Meets	Meets	Exceeds
Physical Science	<p>Recognize that matter is held together by bonds and reaction rates can be changed.</p> <p>Recognize that energy can affect matter and that matter cannot be created or destroyed.</p> <p>Recognize that gravity and other forces have an influence on the motion of objects.</p>	<p>Recognize that chemical bonds can be made or broken, energy has a connection to bonding, and reaction rates can be changed by an external factor.</p> <p>Recognize that matter and energy interact and describe the concept of conservation of mass and energy.</p> <p>Describe the net movement of an object based on the forces acting on it.</p>	<p>Explain how chemical reactions result from the breaking and remaking of new bonds in a process that absorbs or releases energy and explain how different factors affect reaction rates.</p> <p>Explain how physical and chemical changes demonstrate the law of conservation of mass and energy.</p> <p>Apply the laws of motion and gravitation when describing the interaction of forces acting on an object and its resultant motion.</p>	<p>Evaluate the effect of factors such as available energy, reactant concentrations and bond characteristics on chemical reaction rates.</p> <p>Apply the laws of conservation of mass and energy to predict how matter and energy will interact.</p> <p>Predict the resultant motion of an object based on the laws of motion and gravitation and the forces applied.</p> <p>Describe the interconnection of the linear path of energy and the cyclical nature of matter.</p>
Life Science	<p>Recognize that matter and energy move through biological systems in predictable ways.</p> <p>Recognize that an ecosystem can change and distinguish biotic and abiotic factors.</p>	<p>Recognize that energy and chemical elements can be combined in specific ways as they move through biological systems.</p> <p>Describe how biotic and abiotic factors may cause changes in ecosystems.</p>	<p>Explain how energy and chemical elements pass through systems and how elements are combined and recombined in different ways as they cycle through various levels of organization in biological ecosystems.</p>	<p>Describe the interconnection of the linear path of energy and cyclical nature of matter.</p> <p>Predict the response that would occur in an ecosystem due to changes in the biotic and abiotic factors related to</p>

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	Does Not Yet Meet	Nearly Meets	Meets	Exceeds
Life Science (continued)	<p>Recognize the difference between asexual and sexual reproduction.</p> <p>Recognize that species have changed over time.</p>	<p>Recognize that genetic diversity can be affected by the way an organism reproduces.</p> <p>Describe the process of biological evolution through natural selection</p>	<p>Explain how ecosystems change in response to disturbances and interactions. Analyze the relationships among the biotic and abiotic factors in ecosystems.</p> <p>Describe how asexual and sexual reproduction affect genetic diversity.</p> <p>Explain how biological evolution is the consequence of the interactions of genetic variation, reproduction and inheritance, natural selection and time, using multiple lines of supporting scientific evidence.</p>	<p>that ecosystem.</p> <p>Explain how sexual reproduction produces more genetic diversity than asexual reproduction and that each method has advantages and disadvantages.</p> <p>Evaluate the impact of the interactions of genetic variation, reproduction and inheritance, natural selection and time on biological evolution.</p>

Adopted by the Oregon State Board of Education on October 20, 2011

	Does Not Yet Meet	Nearly Meets	Meets	Exceeds
Earth and Space Science	<p>Identify energy sources, physical forces, and transfer processes that occur in the Earth's system.</p> <p>Identify long term changes that have occurred in Earth's system.</p> <p>Recognize that the universe, galaxies, stars and planets have evolved over time.</p> <p>Describe that human activities impact the sustainability of the Earth's system and that resources need to be managed.</p>	<p>Recognize that energy sources, physical forces, and transfer processes have an effect on the Earth's system and that matter and energy are cycled between system components.</p> <p>Recognize that Earth's atmosphere, geosphere, and hydrosphere change over time and that there are techniques used to understand the history of events on Earth.</p> <p>Identify factors that have influenced the evolution of universe, galaxies, stars and planets.</p> <p>Explain how human activity affects the sustainability of the Earth's system and identify environmental factors that may influence resource management.</p>	<p>Identify and predict the effect of energy sources, physical forces, and transfer processes that occur in the Earth system. Describe how matter and energy are cycled between system components over time.</p> <p>Explain how Earth's atmosphere, geosphere, and hydrosphere, change over time and at varying rates and explain techniques used to elucidate the history of events on Earth.</p> <p>Describe how the universe, galaxies, stars and planets evolve over time.</p> <p>Evaluate the impact of human activities on the sustainability of the Earth's system and how environmental factors influence resource management.</p>	<p>Evaluate the impact that changes in energy sources, physical forces and transfer processes will have on matter and energy in the Earth's system.</p> <p>Predict how the Earth's atmosphere, geosphere, and hydrosphere may change due to various factors and how those changes will be measured and recorded.</p> <p>Explain the factors that have caused the universe, galaxies, stars and planet to evolve over time.</p> <p>Evaluate methods humans have can use to support the sustainability of the Earth's system utilizing effective and appropriate resource management.</p>

Adopted by the Oregon State Board of Education on October 20, 2011

Science Achievement Level Descriptors

SCIENTIFIC INQUIRY- High School

	Does Not Yet Meet	Nearly Meets	Meets	Exceeds
Scientific Inquiry	<p>Recognize a question or hypothesis that can be investigated.</p> <p>Design or conduct an investigation to make observations about the natural world.</p> <p>Use data to communicate the findings of a scientific investigation.</p> <p>Recognize that scientific knowledge has changed over time as new information is discovered.</p> <p>Identify that technological problems create a demand for new scientific knowledge.</p>	<p>Based on observations formulate a question or hypothesis that can be investigated through the collection and analysis of data.</p> <p>Design and conduct an investigation to make systematic observations about the natural world, including the collection of data.</p> <p>Analyze data and identify some uncertainties. Draw a conclusion and communicate the findings of a scientific investigation</p> <p>Identify major events that have occurred in the history of science.</p> <p>Recognize that new scientific knowledge enables the creation of new technologies.</p>	<p>Based on observations and science principles, formulate a question or hypothesis that can be investigated through the collection and analysis of relevant information.</p> <p>Design and conduct a controlled experiment, field study or other investigation to make systemic observations about the natural world, including the collection of sufficient and appropriate data.</p> <p>Analyze data and identify uncertainties. Draw a valid conclusion, explain how it is supported by the evidence, and communicate the findings of a scientific investigation.</p> <p>Identify examples from the history of science that illustrate modification of scientific knowledge in light of challenges to prevailing explanations.</p> <p>Explain how technological problems and advances create a demand for new scientific knowledge and how new knowledge enables the creation of new technologies.</p>	<p>Evaluate the connection between the question or hypothesis and the scientific principles being studied.</p> <p>Justify their design choice and methods of controlling variables based on the scientific principles being studied.</p> <p>Evaluate the impact that uncertainties in the experimental design have on the confidence in their conclusion.</p> <p>Relate examples from the history of science that have challenged prevailing explanations and their impact on current scientific endeavors.</p> <p>Explain how the relationship between scientific knowledge and new technologies is used by current scientists to advance science and technology</p>

Adopted by the Oregon State Board of Education on October 20, 2011

Science Achievement Level Descriptors

ENGINEERING DESIGN- High School

	Does Not Yet Meet	Nearly Meets	Meets	Exceeds
Engineering Design	<p>Define a problem and generate a possible solution.</p> <p>Recognize that data is used to analyze possible solutions to a problem and those solutions can be modified based on that data.</p> <p>Recognize that data can be displayed in various ways and that there are always some uncertainties involved with its collection.</p> <p>Recommend a proposed solution. Recognize that there are other possible solutions.</p> <p>Recognize that new technologies can change how people live and work.</p> <p>Recognize that ethics, public opinion, and government policy influence the work of engineers and scientists, and that their work impacts human society and the environment.</p>	<p>Define a problem and specify criteria for a solution. Generate two or more possible solutions to a problem and compare them in terms of criteria and constraints.</p> <p>Test or otherwise analyze a possible solution. Collect and process data. List possible modifications to the solution.</p> <p>Display data and identify some uncertainties involved in its collection.</p> <p>Recommend a proposed solution and describe how it is better than alternative designs. Recognize that further engineering can be done to refine the recommendations.</p> <p>Identify new technologies that have changed how people live and work.</p> <p>Identify ways that ethics, public opinion, and government policy influence the work of engineers and scientists, and list examples of how the results of their work have impacted human society and the environment.</p>	<p>Define a problem and specify criteria for a solution within specific constraints or limits based on science principles. Generate several possible solutions to a problem and use the concept of trade-offs to compare them in terms of criteria and constraints.</p> <p>Create and test or otherwise analyze at least one of the more promising solutions. Collect and process relevant data. Incorporate modifications based on data from testing or other analysis.</p> <p>Analyze data, identify uncertainties, and display data so that the implications for the solution being tested are clear.</p> <p>Recommend a proposed solution, identify its strengths and weaknesses, and describe how it is better than alternative designs. Identify further engineering that might be done to refine the recommendations.</p> <p>Describe how new technologies enable new lines of scientific inquiry and are largely responsible for how people live and work.</p> <p>Evaluate ways that ethics, public opinion, and government policy influence the work of engineers and scientists, and how the results of their work impact human society and the environment.</p>	<p>Defend solutions generated based on the criteria and constraints specified. Predict which solution best meets the criteria and constraints.</p> <p>Justify the selected solution, method of data collection, and proposed modifications to the solution.</p> <p>Explain how the uncertainties may have impacted the interpretation of the data and conclusions.</p> <p>Evaluate multiple solutions, identifying the limits and constraints of each, and suggesting further refinements.</p> <p>Predict how a new technology may change how we live and work.</p> <p>Predict the impact changes in public opinion, and government policy could have on the work of engineers and scientists.</p>

Local Assessments Required by OAR 581-22-2115

Assessment of Essential Skill

Local Performance Assessments

School districts and public charter schools that offer instruction at grades 3 through 8 or high school must administer annual local performance assessments for students in grades 3 through 8 and at least once in high school for the skill areas of writing, speaking, mathematics problem solving, and scientific inquiry. The purpose of the local performance assessment requirement is to ensure that students in grades 3 through high school are afforded opportunities to learn and to receive feedback regarding their progress toward meeting specific state standards throughout their years in public schools.

A local performance assessment is a standardized measure (e.g., activity, exercise, problem, or work sample scored using an official state scoring guide), embedded in the school district's or public charter school's curriculum that evaluates the application of students' knowledge and skills. Local performance assessments must be designed to closely align with state standards and to promote independent, individual student work.

School districts and public charter schools may either use a work sample scored using an official state scoring guide or a comparable measure adopted by the school district or public charter school to satisfy the local performance assessment requirement. *Section 6.0 Local Performance Assessment Requirement* of the 2016-17 Essential Skills and Local

Performance Assessment Manual provides guidance for those school districts and public charter schools choosing to use a work sample to satisfy this requirement.

Assessment of Proficiency in the Essential Skills

As part of the new graduation requirements, high school students must demonstrate proficiency in a set of Essential disciplines and are embedded in the content standards. Starting with the graduating class of 2012, high school students must demonstrate proficiency in the Essential Skills of Reading. Students may demonstrate options approved by the State Board of Education.

As of May 2009, the Oregon Assessment of Knowledge and Skills (OAKS) is one of the approved assessment options for the Essential Skills of Reading, Writing, and Mathematics. Another approved option for the Essential Skills of Writing, Speaking, and Mathematics is the completion of work samples scored locally using an official state scoring guide. *Section 3.4: Local Assessment Option* of the 2016-17 Essential Skills and Local Performance Assessment Manual provides guidance for those school districts and public charter schools choosing to use a work sample to satisfy this requirement.

The Assessment of Essential Skills Review Panel (AESRP), which consists of experts from school districts and post-secondary education institutions, reviews and recommends

additions or changes to the list of approved assessment options. The AESRP bases its recommendations on evidence provided by the school districts, research organizations, and other experts that the proposed assessment option accurately measures the Essential Skill. The State Board of Education then makes the determination whether to adopt the AESRP's recommendations. ODE anticipates that the

State Board of Education will approve additional assessment options based on recommendations from the AESRP in the coming months. In addition, the AESRP is developing a set of criteria for approval by the State Board of Education that school districts and public charter schools may use in developing local assessment options.

Appendices

The Appendices of this document includes ancillary materials provided to students to complete science testing; and additional assessment documents that deal with test construction, design and assessment.

Included in this section are:

Appendix A: Target Cognitive Demand and Item Pool Distribution Goals for all Grades

Appendix B: Item Development Process

Appendix A: Target Cognitive Demand and Item Pool Distribution by Difficulty

Oregon recognizes the importance of Cognitive Demand as part of test specification. To that end, we are implementing a strategy to overtly incorporate a test design process that includes the three dimensions of content, difficulty and Depth of Knowledge.

- The first step in the process was convening content panels to ask for their determination as to the appropriate allocation of Cognitive Demand, given the newly adopted content standards.
- The second step was to analyze the gap between the Cognitive Demand and Level of Complexity of all items in the current pools against the content panel's recommendations.
- The third step involved engaging item writers to write items to fill in the critical gaps. These items were reviewed and field tested through our standard processes.

The three Level of Complexity levels to be addressed are:

- Recall: Item requires a student to recall a fact, information or procedure.
- Skill/Concept: Item requires a student to use a skill or concept, including thinking that requires two or more steps.
- Strategic Thinking: Item requires a student to use reason, develop a plan or use a sequence of steps.

Target Cognitive Demand and Item Pool Distribution by Difficulty for Science

Grade 5	Target Item Pool Difficulty Distribution	Grade 8	Target Item Pool Difficulty Distribution	High School	Target Item Pool Difficulty Distribution
Difficulty		Difficulty		Difficulty	
204-223	33%	213-231	33%	213-233	33%
224-231	33%	232-240	33%	234-241	33%
232-249	33%	241-257	33%	242-258	33%
Cognitive Demand		Cognitive Demand		Cognitive Demand	
Recall	25%	Recall	20%	Recall	20%
Skill/Concept	50%	Skill/Concept	50%	Skill/Concept	50%
Strategic Thinking	25%	Strategic Thinking	30%	Strategic Thinking	30%
RIT Range	204-249	RIT Range	213-257	RIT Range	213-258
Mean RIT	228	Mean RIT	235	Mean RIT	237

Appendix B: Item Development Process

Oregon's item development process is consistent with industry practice and takes approximately two years, including writing, reviewing, and field-testing new items. Just as the development of Oregon's content and performance standards is an open, consensus-driven process, the development of test items and prompts to measure those constructs is grounded in a similar philosophy.

Item Writing

For the Knowledge and Skills (multiple-choice) tests and the Writing Performance Assessment, most item writing takes place during either on site, remote and/or online item writing workshops, in which Oregon teachers across the five main content areas write and review items. The process remains the same regardless of workshop format.

Item writers are typically Oregon teachers who have received training in item construction, are familiar with test specifications, and have demonstrated skill in writing items that pass content and sensitivity panel review. Item writers receive professional development compensation for their time and travel expenses. Among other security precautions, ODE requires item writers to sign confidentiality forms assuring that they will work with the items in a secure manner.

All items are written to measure specific subdomains of the content standards at a variety of specified levels of cognitive complexity. Cognitive complexity is represented by the following classification, developed from Bloom's (1956) educational taxonomy:¹

¹ Bloom, B. S. (ed.), Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: Handbook I: Cognitive domain*. New York: David McKay

- **Recall:** Recall, label, or locate information; define or describe facts or processes.
- **Skill/Concept (Basic Application):** Use information or conceptual knowledge, often requiring two or more steps; summarize, classify, or explain information or processes; make predictions or generalizations; solve problems.
- **Strategic thinking:** Analyze, critique, compare or contrast; create new information; or organize presented information.
- **Extended thinking:** Make connections and extensions (exclusively assessed in the Writing Performance Assessment and local performance assessments).

During the item writing workshop, writers draft items, document rationale of distracters, and conduct peer reviews of each other's items. Examples of items are provided, and facilitators provide process guidance and additional review.

Writers and reviewers evaluate the strength and clarity of the match between the drafted item and the standard it measures. All issues are worked out or solved multiple times by multiple reviewers who verify that distracters are plausible, that answers are correct, and that each item has only a single correct answer.

Following item writing workshops, items are entered into the Item Tracking System (ITS). Oregon's original graphics are initially entered into the ODE's Comprehensive Item Management System (CIMS) and then transferred to ITS. Within ITS and CIMS, each item is given a unique item identification number to facilitate the monitoring and tracking of changes to and usage of the item throughout the review process and each item's history. ITS

Figure 1.

Sample Oregon Item Writing Form

Writer ID <div> <div></div> <div></div> <div></div> <div></div> </div> <div> <input checked="" type="checkbox"/> General Population </div> <div> SRC <div> <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 </div> </div>		Grade <div> <input type="checkbox"/> K-2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> HS <input type="checkbox"/> X Extended </div>	Correct Key Estimated Item Difficulty <div> <input type="checkbox"/> Easy <input type="checkbox"/> Medium <input type="checkbox"/> Hard </div> <div> <input type="checkbox"/> MC <input type="checkbox"/> _____ </div>	Key Words Level of Complexity <div> <input type="checkbox"/> R – Recall <input type="checkbox"/> S/C – Skill & Concept <input type="checkbox"/> ST – Strategic Thinking </div> Standard Code <div> <input type="checkbox"/> . <input type="checkbox"/> . <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> </div>	Sample Content Area Graphic M <div> <div></div> <div></div> <div></div> <div></div> </div> Item ID M <div> <div></div> <div></div> <div></div> <div></div> <div></div> </div> Related Essential Skill(s) # (See pg. 8 in notebook)
Foils				Rationale (Why a student might select this option)	
A					
B					
C					
D					

Although item writing workshops may still occur annually, ODE has recently moved toward distributed item writing in which consistently strong item writers author additional items throughout the year. Items still go through the review process previously described. Item writers are trained on the use of secure item entry using ITS, and graphic drafts are scanned by the item writers and securely transmitted to ODE.

Committee/Panel Review

ODE convenes a series of advisory groups to advise ODE both on assessment-related policy and on item development. ODE seeks to ensure that membership on these advisory groups reflects the demographics of Oregon's student population. Each advisory group has approximately 15–35 members who serve three-year terms with one-third of the members rotating out each year and being replaced by new representatives. The following table describes the structure of these groups.

Panel members commit up to 6 school days of service with an additional 3 or 4 days during the summer. However, panels will be convened remotely rather than in person as secure technology improvements allow distributed work. Although committee members on district contracts are not compensated for their service, they do receive travel reimbursement for committee travel of more than 70 miles, and substitute teachers are provided for service during the school year. When classroom teacher members work for ODE during non-contract time, they are compensated at an hourly wage as temporary employees.

The Assessment Policy Advisory Committee consists of representatives from Oregon school districts, schools, and ESDs who are knowledgeable about assessment-related issues. The purpose of the Committee is to advise ODE on both the procedural and policy implications of Oregon's assessment system, as well as the feasibility of proposed improvements to Oregon's assessment

Structure of ODE Assessment-Related Advisory Groups

Committee/Panel	Number of Members	Meeting Frequency	Who Nominates Members?
Assessment Policy Advisory Committee	15–20	2-3 times a year	School districts, COSA, OSBA, OEA, ESDs, and OPTA
Sensitivity Panel	15–20	4–6 times a year	School districts, OEA, ESDs (application process)
English/Language Arts Content and Assessment Panel	35	4-6 times a year	School districts, OEA, ESDs, and self-nominate (application process)
Mathematics Content and Assessment Panel	35	4 - 6 times a year	School districts, OEA, ESDs, and self-nominate (application process)
Science Content and Assessment Panel	35	4- 6 times a year	School districts, OEA, ESDs, and self-nominate (application process)
Social Sciences Content and Assessment Panel	25	1 - 2 times a year	School districts, OEA, ESDs, and self-nominate (application process)
English Language Proficiency Content and Assessment Panel	35	1 – 2 times a year	School districts, OEA, ESDs, and self-nominate (application process)

Note. Oregon’s Accommodations and Modifications Review Panel is not described here. Link to source [here](#).

system. Committee members provide input regarding the various elements of the state assessment system such as educational technology, electronic reporting, operational assessment issues, and test administration.

In addition to seeking advice on assessment-related policy, ODE requires that all items generated for use on Oregon statewide assessments must pass a series of rigorous reviews before they can be used in field and operational tests. All items go through both a content and a sensitivity review as part of the item development process; only those items that measure the grade-level expectations and meet both overall quality and sensitivity criteria are carried forward to the field-test stage.

ODE Content and Assessment Panels exist for each of the content areas for which statewide tests are given: English/Language Arts (this panel reviews Writing and

Reading/Literature assessment items), Mathematics, Science, Social Sciences, and English Language Proficiency.

Most members of these panels are classroom teachers, with some representation from higher education, district curriculum and assessment personnel, and related businesses. Criteria for panel selection include the following:

- Knowledge of Oregon’s content standards and expertise in the subject area and its eligible content
- Teaching experience at the grade level or benchmark to which the individual will be assigned
- Geographical location to ensure that all regions of Oregon are represented
- Gender and ethnic diversity to ensure that the panel represents the diversity of Oregon’s student population

Current item writers are not allowed to serve on item review

committees. However, in some cases, content and assessment panel experts may be utilized as item writing facilitators.

Items are accepted, rejected, or modified by the Content and Assessment Panel to make sure they represent the constructs embodied in grade-specific content standards and test specifications. In addition to judgments of content relevance, the panels appraise the technical quality of items, looking for items that are free from such flaws as (a) inappropriate readability level, (b) ambiguity, (c) incorrectly keyed answers and distracters, (d) unclear instructions, and (e) factual inaccuracy. The panels for each content area use the following review process:

1. Three content panel members review each item independently and complete an Item Review Form (IRF) (figure 1) using a pre-assigned reviewer ID.
2. Then, the three content panel members review the item collectively, and item reviewers make a recommendation for each item on the IRF to either (a) accept the item as written, (b) accept the item with revisions, or (c) reject the item (sometimes an alternate question is offered that entails a simple revision).
3. When all three reviewers agree that an item should be accepted or rejected, no further discussion is needed. If one or more of the reviewers feel that an item should be revised, then they attempt to reach a consensus and produce a “master copy” of their recommendation. The same is true if one or two of the reviewers reject an item that another reviewer finds acceptable with or without revisions.
4. In most cases, recommendations are followed and revisions are made, or items are eliminated. The ODE assessment

specialist can override the recommendation, but this occurs rarely and only for compelling reasons.

The content panels perform specific checks on items to confirm that:

- the SRC and subcategory match.
- the key is correct.
- alternate valid interpretations making the distracters correct do not exist.
- the item is grade-level appropriate in content and reading levels.
- the item is of overall high quality (wording and grammar, graphic quality, curricular importance, etc).
- the identified level of difficulty (i.e., easy, medium, hard) is correct.
- Reading/Literature passages are appropriate in content and reading levels. Science and Social Sciences stimuli align to appropriate content and reading skills.
- the level of cognitive complexity (i.e., recall, skill/concept or strategic thinking) is appropriate to the item and correctly identified.

Following review by the content panel, and according to panel feedback, ODE assessment specialists edit and revise items in ITS in preparation for review by the Sensitivity Panel.

All items that pass review by the content specialist are next presented to the sensitivity panel. The sensitivity panel reviews convenes day-long meetings, four to six times a year. The panel reviews items from all grade levels and content areas for bias, controversial content, and overly emotional issues.

Figure 2.

Sample Oregon Content and Assessment Panel Item Review Form



The form is titled "Sample Oregon Content and Assessment Panel Item Review Form". It contains several input fields and checkboxes. At the top, there is a "CP Reviewer ID" field and a "Correct Key" field. Below these, there are three rows of checkboxes: "Match to Standard: Strong", "Acceptable", "Poor"; "Overall Quality: Excellent", "Acceptable", "Poor"; and "Recommendation: Accept", "Accept w/Rev", "Reject". To the right of these checkboxes is a "Master" button. At the bottom of the form, there is a "Sensitivity Panel" section with checkboxes for "Rcmd: Acc", "Acc/Rev", and "Rej".

In general, the sensitivity panel ensures that items:

- present racial, ethnic, and cultural groups in a positive light.
- do not contain controversial, offensive, or potentially upsetting content.
- avoid content familiar only to specific groups of students because of race or ethnicity, class, or geographic location.
- aid in the elimination of stereotypes.
- avoid words or phrases that have multiple meanings.

Following the sensitivity panels and according to panel feedback, ODE assessment specialists edit and revise items in the ITS system.

EXPERT REVIEW

Next, ODE assessment specialists submit the new items for review by experts that have experience in the roles of item writer and content and assessment panel member. Expert reviewers add an additional quality control check for the online assessments. Experts have received extensive professional development in ITS to review items in a web-preview format providing the exact rendering provided in the online assessments.

Experts review each item and confirm that:

- the key is correct.
- alternate valid interpretations making the distracters correct do not exist.
- the item is grade-level appropriate in content and reading levels.
- the item is of overall high quality (wording and grammar, graphic quality, curricular importance, etc).

Following the expert review in most cases, recommendations are followed and revisions are made, or items are eliminated. The ODE assessment specialist can override the recommendation, but this occurs rarely and only for compelling reasons.

FIELD TESTING

Once the items have been reviewed by the content and assessment panel, the sensitivity panel, and an expert reviewer, all Mathematics, Reading/Literature, Science, and Social Sciences test items are field tested. Field test items identified by the ODE assessment specialists are embedded in the operational tests by content area. As students take the operational tests, they also respond to field test items embedded in the test.

ODE then receives data files of the student responses, which ODE analyzes to determine whether the field test items are behaving as expected. The ODE assessment specialists eliminate those items which the data analysis indicate performed weakly. ODE assessment staff calibrate the difficulty level for those items that performed successfully in preparation for using the item operationally.

TRANSLATION OF ITEMS TO SPANISH

Concurrent with the field testing of items in English, all Mathematics, Science, and Social Sciences test items are translated into Spanish. All required grade-level and benchmark-level statewide tests for Mathematics and Science are offered in English-Spanish tests. English-Spanish tests are also available for Social Sciences. Stacked English-Spanish items are used on electronic tests. Side-by-side English-Spanish and English-Russian Paper/Pencil assessments are available in Mathematics and Science.

Following translation by ODE's translation vendor, the translated items are reviewed by ODE's Spanish- and Russian-speaking experts to ensure that each item accurately conveys the intent of the English text. While the procedure described below specifically addresses Spanish translation, ODE follows a similar procedure for translation of Paper/Pencil items into Russian.

The following linguistic guidelines are used by ODE's translation vendor and Spanish-speaking experts:

- Students are expected to have subject knowledge and use proper terminology/vocabulary for that subject. In other words, what is expected from English-speaking students is also expected from Spanish-speaking students.
- ODE uses formal Spanish (usted, not tú) for test items and includes proper verb conjugation.
- ODE strives to use Global Spanish language that will be interpreted and understood by all Spanish speakers from anywhere in the world. Global Spanish language includes words used worldwide by most Spanish speakers.

After the ODE Spanish reviewers complete a review of the newly translated items, extensive research is conducted by a small group of reviewers on any word that has not met group consensus. Every attempt is made to choose the most correct translation based upon grade level and cultural relevance.

ADDITIONAL EXPERT REVIEW OF ITEMS

On an annual basis, ODE assessment specialists review items from the field test pool for inclusion within the operational test. This level of review acts as an additional quality control for the online assessments. In addition, whenever ODE transitions to a different test delivery system, ODE submits all of its Reading/Literature, Mathematics, Science, and Social Sciences items for an additional level of expert review to ensure that all items appear consistently from year to year when presented to students.

ITEM USE AND RELEASE

Approximately every three years, ODE releases one sample test for each content area and grade-level and benchmark-level comprised of items used on previous test forms. These items are no longer secure and are taken out of the pool of eligible test items.

Released items are provided in the form of practice tests. Practice tests for Reading/Literature, Mathematics, Social Studies and Science are available on ODE's [website](#).

Sample writing prompts are also available on the [Smarter Balanced Sample Items web page](#).

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