Strengthening Claims-based Interpretations and Uses of Local and Large-scale Science Assessment Scores (SCILLSS)

A Guide to Developing Classroom-based Next Generation Science Standards Assessment Tasks: A Principled-design Approach

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Introduction

Meeting the challenges and responding to advancements in technology inherent in the 21st century require that students be educated and assessed in new ways in science. Science education goals must engage K-12 students as scientists and engineers in the classroom. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (*Framework*; National Research Council [NRC], 2012) provides a foundation for the three-dimensional science learning articulated in the Performance Expectations (PEs) of the Next Generation Science Standards (NGSS; NGSS Lead States, 2013). The PE statements describe what students should be able to do after receiving instruction. The *Framework* expresses a vision of science education that requires students to operate at the nexus of three dimensions of learning: Science and Engineering Practices (SEPs), Disciplinary Core Ideas (DCIs), and Crosscutting Concepts (CCCs). This is a new model for K-12 science education designed to deepen students' understanding of the DCIs and applications of SEPs and CCCs to investigate and explain phenomena and to design and refine solutions to problems.

The guide assumes that educators are already familiar with how to read a NGSS standards page. Educators should also be familiar with the conceptual shifts in the NGSS, the innovations addressed in the NGSS, and research on how students learn science. For related information, refer to the section, New Science Standards: The NGSS, in this guide.

Purpose and Use

This guide describes a replicable principled-design approach and tools (i.e., fillable templates) based on evidence-centered assessment design (ECD) (Almond, Steinberg, & Mislevy, 2002; Mislevy, Almond, & Lukas, 2003, Mislevy & Haertel, 2006) for use by educational stakeholders to develop classroom-based NGSS assessment tasks. This guide focuses on classroom-based NGSS assessment practices described as "embedded in an instructional sequence" using educator-developed assessment tasks that generate meaningful information about students' science learning along and during that instructional sequence. Implementing the NGSS emphasizes student experiences with natural phenomena and designing solutions to problems and the expectation that three-dimensional science learning will be enhanced and assessed. The goal is to provide principled-design and development processes, along with a set of tools, that can support educators in defining in detail the science construct(s) targeted for classroom-based assessment tasks based on the principles of the *Framework*.

The creation of classroom-based assessment tasks is challenging as it presses against traditional ways of measuring student learning. Understanding and employing a principled-design approach can enhance educators' abilities to develop classroom-based assessment tasks that provide critical information about individual student learning. However, the tasks must do more than elicit students' declarative knowledge. They must elicit evidence related to students' integration of their knowledge of DCIs, engagement with scientific practices, and facility with building connections across ideas (CCCs) (Pellegrino, 2013). As stated by NRC, 2014:

> Assessment tasks, in turn, must be designed to provide evidence of students' ability to use practices, to apply their understanding of the crosscutting concepts, and draw on their understanding of specific disciplinary ideas, all in the context of addressing specific problems. (p. 32)

This guide begins with a description of the NGSS followed by an explanation of the role of classroom-based assessment tasks administered during instruction. The sections that follow provide an overview of a principled-design approach that establishes processes and related tools to be utilized by educators to develop classroom-based NGSS assessment tasks. The first tool requires educators to consider the question, “What ideas and skills are associated with a PE?” It sets a meaningful stage for determining the knowledge, skills, and abilities (KSAs) needed to translate the NGSS into pedagogy (i.e., the method and practice of teaching) and classroom-based assessment tasks. The second tool requires educators to address, “How will classroom-based assessments need to be developed to help educators gauge students’ progress towards achieving the NGSS PE?” This is accomplished in the tool as it defines components of an assessment task that educators determine by asking, “What constitutes evidence of three-dimensional science student learning, and how can I develop assessment task specifications that will illicit what students have indeed learned?”

To illustrate the application of this principled-design approach and the development and use of the tools, a grade 5 example classroom-based assessment task and rubric are included. This example illustrates concrete steps to create three-dimensional classroom-based assessments when educators are planning for assessment of student learning during instructional sequences in their classrooms. Further exemplars for grades 5, 8, and 11 are provided in appendices A through F. The exemplars provide additional examples of how educators may begin to address the challenge of implementing conceptual shifts in the NGSS to improve science education by making changes to their instruction and assessment practices that will bring about science learning for the 21st century.

In the conclusion, it is recognized that educators will need professional development opportunities to understand how to use and apply the principled-design and development processes, along with the tools herein, during an instructional sequence in the classroom. Creating opportunities for educators on models of how three-dimensional tasks can be used formatively in the classroom is instrumental for effective use of classroom-based assessment tasks.

New Science Standards: The NGSS

The NGSS are described as “robust” and “forward-looking” standards that all states can use to guide teaching and learning.[1] Based on *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, the NGSS are intended to reflect a new vision for American science education. That vision is new in that students must be engaged at the nexus of the three dimensions: 1) SEPs, 2) CCCs, and 3) DCIs.

Presented as PEs, the standards state what students are expected to be able to do to demonstrate their science knowledge and understanding after instruction to investigate complex ideas, make sense of phenomena, and solve real-world problems (i.e., knowledge in use). The PEs focus on understanding and application as opposed to memorization of facts and procedural skills.

The NGSS do not dictate curriculum materials and instructional practices. Educators can use the NGSS as goals for instruction to develop lessons within an instructional sequence and plan investigations activities to promote a logical progression of three-dimensional science learning within and across grades. Building on the knowledge and skills gained from each grade, from elementary through high

[1] Understanding the Standards. (n.d.). Retrieved from https://www.nextgenscience.org/understanding-standards/understanding-standards.

school, students have multiple opportunities to revisit and expand their understanding of all three dimensions by the end of high school.

The PEs integrate three dimensions of science learning: SEPs, DCIs, and CCCs. The SEPs are used by students to demonstrate understanding of the DCIs and CCCs. The SEPs connect science with mathematics, English language arts, and other disciplines through meaningful and substantive overlapping skills and knowledge. The DCIs are the focused, limited set of science ideas necessary for all students to achieve scientific literacy. The CCCs are used to organize and make sense of the DCIs. They serve as tools that bridge domain boundaries and deepen understanding of content. The DCIs, SEPs, and CCCs each build coherently K-12 to allow for deeper understanding of science concepts. Below is an example for grade 5 physical sciences, specifically Structure and Properties of Matter.

5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.

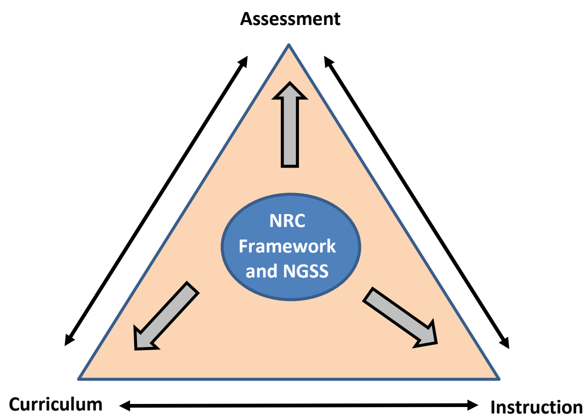
This PE first presents a SEP: *Developing and Using Models*. Second, it presents a DCI: *Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means*. Finally, it includes a CCC: *Scale, Proportion, and Quantity*.

The Role of Classroom-based Assessment of Three-dimensional Science Learning

Understanding the purposes and uses of multiple forms of science assessment (e.g., formative, interim, and summative) found within a well-designed assessment system share a common goal—evaluation of student learning in relation to NGSS-aligned goals and expectations. As with all forms of assessments, when classroom-based assessments are well-designed and are equitable, accessible, and relevant for the widest range of students (Achieve, 2018), performance on these assessments has the potential to be used by educators to make 1) accurate inferences about students' KSAs; 2) monitor student progress; and 3) inform educator actions with respect to adjustments in the design and delivery of instruction. Classroom-based assessments designed to achieve these outcomes must address equity and accessibility for all students including English Learners (ELs) and students who receive special education services (STEM Teaching Tools, 2014-2019). What is being measured must be relevant to all students, presented in meaningful, relatable contexts, and be designed and presented in ways that allows students to demonstrate what they know and can do (e.g., promotes engagement, provides a range of presentation formats, allows for different ways of student responding (Universal design for learning (UDL)). The classroom-based tasks should minimize unnecessary or confusing language and overly complex sentence structures. In addition, the classroom-based tasks should include relevant vocabulary that has been taught and used during investigations and science learning.

Over time, the goal is that student competence and expertise develop and increase in sophistication as the product of coherent systems of curriculum, instruction, and assessment (Pellegrino, 2016). It is not intended that assessment stands alone. Instead, assessment is one of three central components (see Exhibit 1), which are linked in a coherent system (Pellegrino, 2010). For this guide, the goals of instruction are outlined by the NGSS PEs, the curriculum, whether developed or purchased, defines how that content is delivered, and the classroom-based assessments measure the outcomes of teaching and learning and attainment of the goals of instruction by students. To maximize student engagement and interest in science investigations by all students, educators can employ a pedagogical strategy in which relevance and student experiences are central. Educators can consider students' interests and locally-relevant issues to inform the selection and development of science and engineering investigations. These investigations should be relevant to students' lives and make clear how they can apply new learning to improve their lives and the lives of the larger community—beyond the classroom.

Exhibit 1. Illustration of the Interconnections Among Curriculum, Instruction, and Assessment[2]



Based on careful observation, questioning, and monitoring of students, classroom-based three-dimensional science assessments can be developed and embedded at a point within a sequence of instruction within a unit, after single or multiple units of instruction, or at a “mid-term” point. As teaching and learning opportunities occur, an educator is in the driver’s seat and must determine when a “check” is necessary on student acquisition and application of the taught KSAs associated with a PE(s) or an aspect of a PE. Assessment of that learning requires educators to have a deep understanding of the multi-dimensional aspects of the PEs (Unpacking Tool), which form the basis of the instructional sequence. Educators can then create three-dimensional assessment tasks (Task Specifications Tool) that require students to revisit, extend, and apply their learning. These tasks must allow students to transfer the knowledge acquired during instruction and apply it to assessment tasks in a new context with related phenomena or design problems.

The purpose of the tools is to develop classroom-based assessment tasks with a scoring rubric. Using both tools in relation to the instructional sequence, educators begin to develop classroom-based assessments that support their “evaluation” of their instructional prowess. Classroom-based assessments provide evidence (observations, behaviors, or performances) that when evaluated by rubrics reveals what students have learned as a result of NGSS-aligned instruction. Through the intentional development of assessment tasks based on a principled-design approach, educators can answer, “Does the assessment evidence show a more or less sophisticated understanding by each student of what has been taught?” and, “When I aggregate the evidence, what do I know about the understanding of my class as a whole?”

Overview of a Principled-design Approach to Develop Classroom-based NGSS Assessment Tasks

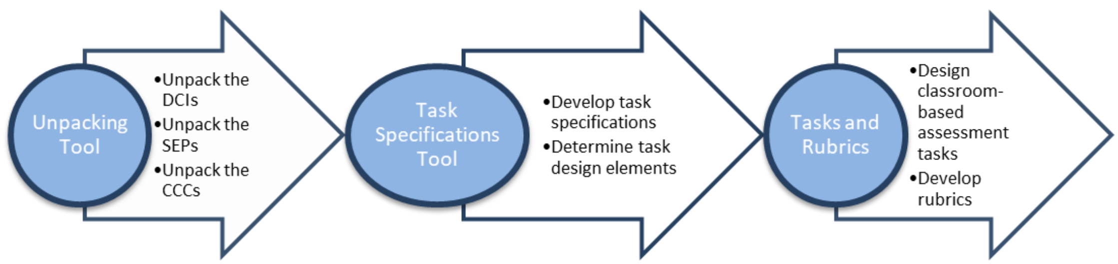
Traditional assessment strategies may not yield enough evidence of students’ abilities to use scientific practice, think critically, and communicate ideas as intended by the *Framework* and the NGSS. For teachers to effectively implement assessment as part of their pedagogy, they need tools for creating tasks and collecting and scoring student performance. Use of a principled-design approach to develop

[2] Modified from Pellegrino, J.W. (2010). The design of an assessment system for the race to the top: A learning sciences perspective on issues of growth and measurement. In P. Forgione & N. Doorey (Eds.), *Exploratory Seminar: Measurement Challenges Within the Race to the Top Agenda*. Princeton, NJ: Center for K–12 Assessment & Performance Management, Educational Testing Service.

classroom-based NGSS-aligned assessment tasks can ensure that the evidence of student learning that is collected and evaluated is consistent with the KSAs represented by the PEs and the intended purpose of the assessment. Using these tools support educators in the creation of assessment tasks and scoring rubrics that support more complex assessments (i.e., multi-dimensional science assessment tasks).

This approach includes two tools that build toward task and rubric construction: 1) unpacking the three dimensions within a NGSS PE to understand and identify assessable components (Harris, Krajcik, Pellegrino, & McElhaney, 2016); and 2) identifying specifications to design assessment tasks (see Exhibit 2). The principled-design approach allows for both the Unpacking Tool and the Task Specifications Tool to be flexible enough for use in designing instruction and assessments and be reusable in the sense of designing multiple assessment tasks to address aspect(s) of a PE. The Task Specifications Tool assists educators in planning the intentional design of assessment tasks, which are meant to elicit information about students' KSAs, describing the context/situation with which students interact, and specifications for the form of a student's response. In addition, it is intended that educators will "revisit" the tools and improve upon them based on their instruction and assessment experiences, increased understanding of the NGSS, purpose and use of the tools, and collaboration with other educators.

Exhibit 2. A Principled-design Process and Tools for Translating the NGSS into Classroom-based Assessment Tasks



The foundation of the principled assessment design described in this guide is the collection of observable student evidence, which demonstrates student understanding of each target of measurement (i.e., KSAs) addressed by the Unpacking Tool. The tool assists educators to make clear what determination of achievement (based on the application of a rubric) is to be made about a student that is relevant to the specific purpose of the assessment. The KSA and evidence requirements shape the design of assessment tasks for students to demonstrate what they have learned. Once identified, the characteristics of these assessment opportunities are fleshed out in the Task Specifications Tool, capable of generating multiple assessment tasks. This tool, which is the basis for task development, flows directly from the Unpacking Tool, which provides further guidance on the interpretation of the three dimensions of a PE and how they can be assessed. This is the backbone of what an educator can claim about what a student knows and can do, and the observable evidence required to support those claims.

The development of classroom-based assessment tasks that yield meaningful and interpretable information requires that educators make many decisions about the design and content of the tasks and evaluation of student responses. To ensure accurate assessment of students' KSAs, educators can enhance access and support student performance by providing multiple ways in which the assessment tasks present information and ways that students express what they know and can do by applying principles of UDL. Educators should ask themselves the following questions when designing classroom-based assessment tasks in the context of the instructional flow of the science unit:

- What PE(s) have been selected for instruction?
- How are the three dimensions interconnected in the PE?
- What are the connections between instruction and assessment?
- How will the assessment tasks be designed to ensure accessibility by all students (i.e., stimulate interest, present information in different ways, differentiate the ways student express what they know and can do)?
- What is the observable evidence of learning a student is expected to demonstrate?
- What is the best way to collect evidence of student learning of a PE or an aspect of a PE (e.g., the work product that is the "container" for the observable evidence)?
- When should assessment tasks be administered to inform instruction?
- What are the qualities of student responses that differentiate a sophisticated from a partial understanding?
- How will I adjust instruction for individual students or groups of students based on the assessments?
- How will I know when I can proceed with instruction?

Unpacking the Dimensions of a Performance Expectation Tool

Unpacking the dimensions of each PE provides a clear focus for what is to be measured and helps educators to plan for assessment. The Unpacking Tool provides a systematic approach to unpacking a PE into its multiple components to ensure educators who are designing NGSS-aligned tasks have a clear and deep understanding of each of the dimensions represented in a PE prior to beginning task development (see Exhibit 3). *Key aspects* are the underlying concepts that support each dimension of the PE and represent knowledge necessary for understanding or investigating more complex ideas and solving problems. *Prior knowledge* refers to the background knowledge that is expected of students to develop an understanding of the SEP and DCI. The *relationships between the CCC and the SEP* is included as well. When students are performing a SEP, they are often addressing one of the CCCs. For example, the CCC *Scale, Proportion, and Quantity* is an essential consideration when deciding how to *develop a model* (SEP) to describe a phenomenon. A completed Unpacking Tool template for grade 5 is found in Exhibit 5. Unpacking Tool for 5-PS1-1.

Exhibit 3. Template for Unpacking Tool

<table>
<tr><td colspan="5">Grade:</td></tr>
<tr><td colspan="5">NGSS Performance Expectation:</td></tr>
<tr><td></td><td>Science and Engineering Practices (SEP)</td><td>Disciplinary Core Ideas (DCI)</td><td colspan="2">Crosscutting Concepts (CCC)</td></tr>
<tr><td>Foundations</td><td>SEP:</td><td>DCI:</td><td colspan="2">CCC:</td></tr>
<tr><td>Key Aspects</td><td>•</td><td>•</td><td colspan="2">•</td></tr>
<tr><td>Prior Knowledge</td><td>•</td><td>•</td><td>Relationships to SEPs</td><td>•</td></tr>
</table>

A selection of resources to support unpacking the PEs to identify *key aspects* and *prior knowledge* includes the *Framework*, the NGSS, and NGSS Appendices E: Disciplinary Core Ideas, F: Science and Engineering Practices, and G: Crosscutting Concepts (i.e., progressions). Research literature on designing NGSS-aligned assessments are included in the reference section. Additional examples of completed tools for grades 5, 8, and 11 are provided in Appendix A through Appendix F of this guide.

Assessment Task Specifications Tool

Identifying the assessment tasks specifications allows educators to translate the PE-specific unpacking of the three dimensions into assessment tasks. Task specifications allow educators to determine what counts as evidence for student learning. The Task Specifications Tool is intended to help educators develop assessment tasks that allow students opportunities to call upon, transfer, and apply learning that has occurred during instruction to new challenges, much the way a scientist or engineer would, in an assessment situation.

Presented as a fillable template (see Exhibit 4), the Task Specifications Tool identifies the key components needed to develop purposeful assessment tasks. This tool is modeled after ECD design patterns (Almond, Steinberg, & Mislevy, 2002; Mislevy, Almond, & Lukas, 2003, Mislevy & Haertel, 2006). The Task Specifications Tool components serve as a set of considerations for the task writer (e.g., educator) when developing classroom-based assessment tasks.

Based on the instructional sequence and which components of the PE(s) have been taught, the educator determines *when* to assess and *what* to assess (i.e., at a point in time, the KSAs that warrant assessment to make inferences about student learning). These decisions are born out of observing students during science investigations, monitoring student-generated questions and problem-solving strategies, and when student evidence is needed to inform the direction of the instructional sequence. To create a task, the educator must define the aspect(s) of the PE to be assessed and make design choices about what information is presented to a student, how it is presented, how the examinee interacts with the tasks, and how responses are provided. The Task Specifications Tool indicates the components needed to be considered by the educator to develop a high-quality task including:

- the aspect(s) of the PE to address (i.e., the KSAs);
- the kinds of behaviors and performances that show what students should be able to do after instruction (i.e., Student Demonstration of Learning);
- the items, situations, or stimuli that will elicit evidence of student learning (i.e., Work Product); and
- the features of task situations that allow students to demonstrate the degree to which expectations have been met (i.e., Task Features)

Exhibit 4. Task Specifications Tool Overview

Element	Description
Performance Expectation	• Indicate the PE from the instructional sequence to be assessed.
Knowledge, Skills, & Abilities (KSAs)	• Develop statements, which specify what is expected of students to demonstrate (i.e., KSAs) to provide evidence that they have learned one or more aspects of a PE.
Student Demonstration of Learning	• List what students should be able to do to demonstrate that they have met the KSA(s). • Define qualities of student performance that constitute student evidence.
Work Product	• Determine the "vehicles" (i.e., work products) that are intended to contain observable evidence (e.g., a model, an argument, a description, a graph, a chart).
Task Features	• List the task features from which the task writer selects to develop an assessment task. • Reference the "Clarification Statement" in the NGSS for the PE as appropriate. • Note: A single question/task may not represent all the features listed.
Aspects of an assessment task that <u>can be varied</u> to shift complexity or focus	• Allows for a range of tasks to be developed of varying complexity. • Allows for development of tasks that focus on various skills related to the PE. • Allows the task developer to match features of the task with the characteristics of students such as their interests, familiarity, and provided instruction.
Assessment Boundaries	• List information that is NOT assessed (i.e., related above grade-level ideas and skills). • Reference the "Assessment Boundary" in the NGSS for the PE as appropriate.

Assessment Task Construction: Classroom-based Assessment Tasks and Rubrics

A well-designed assessment task presents engaging, authentic, real-world contexts and phenomena of interest to a wide range of students and calls for students to transfer and apply their knowledge in keeping with the goals of the *Framework* and the NGSS. This approach would provide a seamless transition from learning to testing. A classroom-based task measures, at a point in time determined by the educator, students' acquisition of KSAs taught during an instructional sequence. Student competency is required in order for additional, more sophisticated learning to occur in the subsequent lessons in the instructional sequence. Developed in these ways, the classroom-based assessment tasks enable educators to get their fingers on the pulse of individual students, groups of students, and/or the entire class as to where they are in their science learning and collect evidence to ultimately inform instruction. The completion of the Unpacking Tool and the Task Specifications Tool lends itself to the development of assessment tasks to evaluate student progress in the instructional sequence.

The Classroom-based Assessment Task

A three-dimensional assessment task must elicit evidence related to students' integration of knowledge of DCIs, engagement with SEPs, and facility with building connections across ideas (CCCs) (NRC, 2012; Pellegrino, 2013). The task may necessarily be comprised of multiple items to elicit evidence that provides specific information about student understanding and competence of the three dimensions as they relate to a PE (e.g., core ideas, representing data, interpreting data, engaging in argument from evidence). The assessment task provides an indication of the student's current understanding of the selected KSAs as set forth in the Task Specifications Tool. A single item may not be sufficient to elicit evidence to allow educators to identify where students may have misunderstandings and need additional instruction. Each task includes scientifically accurate information, is aligned to three-dimensional learning, and may include standalone or a suite/series of questions to allow students to demonstrate the degree to which expectations have been met. The task may include multiple parts, questions, or prompts connected to a phenomenon or problem-solving context or event. When responding to the task, the students must clearly understand how to complete the task and what is expected to demonstrate a high level of competency.

The Rubric

A rubric defines the criteria that educators use to interpret and evaluate student evidence of learning. When developing classroom-based rubrics, the educator must consider the type of student evidence to be collected. Depending upon the intended use of classroom-based assessment tasks during an instructional sequence, the type of evidence gathered may vary from situation to situation. In addition, the educator must decide how to integrate DCIs, SEPs, and CCCs within their rubrics.

It is critical to write a rubric that includes descriptors for each question or prompt in the assessment task that describes the full range of student understanding from low to high levels of competency. In general, a high-level response is scientifically accurate, complete and coherent, and consistent with the type of student evidence expected. A low-level response may include misconceptions, is incomplete, and is not consistent with the type of evidence expected. Student responses should yield accurate inferences about students' KSAs that inform educator actions either to 1) continue with the instructional sequence as planned; or 2) adjust the design, delivery, and sequence of instruction. Instructional decisions can be made at the individual student level, for a small group of students, or at the class level.

Grade 5 Classroom-based Assessment Task Example

The SCILLSS' principled-design approach has been applied to develop an example grade 5 classroom-based assessment task and rubric. A completed Unpacking Tool and Task Specifications Tool for a grade 5 PE are integrated to design a classroom-based assessment task example including exemplar high-level responses.

Unpacking the Dimensions of a Performance Expectation Tool for 5-PS1-1

Exhibit 5 presents the unpacking of the three dimensions associated with 5-PS1-1 utilizing the Unpacking Tool. Refer to the section Unpacking the Dimensions of a Performance Expectation Tool in this guide for related information.

Exhibit 5. Unpacking Tool for 5-PS1-1

Grade: 5

NGSS Performance Expectation: 5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [*Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.*]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)	
Foundations	**SEP: Developing and Using Models** Develop a model to describe phenomena.	**PS1.A: Structure and Properties of Matter** Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.	**CCC: Scale, Proportion, and Quantity** Natural objects exist from the very small to the immensely large.	
Key Aspects	• Identify components of the model. • Use a model to reason about a phenomenon. • Reason about the relationship of the different components of a model. • Select and identify relevant aspects of a situation or phenomena to include in the model.	• Everything around us (matter) is made up of particles that are too small to be seen. • Matter that cannot be seen can be detected in other ways. • Gas (air) has mass and takes up space. • Gas (air) particles, which are too small to be seen, can affect larger particles and objects. • Gas particles freely move around in space, until they hit a material that keeps them from moving further, thus trapping the gas (e.g., air inflating a basketball, an expanding balloon).	• Understand the units used to measure and compare quantities. • Describe relationships between natural objects which vary in size (very small to the immensely large). • Understanding of scale involves not only understanding systems and processes vary in size, time span, and energy, but also different mechanisms operate at different scales.	
Prior Knowledge	• Knowledge that a model contains elements (observable and unobservable) that represent specific aspects of real-world phenomena. • Knowledge that models are used to help explain or predict phenomena.	• Matter is anything that occupies space and has mass. • Matter can change in different ways.	**Relationships to SEPs**	• Models describe the scale of natural objects. • Data analysis serves to demonstrate the relative magnitude of some properties or processes. • Calculate proportions correctly and measure accurately for valid results.

Task Specifications Tool for 5-PS1-1

Exhibit 6 illustrates a completed Task Specifications Tool for 5-PS1-1. It informs the design of tasks and rubrics related to students' evaluation of the correspondence between a model and its real-world counterparts. Refer to the section Task Specifications Tool in this guide for more information.

Exhibit 6. Task Specifications Tool for 5-PS1-1

Element	Description
Performance Expectation	**5-PS1-1** Develop a model to describe that matter is made of particles too small to be seen.
Knowledge, Skills & Abilities (KSAs)	**KSA1:** Develop a model to describe matter. **KSA2:** Use a provided model to describe matter. **KSA3:** Use a provided model to describe that matter is made of particles too small to be seen. **KSA4:** Develop a model to describe that matter is made of particles too small to be seen.
Student Demonstration of Learning	• Model accurately represents the observable phenomena • Model accurately captures all mechanistic features of the observable phenomena • Scale of model components is relevant to various objects, systems, and processes • Model and response accurately describe the particles in the two conditions (i.e., before and after stirring) • Describes a phenomenon that includes the idea that matter is made of particles too small to be seen • Correctly identifies and describes relevant relationships between components of the model
Work Product	• Draw a model • Complete a model • Constructed response
Task Features	• All tasks must prompt students to describe relationships between observed phenomenon or evidence and reasoning underlying the observation/evidence. • Students use scientific reasoning and process skills. • All tasks must elicit core ideas as defined in the PE. • All tasks must include elements from at least two dimensions of the NGSS.

Aspects of an assessment task that <u>can be varied</u> to shift complexity or focus	• Complexity of scientific concept(s) to be modeled
	• Function of the model:
	  o to explain a mechanism underlying a phenomenon;
	  o to predict future outcomes;
	  o to describe a phenomenon;
	  o to generate data to inform how the world works
	• The degree to which components of the model are provided
	• The model may be provided for revision or one that is created from scratch
	• Representation of model
	• What matter is being modeled
	• Use or purpose of the model

	• Type of model (e.g., physical/virtual) • What states of matter are represented and/or included (and how many) and if they are compared
Assessment Boundaries	• Students are not expected to know that matter is made of atoms and molecules. • Students are not expected to explain the properties of the particles. • Students are not expected to apply proportional reasoning skills (Note: should not be included, as students learn proportions in in grade 6, CCSSM[3]). • Density should not be included. • Mass and weight are not distinguished.

Task and Rubric Construction

Exhibit 7 provides an example of a classroom-based assessment task for 5-PS1-1 and Exhibit 8 provides a scoring rubric for evaluating student work products from the administration of the task. Exhibit 9 and Exhibit 10 provide an exemplar high-level student response for question one and question two of the task. The educator task administration guide and the full set of student responses addressing the range of score points for each question are available in Appendix A. It is expected that educators have engaged students in investigations that led to deeper understanding of scientific concepts related to different types of matter and its properties. Refer to section Assessment Task Construction: Classroom-based Assessment Tasks and Rubrics in this guide for further information.

[3] National Governors Association Center for Best Practices, Council of Chief State School Officers. (2010). *Common Core State Standards for Mathematics*. Washington DC: Author.

Exhibit 7. Example 5-PS1-1 Classroom-based NGSS Assessment Task

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: 5

NGSS Performance Expectation: 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.

Background Information

This task is about the particles of matter. Be sure to answer question 1 and question 2.

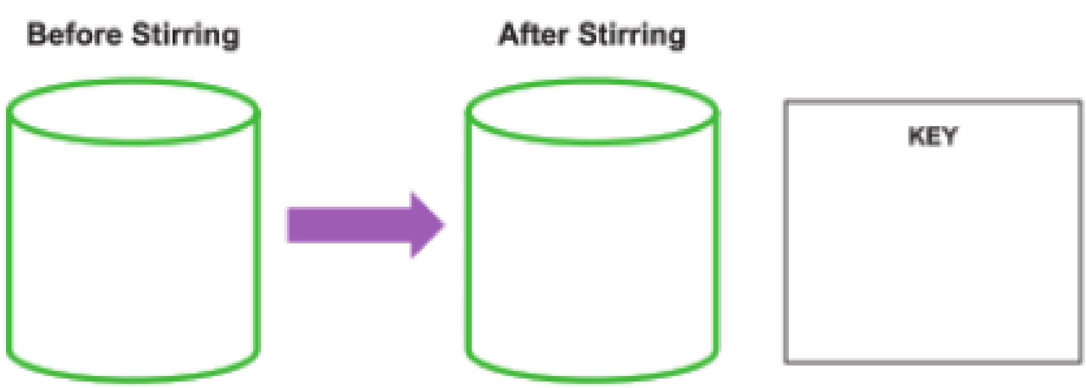
Task

1. Jose cleaned his salt water fish tank. The water in the tank looked clear. His friend Carl visits and asks, "Why can't I see the salt in the water?" Jose creates a model to show Carl what happens to salt when stirred into water.

Complete the model below to show:

- the salt particles and water particles *before* stirring the mixture
- the salt particles and water particles *after* stirring the mixture

Be sure to complete the key to show the salt particles and water particles in both conditions of your model.



2. Describe the change to the salt particles after being stirred in the water. Be sure to use information from your model to support your explanation.

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Exhibit 8. 5-PS1-1 Classroom-based NGSS Assessment Task Example Rubric

Student Response	1	2	3
Question 1	Model does not show two representations each with two different bulk matter and matter too small to see (particles) or representations in the correct position and scale relative to each other. The key is incorrect.	Model shows a flawed connection between bulk matter and particles too small to be seen or a flawed connection between the representations' correct position and scale relative to each other. The key is partially correct.	Model shows two representations each with two different bulk matter and matter too small to be seen (particles) and shows representations in correct position and scale relative to each other. The key is correct.
Question 2	The description is incorrect.	The description is partially correct	The description is correct.

Exhibit 9. Exemplar 5-PS1-1 High-level Student Response: Question 1 Student Model

SCORE POINT 3

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: 5

NGSS Performance Expectation: 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.

Background Information

This task is about the particles of matter. Be sure to answer question 1 and question 2.

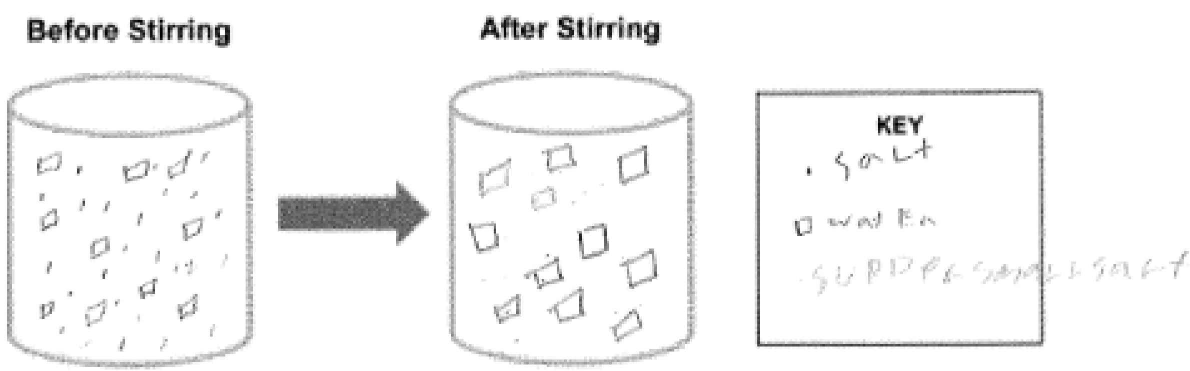
Task

1. Jose cleaned his salt water fish tank. The water in the tank looked clear. His friend Carl visits and asks, "Why can't I see the salt in the water?" Jose creates a model to show Carl what happens to salt when stirred into water.

Complete the model below to show:

- the salt particles and water particles *before* stirring the mixture
- the salt particles and water particles *after* stirring the mixture

Be sure to complete the key to show the salt particles and water particles in both conditions of your model.



Disclaimer: While this student work exemplifies a portion of the evidence necessary to support the assigned score point, it may not reflect all of the evidence for the score point. Given the relatively low n count for this study, the pool of papers from which to select exemplars was limited.

Score Point 3: Student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction.

Model shows two representations, each with two different bulk matter and matter too small to be seen (particles); the models for "Before Stirring" and "After Stirring" represent both salt and water particles. Model shows representations correct position and scale relative to each other; the models for "Before Stirring" and "After Stirring" show the correct position and scale of the particles.

The key is correct and includes a statement about "super small salt." However, it is lacking a representation; the model of after stirring shows small particles and therefore the key does not detract from the overall correctness of the response.

Exhibit 10. Exemplar 5-PS1-1 High-level Student Response: Question 2 Student Model

SCORE POINT 3

Student ID:

2. Describe the change to the salt particles after being stirred in the water. Be sure to use information from your model to support your explanation.

The water and salt are mixed and the the salt dose not just dissaper it desolves that mean it is getting smaller and smaller but when you can't see it the dose not mean it is gone that mean it is just to small to see.

Score Point 3: Student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction.

Description is correct; the response refers to the condition after the water and salt are combined and specifically states that the salt does not disappear. It relates the observation of not being able to see the salt to a reason, which is that the salt has dissolved into small particles, the particles get smaller, and then are too small to be seen. It states that the salt particles are not "gone."

Integration of the Assessment Development Tools: Design of the Task

A well-constructed assessment task generates meaningful information about students' science learning by providing students opportunities to demonstrate what and how well they have learned with respect to a PE or part of that PE through observed behaviors, work products, or performances. The educator integrates the information within and across the assessment development tools to design the tasks by considering and identifying:

- The key aspects addressed by the SEP, DCI, and CCC (Unpacking Tool);
- The elicited prior knowledge (Unpacking Tool);
- The relationship between the identified CCC and the SEPs (Unpacking Tool);
- The KSA from which the task is developed (Task Specifications Tool);
- The production of responses that allow students to demonstrate learning of the PE (Task Specifications Tool);
- The attention to required task features (Task Specifications Tool);
- Determination of student evidence to be collected (Classroom-based Assessment Task); and
- Description of the full range of student understanding from low to high levels of competency (Rubric).

Given that there are multiple aspects of the SEPs, DCIs, CCCs, and KSAs, it is the educator's role to select the aspects from the assessment tool's *palette,* which best address the intended learning target of interest from the instructional sequence. Unpacking the dimensions of the PEs and determining the assessment task specifications support an array of distinct, but related, classroom-based assessment tasks, which allow educators the opportunity to measure students learning against various parts of a three-dimensional PE.

Exhibit 11 is a diagram that illustrates the application of the Unpacking and Task Specifications Tools in the construction of an assessment task measuring 5-PS1-1: KSA4 – Develop a model to describe that matter is made of particles too small to be seen. Based on the integration of the content and components of the assessment development tools, the diagram indicates in what part of the task they are included.

Exhibit 11. Illustration of Task Features Informed by the Unpacking and Task Specifications Tools

Developing and Using Models
Use a model to describe phenomena.
Reason about the relationship of the different components of a model.
Select and identify relevant aspects of a situation or phenomena to include in the model.

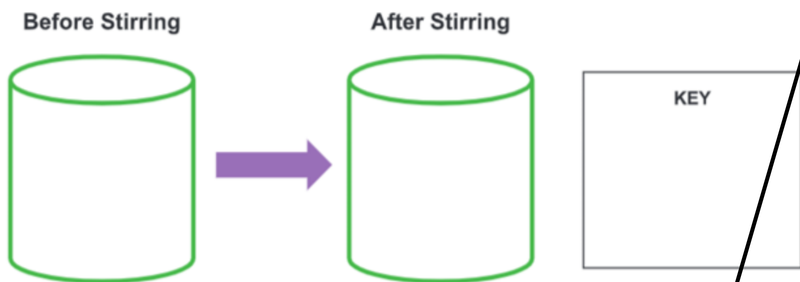
This task is about the particles of matter. Be sure to answer question 1 and question 2.

1. Jose cleaned his salt water fish tank. The water in the tank looked clear. His friend Carl visits and asks, "Why can't I see the salt in the water?" Jose creates a model to show Carl what happens to salt when stirred into water.

Complete the model below to show:

- the salt particles and water particles **before** stirring the mixture
- the salt particles and water particles **after** stirring the mixture

Be sure to complete the key to show the salt particles and water particles in both conditions of your model.



2. Describe the change to the salt particles after being stirred in the water. Be sure to use information from your model to support your explanation.

Task Features: All tasks must prompt students to describe relationships between observed phenomenon or evidence and reasoning underlying the observation/evidence. All tasks must elicit core ideas as defined in the PE. The items within a task should integrate the dimensions.

Student Demonstration of Learning:
Identify and describe relevant relationships between components of a model. Developing and using a model that describes a phenomenon that includes the idea that matter is made of particles too small to be seen.

Scale, Proportion, and Quantity
Describe relationships between natural objects, which vary in size (very small to the immensely large).

Another way to verify that the example assessment task for 5-PS1-1 specific to KSA4 is aligned to the content and components of the completed assessment tool is shown in Exhibit 12. A record of the task serves as documentation to which the educator can refer to before and after the task is administered. In addition to serving as a "check" on alignment, the educator can use a record of each task to build a "task bank" of developed classroom-based tasks. This repository of tasks can support the generation of new tasks or modification to existing tasks based on an educator's evaluation of accessibility, equity, how well the student responses provide evidence of competency of the measured KSA, and the effectiveness of the rubric criteria to interpret and evaluate student evidence of learning.

Exhibit 12. Verification of Alignment to Aspects of the Unpacking and Task Specifications Tools Integrated into the 5-PS1-1 Classroom-based NGSS Assessment Task

NGSS Performance Expectation: 5-PS1-1

Knowledge, Skills & Abilities: KSA4: Develop a model to describe that matter is made of particles too small to be seen.

Student Demonstration of Learning:

- Developing and using a model that describes a phenomenon that includes the idea that matter is made of particles too small to be seen.
- Identify and describe relevant relationships between components of a model.

Work Product:

- Complete a model
- Constructed response

Task Features:

- All tasks must prompt students to describe relationships between observed phenomenon or evidence and reasoning underlying the observation/evidence.
- All tasks must elicit core ideas as defined in the PE.
- All tasks must include elements from at least two dimensions of the NGSS.

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Developing and Using Models**	**PS1.A: Structure and Properties of Matter**	**CCC: Scale, Proportion, and Quantity**
Key Aspects	• Use a model to describe phenomena. • Reason about the relationship of the different components of a model. • Select and identify relevant aspects of a situation or phenomena to include in the model.	• Everything around us (matter) is made up of particles that are too small to be seen.	• Describe relationships between natural objects, which vary in size (very small to the immensely large).
Prior Knowledge		• Matter can change in different ways.	**Relationships to SEPs**: • Models describe the scale of natural objects.

Conclusion

Assessment is one of three central components—curriculum, instruction, and assessment—of an educational system. Ideally, assessment should measure what students are being taught and are expected to learn (Pellegrino, 2010). With respect to classroom-based science assessment tasks, they should measure a state's three-dimensional science standards. Educators and others responsible for designing and implementing curriculum, instruction, and assessment must understand how students represent knowledge and develop competence in the domain of science. Developing competence in science promotes students' ability to address future challenges and technological advancements in our world and relies upon having high-quality assessments of student learning aligned to the NGSS PEs.

The need for a principled-design approach to assessment design, such as ECD, was explicitly discussed in the NRC's report on developing assessments aligned to the NGSS (NRC, 2014). The SCILLSS principled-design approach ensures that classroom-based NGSS science assessment tasks measure the integration of DCIs and CCCs with SEPs that generate meaningful information about students' science learning. The assessment task development tools, based on this principled-design process, are essential in this regard.

Defining the nature of student understanding and developing ways to assess their learning utilizing a principled-design approach is challenging, but achievable. Investing in educators through the provision of time, resources, and collaboration and professional development opportunities can address the challenges of developing classroom-based science assessments that are coherent with curriculum and instruction, produce accurate demonstrations of student learning, and provide flexible opportunities for students to show what they know and can do. The principled-design process and assessment tools in this guide can be capitalized on for such investments in educators and for students who are expected to achieve proficiency overtime with respect to all the PEs in the NGSS.

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Appendices

Appendix A. Grade 5 SCILLSS Classroom-based NGSS Task Administration Guide and Student Responses for 5-PS1-1

5-PS1-1 Classroom Assessment Task Administration Guide

SCILLSS Classroom-based Assessment Resources

Educator Task Administration Guide

Task Title: Salt Water **Grade:** 5 **PE:** 5-PS1-1

Task Introduction

This task is about properties of matter. In this task, students will demonstrate their ability to develop a model to describe that matter is made of particles too small to be seen (5-PS1-1). This task consists of two questions. In question one, students construct a model of what happens when salt and water are mixed. In question two, students use their model to describe the changes that occur when salt particles and water are mixed.

Purpose and Use

This task is intended for use at a point in instruction when the teacher wants to determine if students understand the properties of matter and how to represent those properties in a model. The results of the tasks will be used to adjust instruction as appropriate.

Elements of the Task

This task is designed to measure students' ability to integrate the dimensions and demonstrate their knowledge, skills, and abilities (KSAs) as represented by the PE, 5-PS1-1 "Develop a model to describe that matter is made of particles too small to be seen."

Table 1 specifies the dimensions and the key aspects of the PE that are assessed by the task. In addition, expectations for students' prior knowledge are indicated. Table 2 specifies the KSAs, work products, and task features represented by the task.

Table. 1 Specific Practices, Disciplinary Core Ideas, and Crosscutting Concepts to be Assessed

NGSS Performance Expectation: 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [*Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.*]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Developing and Using Models** • Develop a model to describe phenomena. • Use a model to describe phenomena.	**PS1.A: Structure and Properties of Matter** • Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.	**CCC: Scale, Proportion, and Quantity** • Natural objects exist from the very small to the immensely large.
Key Aspects	• Identify components of the model • Use a model to reason about a phenomenon • Reason about the relationship of the different components of a model • Select and identify relevant aspects of a situation or phenomena to include in the model	• Everything around us (matter) is made up of particles that are too small to be seen • Matter that cannot be seen can be detected in other ways • Gas (air) has mass and takes up space • Gas (air) particles, which are too small to be seen, can affect larger particles and objects • Gas particles freely move around in space, until they hit a material that keeps them from moving further, thus trapping the gas (e.g., air inflating a basketball, an expanding balloon)	• Understand the units used to measure and compare quantities • Describe relationships between natural objects which vary in size (very small to the immensely large) • Understanding of scale involves not only understanding systems and processes vary in size, time span, and energy, but also different mechanisms operate at different scales

Prior Knowledge	• Knowledge that a model contains elements (observable and unobservable) that represent specific aspects of real-world phenomena • Knowledge that models are used to help explain or predict phenomena	• Matter is anything that occupies space and has mass • Matter can change in different ways	**Relationships to SEPs**	• Models describe the scale of natural objects • Data analysis serves to demonstrate the relative magnitude of some properties or processes • Calculate proportions correctly and measure accurately for valid results

Table 2. Components of the Assessment Task

Knowledge, Skills, & Abilities: • **KSA1:** Develop a model to describe that matter is made of particles too small to be seen.
Student Demonstration of Learning: • Developing and using a model that describes a phenomenon that includes the idea that matter is made of particles too small to be seen • Identify and describe relevant relationships between components of a model
Work Product: • Complete a model • Constructed response
Task Features: • The task must prompt students to describe relationships between observed phenomenon or evidence and reasoning underlying the observation/evidence. • The task must elicit core ideas as defined in the PE. • The task must include elements from at least two dimensions of the NGSS.

Task Administration

Materials and Set-up

Materials

To administer the task, educators will need:

- Task administration guide
- Student task worksheet (one copy per student)

Duration

This task can be administered in approximately one class period.

Set-up

Prior to administration, print copies of the student task worksheet.

Directions for Administration

During administration, educators should:

1. Provide each student with a pencil and the student task worksheet.
2. In the student task worksheet, read the *Background Information* section to students. Address questions from the students related to expectations for completing the task. However, ensure that the discussion does not include information that provides an unfair advantage for students to complete the task/items. Tell the students the task includes two questions. Remind students to check their work and to ensure that all parts of the task are completed.
3. Allow students to complete the task. While the task should take approximately a class period to complete, students can take additional time as needed to finish. While students are working, walk around and monitor student progress, noting any misconceptions or areas in which students are struggling. Follow up with individual students as needed.

Guidelines for Evaluating Student Performance

Following administration of the task, evaluate each student response using the provided rubric. Identify the evidence of what each student knows and can do with regard to each question. Assign each student a "score" in order to classify the student's performance and to inform how he or she may be grouped with other students for instruction. Consider whether the student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction (a "3"); has a partial understanding and needs additional instruction on some concepts before new instruction is provided (a "2"); or has not learned the material and/or has misconceptions and reteaching of the key concepts is required (a "1").

Collectively consider the evidence of student performance across all students. Do any patterns or trends emerge with regard to students' demonstrated knowledge, skills, and abilities related to this standard/performance expectation? Do you notice any common misconceptions or misunderstandings?

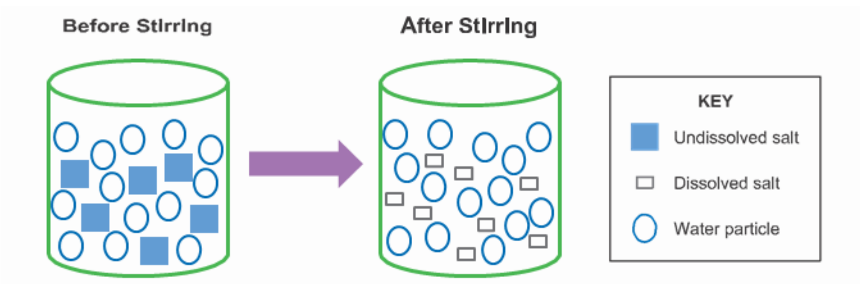
Next, consider how you might address students' needs. How will you adjust instruction based on the observed patterns and trends? Consider what aspects of the standard/performance expectation (i.e., dimensions) require additional instruction for individuals, small groups, or the class.

Rubric

Student Response	1	2	3
Question 1	Model does not show two representations each with two different bulk matter and matter too small to see (particles) or representations in the correct position and scale relative to each other. The key is incorrect.	Model shows a flawed connection between bulk matter and particles too small to be seen or a flawed connection between the representations' correct position and scale relative to each other. The key is partially correct.	Model shows two representations each with two different bulk matter and matter too small to be seen (particles) and shows representations in correct position and scale relative to each other. The key is correct.
Question 2	The description is incorrect.	The description is partially correct	The description is correct.

Student Exemplar(s)

Question 1: Construct a Model



Question 2: Constructed Response

"The model shows that the salt particles dissolve. They break into smaller pieces after they are stirred into water. The salt particles are still in the water, but you can't see them. That's because they got so small."

Question 1, Score Point 1

SCORE POINT 1

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: 5

NGSS Performance Expectation: 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.

Background Information

This task is about the particles of matter. Be sure to answer question 1 and question 2.

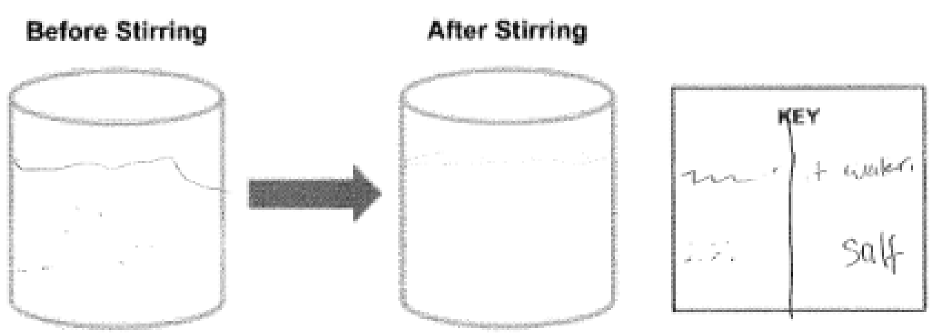
Task

1. Jose cleaned his salt water fish tank. The water in the tank looked clear. His friend Carl visits and asks, "Why can't I see the salt in the water?" Jose creates a model to show Carl what happens to salt when stirred into water.

Complete the model below to show:

- the salt particles and water particles *before* stirring the mixture
- the salt particles and water particles *after* stirring the mixture

Be sure to complete the key to show the salt particles and water particles in both conditions of your model.



Score Point 1: Student has not learned the material and/or has misconceptions and reteaching of the key concepts is required.

Model shows a flawed connection between bulk matter and particles too small to be seen; the water particles are not shown in either condition; rather, the level of the water is indicated. Model does not show the position and relative scale of the water and salt particles.

Key is incomplete as it does not include representations of the salt and water molecules for both conditions. 1

Question 1, Score Point 2

SCORE POINT 2

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: 5

NGSS Performance Expectation: 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.

Background Information

This task is about the particles of matter. Be sure to answer question 1 and question 2.

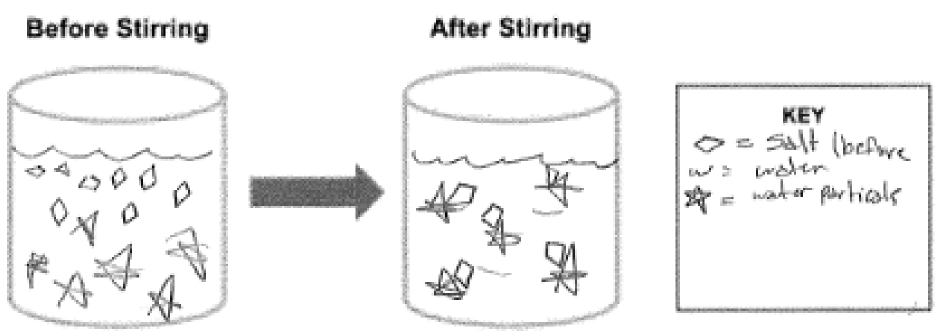
Task

1. Jose cleaned his salt water fish tank. The water in the tank looked clear. His friend Carl visits and asks, "Why can't I see the salt in the water?" Jose creates a model to show Carl what happens to salt when stirred into water.

Complete the model below to show:

- the salt particles and water particles *before* stirring the mixture
- the salt particles and water particles *after* stirring the mixture

Be sure to complete the key to show the salt particles and water particles in both conditions of your model.



Score Point 2: Student has a partial understanding and needs additional instruction on some concepts before new instruction is provided. Model shows a flawed connection between bulk matter and particles too small to be seen. Model shows a flawed connection between the representation's correct position and scale relative to each other. Key is partially correct; it shows the salt particles in one condition.

Question 2, Score Point 1

SCORE POINT 1

Student ID:

2. Describe the change to the salt particles after being stirred in the water. Be sure to use information from your model to support your explanation.

The salt particals disipeared because the salt crystals are clear so the water mathes the salt particals.

Score Point 1: Student has not learned the material and/or has misconceptions and reteaching of the key concepts is required.

Description is incorrect; the response includes a misconception that the salt has disappeared and also states that the salt particles become clear and cannot be seen.

Question 2, Score Point 2

SCORE POINT 2

Student ID:

2. Describe the change to the salt particles after being stirred in the water. Be sure to use information from your model to support your explanation.

well when you stir well the salt Particels disolve so you cant see them but there still in the water it just disoved

Score Point 2: Student has a partial understanding and needs additional instruction on some concepts before new instruction is provided.

Description is partially correct; the response correctly states that the salt particles have dissolved in the condition when they are stirred and that they cannot be seen; however, the response does not state why they cannot be seen, which is because the salt particles have broken into smaller pieces and get so small that they cannot be seen.

Appendix B. Grade 5 SCILLSS Classroom-based NGSS Assessment Tools, Tasks, Administration Guide, and Anchor Papers for 5-PS1-3

Unpacking Tool for 5-PS1-3

Grade: 5

NGSS Performance Expectation: 5-PS1-3 Make observations and measurements to identify materials based on their properties. [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [*Assessment Boundary: Assessment does not include density or distinguishing mass and weight.*]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)	
Foundations	**SEP: Planning and Carrying Out Investigations** Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	**PS1.A: Structure and Properties of Matter** Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.)	**CCC: Scale, Proportion, and Quantity** Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.	
Key Aspects	• Make observations to collect data. • Make measurements to collect data. • Use data from an investigation as evidence for an explanation of a phenomenon or support an explanation. • Identify the purpose of the investigation.	• Properties can be used to identify materials. • Properties can be measured. • Materials can be identified based on their observable and measurable properties. • Properties of materials may include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility.	• Measure and describe physical quantities such as weight, time, temperature, and volume. • Collect and record data according to the given investigation plan.	
Prior Knowledge	• Knowledge of units and unit conversions among different-sized standard measurement units within a given measurement system • Knowledge of bar graphs and histograms • Knowledge of line graphs (Note: CCSS Mathematics: "Students solve problems involving information presented in line plots" beginning in grade 5) • Knowledge of how and when to use estimations	• Matter is anything that occupies space and has mass. • Everything around us has unique properties that can be used to identify them, such as what color they are, how hard they are, if they reflect light, whether they conduct electricity or heat, whether they are magnetic, and whether they dissolve in water.	**Relationships to SEPs**	• Models describe the scale of natural objects. • Data analysis serves to interpret quantitative measures of properties, in standard units (e.g., grams, liters). • Planning and carrying out investigations support students in identifying phenomena to be investigated, and how to observe, measure, and record outcomes.

Task Specifications Tool for 5-PS1-3

Element	Description
Performance Expectation	**5-PS1-3** Make observations and measurements to identify materials based on their properties.
Knowledge, Skills & Abilities (KSAs)	**KSA1:** Use observations and measurements as evidence to explain the identification of a material. **KSA2:** Use observations of the properties of matter to identify a substance. **KSA3:** Use standard measurements and tools to determine a property of a substance. **KSA4**: Make observations and measurements to identify materials based on their properties.
Student Demonstration of Learning	• Make correct calculations • Use appropriate units • Correct use of quantitative and qualitative data to identify materials based on their properties • Complete and appropriate explanation, using evidence, that materials can be identified based on their observable and measurable properties • Description of why some properties (e.g., shape) are or are not a characteristic property • Use observations to support conclusion, rather than inference
Work Product	• Interpretation of data • Constructed response • Selected-response
Task Features	• All tasks require evidence of qualitative and quantitative thinking. • All tasks must prompt students to make connections between observed phenomenon or evidence and reasoning underlying the observation/evidence. • Students use scientific reasoning and process skills in observational (nonexperimental) investigations. • All tasks must elicit core ideas as defined in the PE. • All tasks must include elements from at least two dimensions of the NGSS.
Aspects of an assessment task that <u>can be varied</u> to shift complexity or focus	• Properties presented (e.g., color, conductivity, magnetic, conductors) • Format of "real-world" phenomenon under investigation: image, data, text, combination • Standard units used (e.g., grams, liters) • Use or purpose of the model • Type of model (e.g., physical/virtual) • What states of matter are represented and/or included (and how many) and if they are compared
Assessment Boundaries	• Density should not be included as a property. • Mass and weight are not distinguished. • Task may include physical or chemical reactions.

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: 5

NGSS Performance Expectation: 5-PS1-3. Make observations and measurements to identify materials based on their properties.

Background Information

This task is about the identification of a powder based on its properties. Be sure to answer question 1 and question 2.

Task

1. A white powder was found on the kitchen floor of a crime scene. A white powder was also found on the shoes of a suspect. To solve the mystery, a detective tests different white powders often found in a kitchen.

The detective tests how the white powders react when water, heat, and vinegar are added. The test results are shown below in the data table.

Results of Testing White Powders

White Powder	Weight	Water	Heat	Vinegar
Sugar	15g	Dissolves	Melts, bubbles, and smokes	No change
Baking Soda	20g	Turns a milky color	No change	Bubbles
Salt	20g	Dissolves	No change	No change
Plaster of Paris	30g	Turns to a hard solid	No change	Bubbles
Cornstarch	50g	Turns to a soft solid	Turns brown	Thickens

How could you identify if the powder found on the kitchen floor and the suspect's shoes are the same? Support your explanation by using examples from the data table and what you know about characteristic properties of matter.

2. The characteristics of the white mystery powder found at the scene of the crime match those found on the suspect's shoes. Below are the results of the tests on the powder.

Results of Testing White Mystery Powder

White Powder	Weight	Water	Heat	Vinegar
Mystery Powder	50g	Turns to a hard solid	No change	Bubbles

What is the mystery powder? Be sure to support your answer with the information provided in both data tables.

SCILLSS Classroom-based Assessment Resources

Educator Task Administration Guide

Task Title: The Case of the Mystery Powder **Grade:** 5 **PE:** 5-PS1-3

Task Introduction

This task is about properties of matter. In this task, students will demonstrate their ability to make observations and measurements to identify materials based on their properties (5-PS1-3). This task consists of two questions. In question one, students are asked to explain how you could use the provided information to identify the mystery powder. In question two, students are asked to use their understanding of the properties of matter to identify the mystery white powder.

Purpose and Use

This task is intended for use at a point in instruction when the teacher wants to determine if students understand the properties of matter and can use observations and measurements as evidence to identify a material. The results of the tasks will be used to adjust instruction as appropriate.

Elements of the Task

This task is designed to measure students' ability to integrate the dimensions and demonstrate their knowledge, skills, and abilities (KSAs) as represented by the PE, 5-PS1-3 "Make observations and measurements to identify materials based on their properties."

Table 1 specifies the dimensions and the key aspects of the PE that are assessed by the task. In addition, expectations for students' prior knowledge are indicated. Table 2 specifies the KSAs, work products, and task features represented by the task.

Table 1. Specific Practices, Disciplinary Core Ideas, and Crosscutting Concepts to be Assessed

NGSS Performance Expectation: 5-PS1-3. Make observations and measurements to identify materials based on their properties. [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [*Assessment Boundary: Assessment does not include density or distinguishing mass and weight.*]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Planning and Carrying Out Investigations** • Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	**PS1.A: Structure and Properties of Matter** • Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.)	**CCC: Scale, Proportion, and Quantity** • Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.
Key Aspects	• Make observations to collect data • Make measurements to collect data • Use data from an investigation as evidence for an explanation of a phenomenon or support an explanation • Identify the purpose of the investigation	• Properties can be used to identify materials • Properties can be measured • Materials can be identified based on their observable and measurable properties • Properties of materials may include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility	• Measure and describe physical quantities such as weight, time, temperature, and volume • Collect and record data according to the given investigation plan
Prior Knowledge	• Knowledge of units and unit conversions among different-sized standard measurement units within a given measurement system • Knowledge of bar graphs and histograms • Knowledge of line graphs (Note: CCSS	• Matter is anything that occupies space and has mass • Everything around us has unique properties that can be used to identify them, such as what color they are, how hard they are, if they reflect light, whether they conduct electricity or heat,	**Relationships to SEPs** • Models describe the scale of natural objects • Data analysis serves to interpret quantitative measures of properties, in standard units

	Mathematics: “Students solve problems involving information presented in line plots” beginning in grade 5) • Knowledge of how and when to use estimations	whether they are magnetic, and whether they dissolve in water		(e.g., grams, liters) • Planning and carrying out investigations support students in identifying phenomena to be investigated, and how to observe, measure, and record outcomes

Table 2. Components of the Assessment Task

Knowledge, Skills, & Abilities:

- **KSA1:** Use observations and measurements as evidence to explain the identification of a material.
- **KSA2:** Use observations of the properties of matter to identify a substance.
- **KSA3:** Use standard measurements and tools to determine a property of a substance.
- **KSA4:** Make observations and measurements to identify materials based on their properties.

Student Demonstration of Learning:

- Make correct calculations
- Use appropriate units
- Correct use of quantitative and qualitative data to identify materials based on their properties
- Complete and appropriate explanation, using evidence, that materials can be identified based on their observable and measurable properties
- Description of why some properties (e.g., shape) are or are not a characteristic property
- Use observations to support conclusion, rather than inference

Work Product:

- Interpretation of data
- Constructed response
- Selected response

Task Features:

- All tasks require evidence of qualitative and quantitative thinking.
- All tasks must prompt students to make connections between observed phenomenon or evidence and reasoning underlying the observation/evidence.
- Students use scientific reasoning and process skills in observational (nonexperimental) investigations.
- All tasks must elicit core ideas as defined in the PE.
- All tasks must include elements from at least two dimensions of the NGSS.

Task Administration

Materials and Set-up

Materials

To administer the task, educators will need:

- Task administration guide
- Student task worksheet (one copy per student)

Duration

This task can be administered in approximately one class period.

Set-up

Prior to administration, print copies of the student task worksheet.

Directions for Administration

During administration, educators should:

1. Provide each student with a pencil and the student task worksheet.
2. In the student task worksheet, read the *Background Information* section to students. Address questions from the students related to expectations for completing the task. However, ensure that the discussion does not include information that provides an unfair advantage for students to complete the task/items. Tell the students the task includes two questions. Remind students to check their work and to ensure that all parts of the task are completed.
3. Allow students to complete the task. While the task should take approximately a class period to complete, students can take additional time as needed to finish. While students are working, walk around and monitor student progress, noting any misconceptions or areas in which students are struggling. Follow up with individual students as needed.

Guidelines for Evaluating Student Performance

Following administration of the task, evaluate each student response using the provided rubric. Identify the evidence of what each student knows and can do with regard to each question. Assign each student a "score" in order to classify the student's performance and to inform how he or she may be grouped with other students for instruction. Consider whether the student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction (a "3"); has a partial understanding and needs additional instruction on some concepts before new instruction is provided (a "2"); or has not learned the material and/or has misconceptions and reteaching of the key concepts is required (a "1").

Collectively consider the evidence of student performance across all students. Do any patterns or trends emerge with regard to students' demonstrated knowledge, skills, and abilities related to this standard/performance expectation? Do you notice any common misconceptions or misunderstandings?

Next, consider how you might address students' needs. How will you adjust instruction based on the observed patterns and trends? Consider what aspects of the standard/performance expectation (i.e., dimensions) require additional instruction for individuals, small groups, or the class.

Rubric

Dimension Element	1 Students can …	2 Students can …	3 Students can …
Make observations and measurements to produce data to serve as the basis for evidence for an explanation.	Interpret observations from a data table(s) to determine a partial explanation but does not link explanation to the scenario.	Interpret observations from a data table(s) to determine an explanation and links it to the scenario.	Interpret observations from a data table(s), justifying using or not using particular elements of the data to support an explanation linked to the scenario with examples.
Measure and describe physical quantities.	Describe physical properties, but not in the context of the scenario with limited to no use of standard units when describing data.	Describe physical properties in the context of the scenario with inconsistent use of standard units when describing data.	Describe physical properties in the context of the scenario, noting gaps or limitations in the data, with accurate use of standard units when describing data.
A variety of properties can be used to identify materials.	Explain the differences in properties of materials, but not the most relevant or most important aspect of it as it pertains to the scenario.	Explain the differences in properties of materials relevant to the scenario.	Explain the differences in properties of materials being focused on and building from the relationships between those elements of the scenario.

Student Exemplar(s)

Question 1: Constructed Response

"All the powders are white. So, color won't tell what the powder is made of. Each of the powders reacts in a different way when water, heat, or vinegar are tested. If the powder found on the kitchen floor does the same thing as the powder found on the suspect's shoes with water, heat, and vinegar, then it is the same powder."

Question 2: Constructed Response

"The powder found in the crime scene and the powder on the suspect's shoes are both plaster of Paris. The color and the weight of the samples don't tell which powder matches. But, the white mystery powder found at the crime scene has all the same characteristics when heat, water, and vinegar are added like plaster of Paris."

5-PS1-3 Classroom Assessment Task Anchor Student Responses

Dimension Element 1: Make observations and measurements to produce data to serve as the basis for evidence for an explanation, Score Point 1

SCORE POINT 1

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: 5

NGSS Performance Expectation: 5-PS1-3. Make observations and measurements to identify materials based on their properties.

Background Information

This task is about the identification of a powder based on its properties. Be sure to answer question 1 and question 2.

Task

1. A white powder was found on the kitchen floor of a crime scene. A white powder was also found on the shoes of a suspect. To solve the mystery, a detective tests different white powders often found in a kitchen.

The detective tests how the white powders react when water, heat, and vinegar are added. The test results are shown below in the data table.

Results of Testing White Powders

White Powder	Weight	Water	Heat	Vinegar
Sugar	15g	Dissolves	Melts, bubbles, and smokes	No change
Baking Soda	20g	Turns a milky color	No change	Bubbles
Salt	20g	Dissolves	No change	No change
Plaster of Paris	30g	Turns to a hard solid	No change	Bubbles
Cornstarch	50g	Turns to a soft solid	Turns brown	Thickens

How could you identify if the powder found on the kitchen floor and the suspect's shoes are the same? Support your explanation by using examples from the data table and what you know about characteristic properties of matter. you could try diffrent types of tests to figure out if they are the samme

2. The characteristics of the white mystery powder found at the scene of the crime match those found on the suspect's shoes. Below are the results of the tests on the powder.

Results of Testing White Mystery Powder

White Powder	Weight	Water	Heat	Vinegar
Mystery Powder	50g	Turns to a hard solid	No change	Bubbles

What is the mystery powder? Be sure to support your answer with the information provided in both data tables.

the white mystery powder is plaster of paris because they did all the same tests and the same thing happened to both of them.

Dimension Element: Make observations and measurements to produce data to serve as the basis for evidence for an explanation.

Score Point 1: Student has not learned the material and/or has misconceptions and reteaching of the key concepts is required.

Question 1: Interpreting Data from Observations

The student response indicates that different types of testing could be completed to identify the mystery powder.

The student explanation does not use examples from the data table or previous knowledge of the characteristic properties of matter.

Question 2: Evidence to Support an Explanation

The student response correctly indicates that the mystery powder is Plaster of Paris.

The explanation is not supported by interpretation of the data from either tables (what is useful and what is not).

Dimension Element 1: Make observations and measurements to produce data to serve as the basis for evidence for an explanation, Score Point 2

SCORE POINT 2

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: 5

NGSS Performance Expectation: 5-PS1-3. Make observations and measurements to identify materials based on their properties.

Background Information

This task is about the identification of a powder based on its properties. Be sure to answer question 1 and question 2.

Task

1. A white powder was found on the kitchen floor of a crime scene. A white powder was also found on the shoes of a suspect. To solve the mystery, a detective tests different white powders often found in a kitchen.

The detective tests how the white powders react when water, heat, and vinegar are added. The test results are shown below in the data table.

Results of Testing White Powders

White Powder	Weight	Water	Heat	Vinegar
Sugar	15g	Dissolves	Melts, bubbles, and smokes	No change
Baking Soda	20g	Turns a milky color	No change	Bubbles
Salt	20g	Dissolves	No change	No change
Plaster of Paris	30g	Turns to a hard solid	No change	Bubbles
Cornstarch	50g	Turns to a soft solid	Turns brown	Thickens

How could you identify if the powder found on the kitchen floor and the suspect's shoes are the same? Support your explanation by using examples from the data table and what you know about characteristic properties of matter.

Put water onit use heat, and pour vinegar on it

2. The characteristics of the white mystery powder found at the scene of the crime match those found on the suspect's shoes. Below are the results of the tests on the powder.

Results of Testing White Mystery Powder

White Powder	Weight	Water	Heat	Vinegar
Mystery Powder	50g	Turns to a hard solid	No change	Bubbles

What is the mystery powder? Be sure to support your answer with the information provided in both data tables.

Plaster or Paris because on the tests it ses that it turns too hard solid with water there were No changes on the heat and it Bubbles with vinigar.

Dimension Element: Make observations and measurements to produce data to serve as the basis for evidence for an explanation.

Score Point 2: Student has a partial understanding and needs additional instruction on some concepts before new instruction is provided.

Question 1: Interpreting Data from Observations

The student response refers to the types of test that are completed based on data from the table.

The way in which the data would be used to identify the powder is not specified nor are the results referenced.

Question 2: Evidence to Support an Explanation

The response correctly indicates that the mystery power is Plaster of Paris and refers to the completed tests.

The response does not explicitly compare the data and results from the scenario (i.e., known characteristics of the powders) to the results of testing the mystery powder to support an explanation.

Dimension Element 1: Make observations and measurements to produce data to serve as the basis for evidence for an explanation, Score Point 3

SCORE POINT 3

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: 5

NGSS Performance Expectation: 5-PS1-3. Make observations and measurements to identify materials based on their properties.

Background Information

This task is about the identification of a powder based on its properties. Be sure to answer question 1 and question 2.

Task

1. A white powder was found on the kitchen floor of a crime scene. A white powder was also found on the shoes of a suspect. To solve the mystery, a detective tests different white powders often found in a kitchen.

The detective tests how the white powders react when water, heat, and vinegar are added. The test results are shown below in the data table.

Results of Testing White Powders

White Powder	Weight	Water	Heat	Vinegar
Sugar	15g	Dissolves	Melts, bubbles, and smokes	No change
Baking Soda	20g	Turns a milky color	No change	Bubbles
Salt	20g	Dissolves	No change	No change
Plaster of Paris	30g	Turns to a hard solid	No change	Bubbles
Cornstarch	50g	Turns to a soft solid	Turns brown	Thickens

How could you identify if the powder found on the kitchen floor and the suspect's shoes are the same? Support your explanation by using examples from the data table and what you know about characteristic properties of matter.

you could sweep up as much of the powder as you can and cunduct experiments and do one experiment

Student ID:

at a time and see how it reacts. Then list the possible powder it might be and look up what it is from your discoveries

2. The characteristics of the white mystery powder found at the scene of the crime match those found on the suspect's shoes. Below are the results of the tests on the powder.

Results of Testing White Mystery Powder

White Powder	Weight	Water	Heat	Vinegar
Mystery Powder	50g	Turns to a hard solid	No change	Bubbles

What is the mystery powder? Be sure to support your answer with the information provided in both data tables.

I think the powder is plaster of paris because when you ad water it turns to a hard solid and plaster of paris was the olny powder that turned to a solid. And heat had no effect and there were two more powders that stayed the same. and vinigor caused it to bubble. I put all the facts togather and thought it was plaster of paris.

Dimension Element: Make observations and measurements to produce data to serve as the basis for evidence for an explanation.

Score Point 3: Student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction.

Question 1: Interpreting Data from Observations

The student response indicates that different experiments can be conducted and based on the results from different tests, and the data could be interpreted to understand and compare the characteristic properties of the powders from the first data table ("...look up what it is...").

Question 2: Evidence to Support an Explanation

The response correctly indicates that the mystery power is Plaster of Paris.

The response refers to the completed tests and compares data from both data tables as the basis for evidence for drawing a conclusion and supporting an explanation.

Dimension Element 2: Measure and describe physical quantities, Score Point 1

SCORE POINT 1

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: 5

NGSS Performance Expectation: 5-PS1-3. Make observations and measurements to identify materials based on their properties.

Background Information

This task is about the identification of a powder based on its properties. Be sure to answer question 1 and question 2.

Task

1. A white powder was found on the kitchen floor of a crime scene. A white powder was also found on the shoes of a suspect. To solve the mystery, a detective tests different white powders often found in a kitchen.

The detective tests how the white powders react when water, heat, and vinegar are added. The test results are shown below in the data table.

Results of Testing White Powders

White Powder	Weight	Water	Heat	Vinegar
Sugar	15g	Dissolves	Melts, bubbles, and smokes	No change
Baking Soda	20g	Turns a milky color	No change	Bubbles
Salt	20g	Dissolves	No change	No change
Plaster of Paris	30g	Turns to a hard solid	No change	Bubbles
Cornstarch	50g	Turns to a soft solid	Turns brown	Thickens

How could you identify if the powder found on the kitchen floor and the suspect's shoes are the same? Support your explanation by using examples from the data table and what you know about characteristic properties of matter.

test the powder by weight, water, heat and vinegar to see what happens.

2. The characteristics of the white mystery powder found at the scene of the crime match those found on the suspect's shoes. Below are the results of the tests on the powder.

Results of Testing White Mystery Powder

White Powder	Weight	Water	Heat	Vinegar
Mystery Powder	50g	Turns to a hard solid	No change	Bubbles

What is the mystery powder? Be sure to support your answer with the information provided in both data tables.

Plaster of Paris weight is the only difference

Dimension Element: Measure and describe physical quantities.

Score Point 1: Student has not learned the material and/or has misconceptions and reteaching of the key concepts is required

Question 1: Describe Physical Quantities

Student restates the table headings in the first row without relating the relationships among different types of powders and the purpose of each test condition.

Question 2: Use of Standard Units to Describe Data

Student makes a reference to the relative weight (quantity) of the Plaster of Paris in the scenario and the mystery powder test. However, there is no mention of any of the other test results, which is important for making sense of data.

Dimension Element 2: Measure and describe physical quantities, Score Point 2

SCORE POINT 2

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: 5

NGSS Performance Expectation: 5-PS1-3. Make observations and measurements to identify materials based on their properties.

Background Information

This task is about the identification of a powder based on its properties. Be sure to answer question 1 and question 2.

Task

1. A white powder was found on the kitchen floor of a crime scene. A white powder was also found on the shoes of a suspect. To solve the mystery, a detective tests different white powders often found in a kitchen.

The detective tests how the white powders react when water, heat, and vinegar are added. The test results are shown below in the data table.

Results of Testing White Powders

White Powder	Weight	Water	Heat	Vinegar
Sugar	15g	Dissolves	Melts, bubbles, and smokes	No change
Baking Soda	20g	Turns a milky color	No change	Bubbles
Salt	20g	Dissolves	No change	No change
Plaster of Paris	30g	Turns to a hard solid	No change	Bubbles
Cornstarch	50g	Turns to a soft solid	Turns brown	Thickens

How could you identify if the powder found on the kitchen floor and the suspect's shoes are the same? Support your explanation by using examples from the data table and what you know about characteristic properties of matter.

first, you could scoup a bit of the powder off of the shoes and add water. then, See What happens. Lets Say It turns a

Student ID: [redacted]

milky color. you [redacted]now know its baking soda. then test the rest with water and find out the match

2. The characteristics of the white mystery powder found at the scene of the crime match those found on the suspect's shoes. Below are the results of the tests on the powder.

Results of Testing White Mystery Powder

White Powder	Weight	Water	Heat	Vinegar
Mystery Powder	50g	Turns to a hard solid	No change	Bubbles

What is the mystery powder? Be sure to support your answer with the information provided in both data tables.

Plaster of Paris. because it weighs 50g, if you have more of it, water turns It to a hard Solid, heat dose noting, vinegar makes it bubble.

Dimension Element: Measure and describe physical quantities.

Score Point 2: Student has a partial understanding and needs additional instruction on some concepts before new instruction is provided.

Question 1: Describe Physical Quantities

The student response describes the process for identifying the powder found on the shoes. The response only describes the water test with no mention of the other tests utilizing heat and vinegar. Because two of the powders dissolve in water (i.e., sugar and salt), the water test alone is not sufficient.

Question 2: Use of Standard Units to Describe Data

The student response accurately refers to the weight measured in grams. The results shown in the table are restated without the interpretation necessary to reach a conclusion.

Dimension Element 2: Measure and describe physical quantities, Score Point 3

For SCILLSS #2, Dimension 2, Score Point 3, an exemplar paper was not identified given the limited pool from which selections could be made.

Dimension Element 3: A variety of properties can be used to identify materials, Score Point 1

SCORE POINT 1

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: 5

NGSS Performance Expectation: 5-PS1-3. Make observations and measurements to identify materials based on their properties.

Background Information

This task is about the identification of a powder based on its properties. Be sure to answer question 1 and question 2.

Task

1. A white powder was found on the kitchen floor of a crime scene. A white powder was also found on the shoes of a suspect. To solve the mystery, a detective tests different white powders often found in a kitchen.

The detective tests how the white powders react when water, heat, and vinegar are added. The test results are shown below in the data table.

Results of Testing White Powders

White Powder	Weight	Water	Heat	Vinegar
Sugar	15g	Dissolves	Melts, bubbles, and smokes	No change
Baking Soda	20g	Turns a milky color	No change	Bubbles
Salt	20g	Dissolves	No change	No change
Plaster of Paris	30g	Turns to a hard solid	No change	Bubbles
Cornstarch	50g	Turns to a soft solid	Turns brown	Thickens

How could you identify if the powder found on the kitchen floor and the suspect's shoes are the same? Support your explanation by using examples from the data table and what you know about characteristic properties of matter.

test the powder by weight, water, heat and

vinegar to see what happens.

2. The characteristics of the white mystery powder found at the scene of the crime match those found on the suspect's shoes. Below are the results of the tests on the powder.

Results of Testing White Mystery Powder

White Powder	Weight	Water	Heat	Vinegar
Mystery Powder	50g	Turns to a hard solid	No change	Bubbles

What is the mystery powder? Be sure to support your answer with the information provided in both data tables.

Plaster of Paris weight is the only difference

Dimension Element: A variety of properties can be used to identify materials.

Score Point 1: Student has not learned the material and/or has misconceptions and reteaching of the key concepts is required.

Using Properties of Materials to Support an Explanation:

Student response demonstrates an understanding that the powders should be tested in different conditions; however, it does not include information related to the results of the tests to support the identification of the mystery powder ("test the powder by weight, water, heat... see what happens"). It does not identify that what happens is different.

Student response includes the correct identification of the mystery powder, but does not support the identification of the powder using any of the test results from either data table.

Dimension Element 3: A variety of properties can be used to identify materials, Score Point 2

SCORE POINT 2

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: 5

NGSS Performance Expectation: 5-PS1-3. Make observations and measurements to identify materials based on their properties.

Background Information

This task is about the identification of a powder based on its properties. Be sure to answer question 1 and question 2.

Task

1. A white powder was found on the kitchen floor of a crime scene. A white powder was also found on the shoes of a suspect. To solve the mystery, a detective tests different white powders often found in a kitchen.

The detective tests how the white powders react when water, heat, and vinegar are added. The test results are shown below in the data table.

Results of Testing White Powders

White Powder	Weight	Water	Heat	Vinegar
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Baking Soda	20g	Turns a milky color	No change	Bubbles
Salt	20g	Dissolves	No change	No change
Plaster of Paris	30g	Turns to a hard solid	No change	Bubbles
Cornstarch	50g	Turns to a soft solid	Turns brown	Thickens

How could you identify if the powder found on the kitchen floor and the suspect's shoes are the same? Support your explanation by using examples from the data table and what you know about characteristic properties of matter.

I'd say heat it because then you could tell unless there is no change if there is no change, pour water on it because now you already know it's NOT sugar or cornstarch and

Student ID:

They all(but sugar & salt but sugars already ~~ll~~ eliminated) react ~~diver~~ differently.

2. The characteristics of the white mystery powder found at the scene of the crime match those found on the suspect's shoes. Below are the results of the tests on the powder.

Results of Testing White Mystery Powder

White Powder	Weight	Water	Heat	Vinegar
Mystery Powder	50g	Turns to a hard solid	No change	Bubbles

What is the mystery powder? Be sure to support your answer with the information provided in both data tables.

It could be plaster of Paris, but the weigts not the same, but everything elseis. it could be a mix of plaster ~~of~~ Paris and something, but nothing weighs 10grams.

Dimension Element: A variety of properties can be used to identify materials.

Score Point 2: Student has a partial understanding and needs additional instruction on some concepts before new instruction is provided.

Using Properties of Materials to Support an Explanation:

Student response shows an understanding that different materials, based on their properties, react differently to the addition of water, heat, and vinegar. Student response includes the correct identification of the mystery powder based on using the same tests for all of the powders and using the test results to identify for which two powders the test results were the same (i.e., "It could be Plaster of Paris but the weight's not the same").

The student response shows a misconception that weight can be a material's characteristic property (i.e., "it could be Plaster of Paris but the weight's not the same").

Dimension Element 3: A variety of properties can be used to identify materials, Score Point 3

SCORE POINT 3

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: 5

NGSS Performance Expectation: 5-PS1-3. Make observations and measurements to identify materials based on their properties.

Background Information

This task is about the identification of a powder based on its properties. Be sure to answer question 1 and question 2.

Task

1. A white powder was found on the kitchen floor of a crime scene. A white powder was also found on the shoes of a suspect. To solve the mystery, a detective tests different white powders often found in a kitchen.

The detective tests how the white powders react when water, heat, and vinegar are added. The test results are shown below in the data table.

Results of Testing White Powders

White Powder	Weight	Water	Heat	Vinegar
Sugar	15g	Dissolves	Melts, bubbles, and smokes	No change
Baking Soda	20g	Turns a milky color	No change	Bubbles
Salt	20g	Dissolves	No change	No change
Plaster of Paris	30g	Turns to a hard solid	No change	Bubbles
Cornstarch	50g	Turns to a soft solid	Turns brown	Thickens

How could you identify if the powder found on the kitchen floor and the suspect's shoes are the same? Support your explanation by using examples from the data table and what you know about characteristic properties of matter.

you could sweep up as much of the powder as you can and cunduct experiments and do one experiment

Student ID:

at a time and see how it reacts. Then list the possible powder it might be and look up what it is from your discoveries

2. The characteristics of the white mystery powder found at the scene of the crime match those found on the suspect's shoes. Below are the results of the tests on the powder.

Results of Testing White Mystery Powder

White Powder	Weight	Water	Heat	Vinegar
Mystery Powder	50g	Turns to a hard solid	No change	Bubbles

What is the mystery powder? Be sure to support your answer with the information provided in both data tables.

I think the powder is plaster of paris because when you ad water it turns to a hard solid and plaster of paris was the olny powder that turned to a solid. And heat had no effect and there were two more powders that stayed the same. and vinigar caused it to bubble. I put all the facts togather and thought it was plaster of paris.

Dimension Element: A variety of properties can be used to identify materials.

Score Point 3: Student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction.

Using Properties of Materials to Support an Explanation:

Student response demonstrates an understanding that multiple "experiments" or tests need to be completed one at a time to observe the reaction (i.e., "...see how it reacts") in order to use the property of the materials to identify an unknown substance (i.e., mystery powder). Student response includes the correct identification of the mystery powder based on the properties of the different materials using data from both tables and a process of elimination to reach a conclusion.

Appendix C. Grade 8 SCILLSS Classroom-based NGSS Science Assessment Tools, Tasks, Administration Guide, and Anchor Papers for MS-PS4-1

Unpacking Tool for MS-PS4-1

Grade: 8

NGSS Performance Expectation: MS-PS4-1 Use mathematical representations to describe and/or support scientific conclusions and design solutions. A simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] [*Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.*]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Using Mathematics and Computational Thinking** Use mathematical representations to describe and/or support scientific conclusions and design solutions.	**PS4.A: Wave Properties** A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.	**CCC: Patterns** Graphs and charts can be used to identify patterns in data.
Key Aspects	• Use mathematical representations to describe scientific conclusions. • Use mathematical representations to support scientific conclusions. • Use mathematical representations to describe design solutions. • Use mathematical representations to support design solutions.	• A simple wave has a repeating pattern. • A simple wave has a specific wavelength. • A simple wave has a specific frequency. • A simple wave has a specific amplitude. • The wavelength and frequency of a wave are related to one another by the speed of travel of the wave. • The higher the frequency of the wave the shorter the wavelength. • The lower the frequency of the wave the longer the wavelength. • The higher the frequency of the wave the higher the amplitude. • The lower the frequency of the wave the lower the amplitude.	• Use graphs to represent and identify patterns. • Use charts to represent and identify patterns. • Identify the presence of patterns in phenomena or data. • Characterize the strength, direction, or nature of patterns in phenomena or data.
Prior Knowledge	• Knowledge of units and unit conversions • Knowledge of ratio relationships • Ability to interpret qualitative data • Ability to represent proportional relationships • Knowledge of linear relationships	• Waves can cause objects to move. • Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).	**Relationships to SEPs** • Explanations address how and why particular patterns occur. • Models describe observed patterns or predict patterns. • Data analysis serves to identify and characterize patterns.

Task Specifications Tool for MS-PS4-1

Element	Description
Performance Expectation	**MS-PS4-1** Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
Knowledge, Skills & Abilities (KSAs)	**KSA1**: Create a representation that describes a simple wave has a repeating pattern. **KSA2**: Use models and mathematical thinking to demonstrate understanding of wave properties. **KSA3**: Identify patterns as an organizing concept for understanding wave properties. **KSA4**: Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
Student Demonstration of Learning	• Model accurately represents the observable phenomena • Model accurately captures all mechanistic features of the observable phenomena • Model accurately shows relationships among wave properties • Applies correctly a simple mathematical wave model to a physical system or phenomenon to identify how the wave model characteristics correspond with physical observations • Predicts correctly the change in the energy of the wave if any one of the parameters of the wave is changed • Identifies relevant or meaningful patterns that address a scientific question • Identifies and describes relevant relationships between components of the model • Shows patterns in waves that accurately interpret the relationship between frequency and wavelength
Work Product	• Draw a model • Complete a model • Mathematical representations • Constructed response
Task Features	• All tasks require evidence of qualitative or quantitative thinking. • All tasks must prompt students to make connections between observed phenomenon or evidence and reasoning underlying the observation/evidence (e.g., related to standard repeating waves). • All tasks must elicit core ideas as defined in the PE. • All tasks must include elements from at least two dimensions of the NGSS.
Aspects of an assessment task that <u>can be varied</u> to shift complexity or focus	• Complexity of scientific concept(s) to be represented • Function of the representation: o to explain a mechanism underlying a phenomenon; o to predict future outcomes; o to describe a phenomenon; o to generate data to inform how the world works • The representation may be provided for revision or one that is created from scratch • What type of wave is being modeled • Use or purpose of the representation • Type of representation (e.g., mathematical/picture) • Core idea targeted (e.g., sound sources, the medium, deformation, and vibration of an instrument’s string)
Assessment Boundaries	• Assessment does not include electromagnetic waves and is limited to standard repeating waves. • Assessment should be limited to qualitative applications pertaining to light and mechanical waves.

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: Middle School

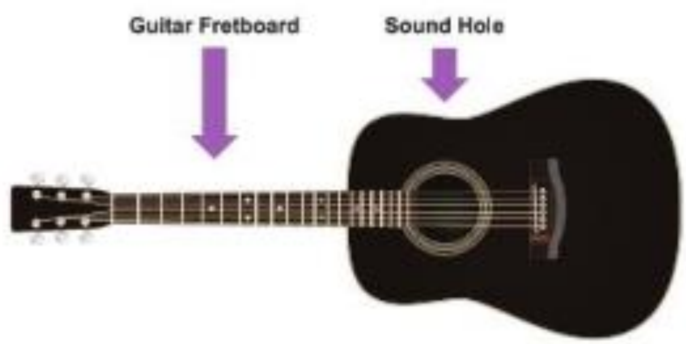
NGSS Performance Expectation: MS-PS4-1. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

Background Information

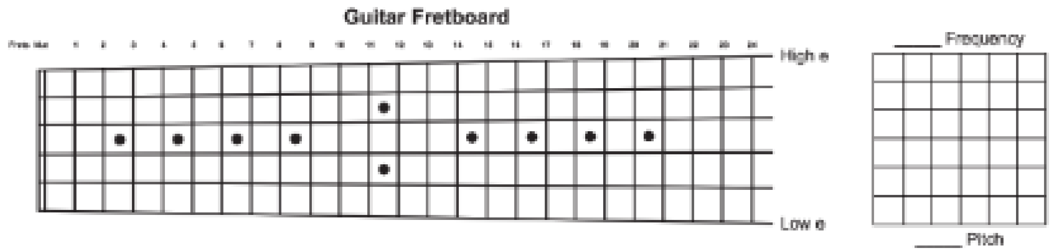
This task is about sound waves.

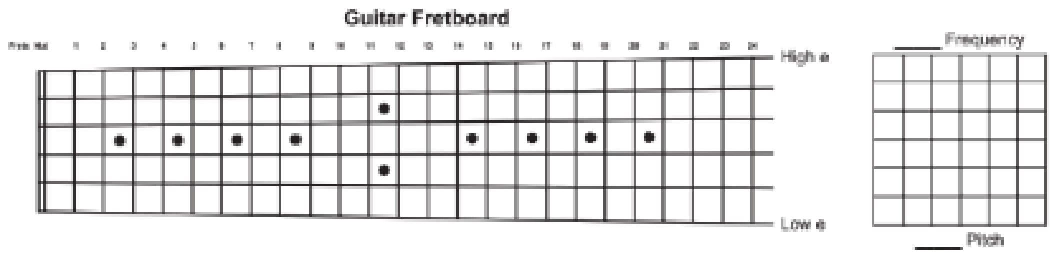
Task

1. Jenna is learning how to play a guitar. Her guitar is shown below.



Jenna experiments by pressing down her finger on a single string at different locations on the guitar fretboard. When Jenna places her finger on a string near the sound hole, this shortens the length of string that vibrates, called the plucked string. When she places her finger on a string far away from the sound hole, the plucked string has a longer length. Jenna hears different notes. Two models of Jenna's guitar fretboard are shown below.





Use the models to show the relationship between the frequency of a sound wave and pitch for a low note and a high note. On each model, be sure to:

- Show the place on the guitar fretboard where a string is held down.
- Label the frequency and pitch (low / high) of the sound wave that is produced.
- Draw a simple sound wave of that sound on each of the models.

2. What is the relationship between the length of a plucked string and the low or high note produced? Use your model to support your explanation.

SCILLSS Classroom-based Assessment Resources

Educator Task Administration Guide

Task Title: Sound Waves Made by a Guitar **Grade:** Middle School **PE:** MS-PS4-1

Task Introduction

This task is about waves. In this task, students will demonstrate their ability to use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave (MS-PS4-1). This task consists of two questions. In question one, students are asked to show the relationship between the frequency of a sound wave and pitch for a low note and a high note. In question two, students are asked to explain the relationship between the length of a plucked string and the low or high note.

Purpose and Use

This task is intended for use at a point in instruction when the teacher wants to determine if students understand wave properties and how to represent those properties in a model (i.e., graphing frequency and amplitude, etc.). The results of the tasks will be used to adjust instruction as appropriate.

Elements of the Task

This task is designed to measure students' ability to integrate the dimensions and demonstrate their knowledge, skills, and abilities (KSAs) as represented by the PE, MS-PS4-1 "Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave."

Table 1 specifies the dimensions and the key aspects of the PE that are assessed by the task. In addition, expectations for students' prior knowledge are indicated. Table 2 specifies the KSAs, work products, and task features represented by the task.

Table 1. Specific Practices, Disciplinary Core Ideas, and Crosscutting Concepts to be Assessed

NGSS Performance Expectation: MS-PS4-1. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] [*Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.*]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Using Mathematics and Computational Thinking**	**PS4.A: Wave Properties** • A simple wave has a repeating pattern with a specific wavelength,	**CCC: Patterns** • Graphs and charts can be used to identify patterns in data.

	• Use mathematical representations to describe and/or support scientific conclusions and design solutions.	frequency, and amplitude.	
Key Aspects	• Use mathematical representations to describe scientific conclusions • Use mathematical representations to support scientific conclusions • Use mathematical representations to describe design solutions • Use mathematical representations to support design solutions	• A simple wave has a repeating pattern • A simple wave has a specific wavelength • A simple wave has a specific frequency • A simple wave has a specific amplitude • The wavelength and frequency of a wave are related to one another by the speed of travel of the wave • The higher the frequency of the wave the shorter the wavelength • The lower the frequency of the wave the longer the wavelength • The higher the frequency of the wave the higher the amplitude • The lower the frequency of the wave the lower the amplitude	• Use graphs to represent and identify patterns • Use charts to represent and identify patterns • Identify the presence of patterns in phenomena or data • Characterize the strength, direction, or nature of patterns in phenomena or data
Prior Knowledge	• Knowledge of units and unit conversions • Knowledge of ratio relationships • Ability to interpret qualitative data • Ability to represent proportional relationships • Knowledge of linear relationships	• Waves can cause objects to move • Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks)	**Relationships to SEPs** • Explanations address how and why particular patterns occur • Models describe observed patterns or predict patterns • Data analysis serves to identify and characterize patterns

Table 2. Components of the Assessment Task

Knowledge, Skills, & Abilities:
- **KSA1:** Create a representation that describes a simple wave has a repeating pattern.
- **KSA2:** Use models and mathematical thinking to demonstrate understanding of wave properties.
- **KSA3:** Identify patterns as an organizing concept for understanding wave properties.
- **KSA4:** Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

Student Demonstration of Learning:
- Model accurately represents the observable phenomena
- Model accurately captures all mechanistic features of the observable phenomena
- Model accurately shows relationships among wave properties
- Applies correctly a simple mathematical wave model to a physical system or phenomenon to identify how the wave model characteristics correspond with physical observations
- Predicts correctly the change in the energy of the wave if any one of the parameters of the wave is changed
- Identifies relevant or meaningful patterns that address a scientific question
- Identifies and describes relevant relationships between components of the model
- Shows patterns in waves that accurately interpret the relationship between frequency and wavelength

Work Product:
- Draw a model
- Complete a model
- Mathematical representations
- Constructed response

Task Features:
- All tasks require evidence of qualitative or quantitative thinking.
- All tasks must prompt students to make connections between observed phenomenon or evidence and reasoning underlying the observation/evidence (e.g., related to standard repeating waves).
- All tasks must elicit core ideas as defined in the PE.
- All tasks must include elements from at least two dimensions of the NGSS.

Task Administration

Materials and Set-up

Materials

To administer the task, educators will need:

- Task administration guide
- Student task worksheet (one copy per student)

Duration

This task can be administered in approximately one class period.

Set-up

Prior to administration, print copies of the student task worksheet.

Directions for Administration

During administration, educators should:

1. Provide each student with a pencil and the student task worksheet.
2. In the student task worksheet, read the *Background Information* section to students. Address questions from the students related to expectations for completing the task. However, ensure that the discussion does not include information that provides an unfair advantage for students to complete the task/items. Tell the students the task includes two questions. Remind students to check their work and to ensure that all parts of the task are completed.
3. Allow students to complete the task. While the task should take approximately a class period to complete, students can take additional time as needed to finish. While students are working, walk around and monitor student progress, noting any misconceptions or areas in which students are struggling. Follow up with individual students as needed.

Guidelines for Evaluating Student Performance

Following administration of the task, evaluate each student response using the provided rubric. Identify the evidence of what each student knows and can do with regard to each question. Assign each student a "score" in order to classify the student's performance and to inform how he or she may be grouped with other students for instruction. Consider whether the student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction (a "3"); has a partial understanding and needs additional instruction on some concepts before new instruction is provided (a "2"); or has not learned the material and/or has misconceptions and reteaching of the key concepts is required (a "1").

Collectively consider the evidence of student performance across all students. Do any patterns or trends emerge with regard to students' demonstrated knowledge, skills, and abilities related to this standard/performance expectation? Do you notice any common misconceptions or misunderstandings?

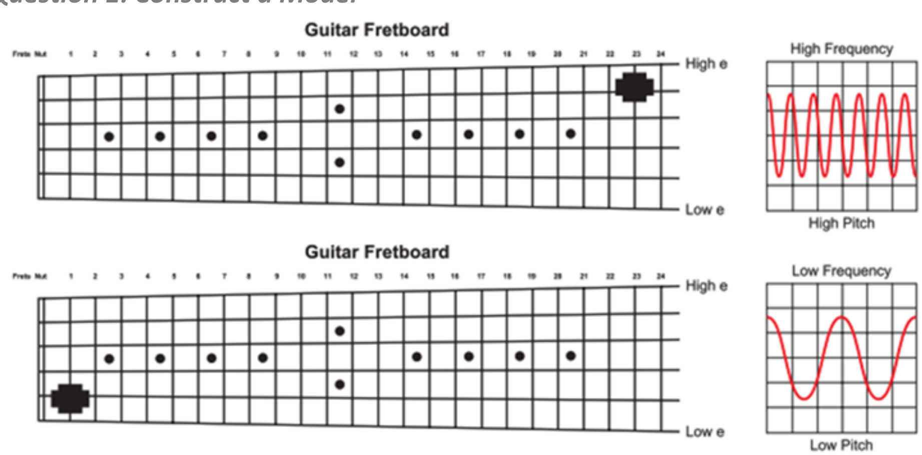
Next, consider how you might address students' needs. How will you adjust instruction based on the observed patterns and trends? Consider what aspects of the standard/performance expectation (i.e., dimensions) require additional instruction for individuals, small groups, or the class.

Rubric

Student Response	**1**	**2**	**3**
Question 1	Student develops a model that does not show the relationship between frequency and pitch and notes played on the guitar. Model does not show the ways that vibrating strings cause differences in sounds.	Student develops a model that shows a slightly flawed connection between frequency, pitch, and the notes played on the guitar (e.g., high frequency paired with low pitch, high note matched low frequency, etc.). Model shows a slightly flawed connection of the ways that vibrating strings cause differences in sounds.	Student creates a model that shows the relationship between frequency, pitch, and notes played of the guitar and the ways that vibrating strings cause differences in sounds.
Question 2	Explanation is not supported by model or is not present.	Explanation uses simple mathematical wave models to identify patterns).	Explanation applies the mathematical model to identify how the wave model characteristics correspond with physical observations.

Student Exemplar(s)

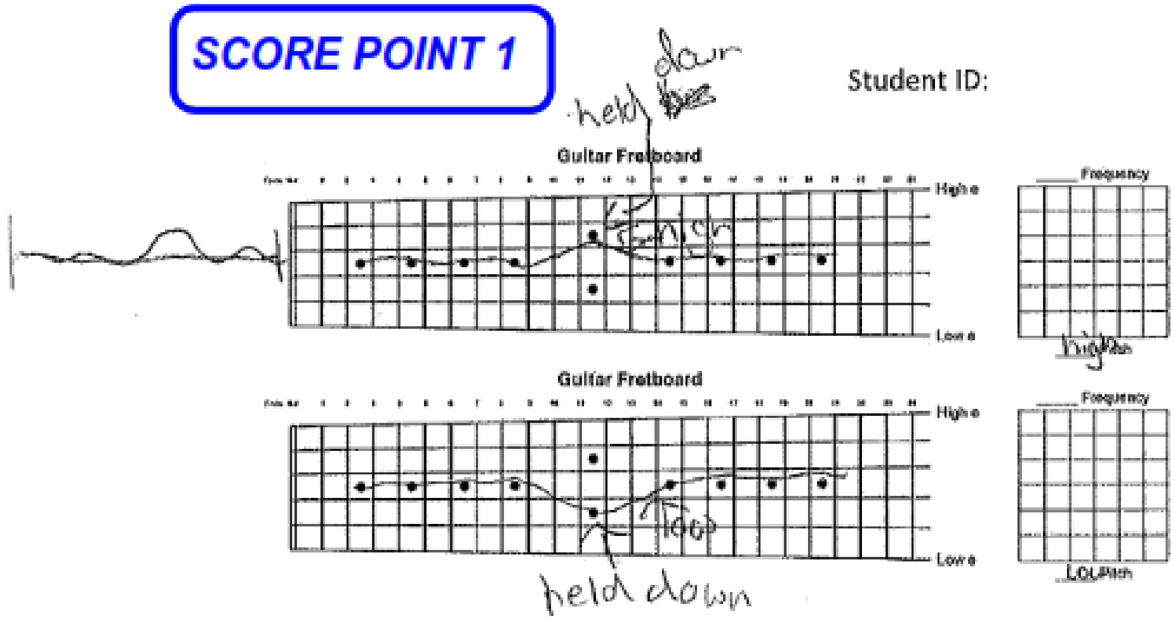
Question 1: Construct a Model



Question 2: Constructed Response

"Stringed instruments have strings that vibrate when plucked or struck. A short string vibrates at a higher frequency and produces a high note with a high pitch. A long string vibrates at a low frequency and produces a lower pitched sound or a low note."

Question 1, Score Point 1



Use the models to show the relationship between the frequency of a sound wave and pitch for a low note and a high note. On each model, be sure to:

- Show the place on the guitar fretboard where a string is held down.
- Label the frequency and pitch (low / high) of the sound wave that is produced.
- Draw a simple sound wave of that sound on each of the models.

Score Point 1: Student has not learned the material and/or has misconceptions and reteaching of the key concepts is required.

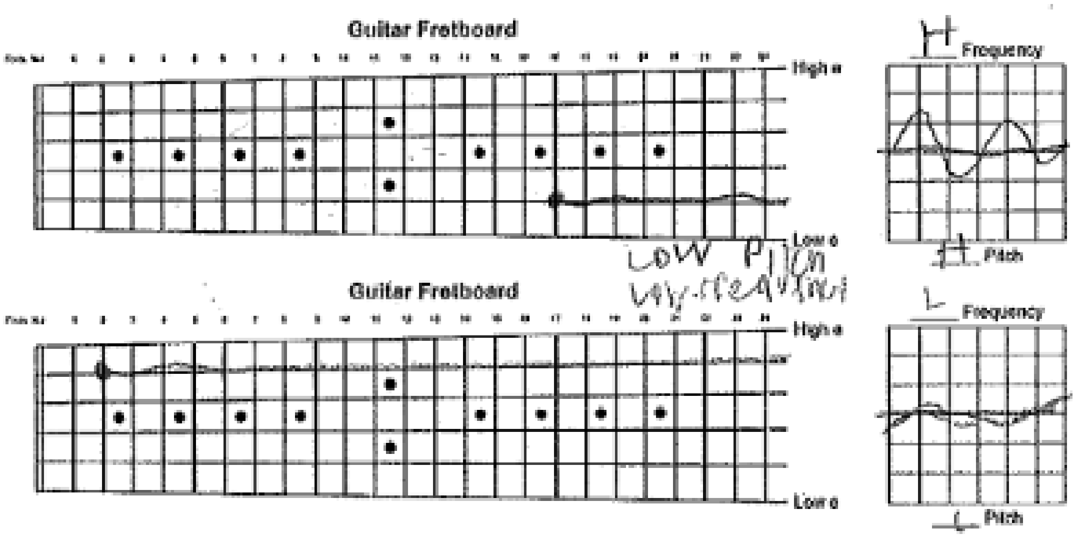
Model does not include a representation of the relationship between frequency and pitch.

Model includes the place and string on the guitar fretboard where a string is held down. The model matches correct notes to high and low pitch.

Question 1, Score Point 2

SCORE POINT 2

Student ID:



Use the models to show the relationship between the frequency of a sound wave and pitch for a low note and a high note. On each model, be sure to:

- Show the place on the guitar fretboard where a string is held down.
- Label the frequency and pitch (low / high) of the sound wave that is produced.
- Draw a simple sound wave of that sound on each of the models.

Score Point 2: Student has a partial understanding and needs additional instruction on some concepts before new instruction is provided.

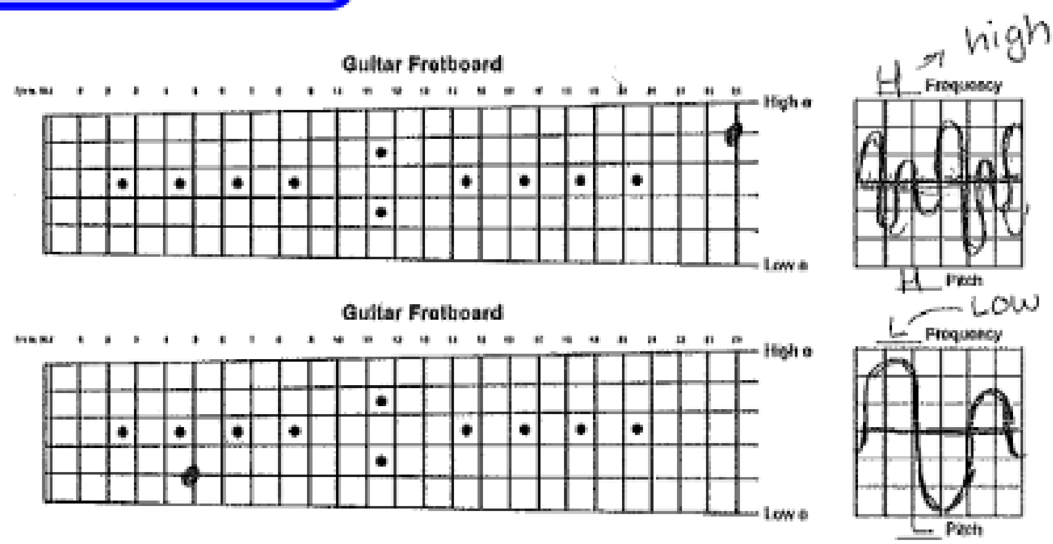
Model shows a slightly flawed connection between frequency, pitch, and notes played on the guitar.

Model includes the place on the guitar fretboard where a string is held down, and it matches correct notes to high and low frequency and pitch (i.e., a low note and a high note). The model includes a flawed representation of sound waves with high and low frequency and pitch.

Question 1, Score Point 3

SCORE POINT 3

Student ID:



Use the models to show the relationship between the frequency of a sound wave and pitch for a low note and a high note. On each model, be sure to:

- Show the place on the guitar fretboard where a string is held down.
- Label the frequency and pitch (low / high) of the sound wave that is produced.
- Draw a simple sound wave of that sound on each of the models.

Score Point 3: Student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction.

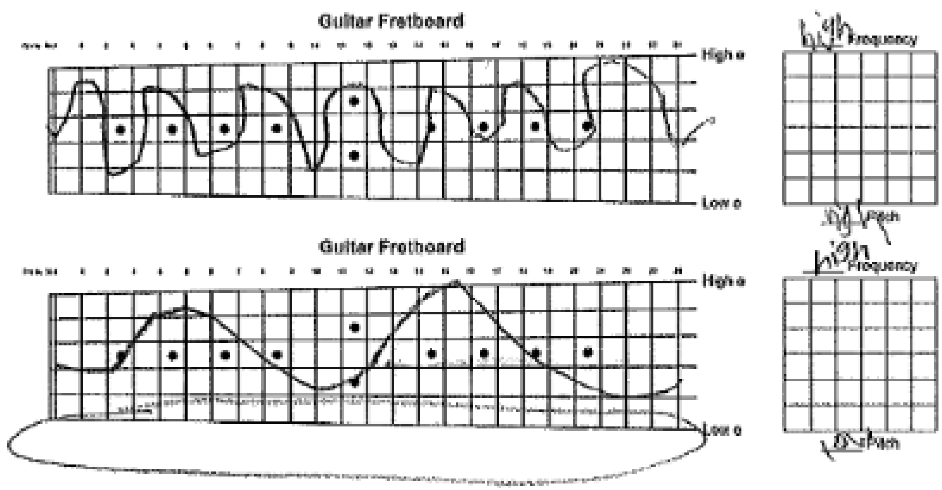
Model shows the relationship between the frequency of a sound wave and pitch for a low note and a high note.

Model includes the place on the guitar fretboard where a string is held down, the frequency and pitch of the sound wave that is produced for a low note and a high note, a simple sound wave of that sound on each of the models (i.e., for a low note and a high note), and the ways that vibrating strings cause differences in sounds.

Question 2, Score Point 1

SCORE POINT 1

Student ID:



Use the models to show the relationship between the frequency of a sound wave and pitch for a low note and a high note. On each model, be sure to:

- Show the place on the guitar fretboard where a string is held down.
- Label the frequency and pitch (low / high) of the sound wave that is produced.
- Draw a simple sound wave of that sound on each of the models.

2. What is the relationship between the length of a plucked string and the low or high note produced? Use your model to support your explanation.

well I think the relationship is about the same because when you pluck a string and than the closer you are to the sound hole that is the sound that is produced

Score Point 1: Student has not learned the material and/or has misconceptions and reteaching of the key concepts is required.

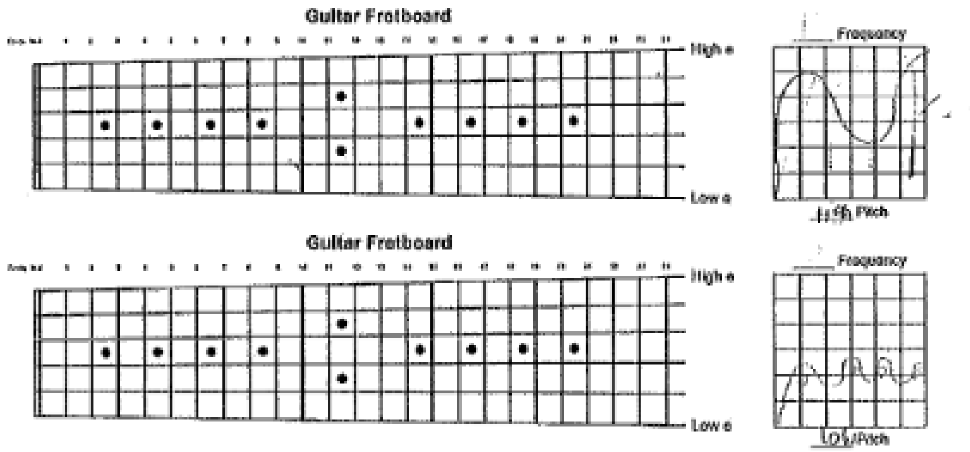
Student response does not include any reference to the relationship between pitch and the length of the plucked string. Explanation does not make a reference to the model.

The explanation includes a reference to the distance of a note to the guitar's sound hole.

Question 2, Score Point 2

SCORE POINT 2

Student ID:



Use the models to show the relationship between the frequency of a sound wave and pitch for a low note and a high note. On each model, be sure to:

- Show the place on the guitar fretboard where a string is held down.
- Label the frequency and pitch (low / high) of the sound wave that is produced.
- Draw a simple sound wave of that sound on each of the models.

2. What is the relationship between the length of a plucked string and the low or high note produced? Use your model to support your explanation.

I Know that when the String is Shorter it a Higher pitch and when the String is longer it is a lower picth.

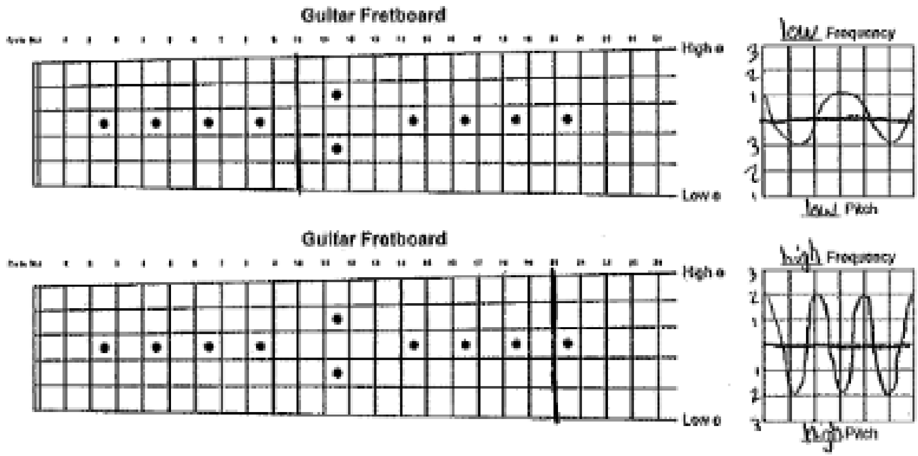
Score Point 2: Student has a partial understanding and needs additional instruction on some concepts before new instruction is provided.

Student identifies the relationship of the length of a plucked string to the pitch of a sound, indirectly referencing the model.

Question 2, Score Point 3

SCORE POINT 3

Student ID:



Use the models to show the relationship between the frequency of a sound wave and pitch for a low note and a high note. On each model, be sure to:

- Show the place on the guitar fretboard where a string is held down.
- Label the frequency and pitch (low / high) of the sound wave that is produced.
- Draw a simple sound wave of that sound on each of the models.

2. What is the relationship between the length of a plucked string and the low or high note produced? Use your model to support your explanation.

The relationship between length of a plucked string and the note is a shorter string makes a higher frequency and a longer string makes a lowe frequency and I know this from a video we watche yesterday about how vilins play higher notes than a cello. Also, on my diagram the string was held down farther back and it had lower pitch and frequency.

Score Point 3: Student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction.

Student applies the mathematical model and previous learning to identify how the wave model characteristics correspond with physical observations. The explanation includes a reference to the model and a description of where the notes are played of the guitar, and how that relates to the frequency and pitch of the sound heard.

Appendix D. Grade 8 SCILLSS Classroom-based NGSS Science Assessment Tools, Tasks, Administration Guide, and Anchor Papers for MS-PS4-2

Unpacking Tool for MS-PS4-2

Grade: 8

NGSS Performance Expectation: MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [*Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.*]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Developing and Using Models** Develop and use a model to describe phenomena.	**PS4.A: Wave Properties** A sound wave needs a medium through which it is transmitted.	**CCC: Structure and Function** Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and use.
Key Aspects	• Develop a model to predict phenomena. • Develop a model to describe phenomena. • Identify appropriate aspects of a given phenomenon to include in a model. • Explain the relationships among the components of a model. • Specify or identify the limitations of the model and describe why these limitations exist.	• Sound waves need a medium (air, water, or solid material) to travel through.	• Design structures to serve different functions. • Design structures based on the properties of its materials. • The shape and stability of structures of natural and designed objects are related to their function(s).
Prior Knowledge	• Knowledge of units and unit conversions • Knowledge of ratio relationships • Ability to interpret qualitative data • Ability to represent proportional relationships • Knowledge of linear relationships	• Waves can cause objects to move. • Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).	**Relationships to SEPs** • A sense of scale is necessary in order to know what properties and what aspects of shape or material are relevant at a particular magnitude or in investigating particular phenomena. • Data analysis serves to demonstrate the relative magnitude of some properties or processes.

Task Specifications Tool for MS-PS4-2

Element	Description
Performance Expectation	**MS-PS4-2** Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various material.
The Knowledge, Skills & Abilities (KSAs)	**KSA1**: Develop a model to describe the transmission of waves. **KSA2**: Use a model to make sense of given phenomena involving reflection, absorption, or transmission properties of light and matter waves. **KSA3**: Identify characteristics of the wave after it has interacted with a material (e.g., frequency, amplitude, wavelength). **KSA4**: Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various material.
Student Demonstration of Learning	• Model accurately represents the observable phenomena • Model accurately captures all mechanistic features of the observable phenomena • Model accurately shows the transmission of waves • Describes correctly how waves transmit energy • Describes accurately that vibrations in materials set up wavelike disturbances that spread away from the source, such as sound waves • Describes correctly whether the model shows how waves are reflected, absorbed, or transmitted through a material
Work Product	• Draw a model • Complete a model • Constructed response • Short response
Task Features	• All tasks require evidence of qualitative and quantitative thinking. • All tasks must prompt students to make connections between observed phenomenon or evidence and reasoning underlying the observation/evidence. • Students use scientific reasoning and process skills in observational (nonexperimental) investigations. • All tasks must elicit core ideas as defined in the PE. • All tasks must include elements from at least two dimensions of the NGSS.
Aspects of an assessment task that <u>can be varied</u> to shift complexity or focus	• Type of wave presented (e.g., sound, electromagnetic, mechanical, light) • Format of "real-world" phenomenon under investigation: image, data, text, combination • Standard units used (e.g., grams, liters) • Use or purpose of the model • Type of model (e.g., physical/virtual) • Core idea targeted in model (e.g., light sources, the materials, polarization of light, ray diagrams)
Assessment Boundaries	• Assessment is limited to qualitative applications pertaining to mechanical waves. • Assessment is limited to standard repeating waves and should not include electromagnetic waves. • Assessment should be limited to qualitative applications pertaining to light and mechanical waves.

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: Middle School

NGSS Performance Expectation: MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Task

This task is about sound waves.

1. Can you make something move by using only sound? Think about the video you just watched. Develop a model and describe this phenomenon using a bowl with plastic cling wrap as the sound detector and a radio speaker as the sound source. Be sure to label the parts of your model. Be sure your model shows:
   - what is happening at the sound source;
   - how the sound source affects the surrounding medium;
   - how the medium causes changes to the sound detector; and
   - what happens to the salt on the sound detector.

2. Based on your model, describe:
   - how sound waves are transmitted through the material;
   - why the salt appears to move differently during the song; and
   - why the plastic wrap acts as a sound detector.

SCILLSS Classroom-based Assessment Resources

Educator Task Administration Guide

Task Title: Interactions Between Sound Waves and Matter **Grade:** Middle School **PE:** MS-PS4-2

Task Introduction

This task is about waves. In this task, students will demonstrate their ability to develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials (MS-PS4-2). This task consists of two questions. In question one, students are asked to develop a model and describe this phenomenon using a bowl with plastic cling wrap as the sound detector and a radio speaker as the sound source. In question two, students are asked to explain how sound waves are reflected, absorbed, or transmitted through a material.

Purpose and Use

This task is intended for use at a point in instruction when the teacher wants to determine if students can use their models about phenomena involving sound waves to describe the differences between how sound and matter waves interact with different materials. The results of the tasks will be used to adjust instruction as appropriate.

Elements of the Task

This task is designed to measure students' ability to integrate the dimensions and demonstrate their knowledge, skills, and abilities (KSAs) as represented by the PE, MS-PS4-2 "Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials."

Table 1 specifies the dimensions and the key aspects of the PE that are assessed by the task. In addition, expectations for students' prior knowledge are indicated. Table 2 specifies the KSAs, work products, and task features represented by the task.

Table 1. Specific Practices, Disciplinary Core Ideas, and Crosscutting Concepts to be Assessed

NGSS Performance Expectation: MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [*Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.*]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Developing and Using Models** • Develop and use a model to describe phenomena.	**PS4.A: Wave Properties** • A sound wave needs a medium through which it is transmitted.	**CCC: Structure and Function** • Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.
Key Aspects	• Develop a model to predict phenomena • Develop a model to describe phenomena • Identify appropriate aspects of a given phenomenon to include in a model • Explain the relationships among the components of a model • Specify or identify the limitations of the model and describe why these limitations exist	• Sound waves need a medium (air, water, or solid material) to travel through	• Design structures to serve different functions • Design structures based on the properties of its materials • The shape and stability of structures of natural and designed objects are related to their function(s)
Prior Knowledge	• Knowledge of units and unit conversions • Knowledge of ratio relationships • Ability to interpret qualitative data • Ability to represent proportional relationships • Knowledge of linear relationships	• Waves can cause objects to move • Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks)	**Relationships to SEPs** • A sense of scale is necessary in order to know what properties and what aspects of shape or material are relevant at a particular magnitude or in investigating particular phenomena • Data analysis serves to demonstrate the relative magnitude of some properties or processes

Table 2. Components of the Assessment Task

Knowledge, Skills, & Abilities: • **KSA1:** Develop a model to describe the transmission of waves. • **KSA2:** Use a model to make sense of given phenomena involving reflection, absorption, or transmission properties of light and matter waves. • **KSA3:** Identify characteristics of the wave after it has interacted with a material (e.g., frequency, amplitude, wavelength). • **KSA4:** Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various material.
Student Demonstration of Learning: • Model accurately represents the observable phenomena • Model accurately captures all mechanistic features of the observable phenomena • Model accurately shows the transmission of waves • Describes correctly how waves transmit energy • Describes accurately that vibrations in materials set up wavelike disturbances that spread away from the source, such as sound waves • Describes correctly whether the model shows how waves are reflected, absorbed, or transmitted through a material
Work Product: • Draw a model • Complete a model • Constructed response • Short response
Task Features: • All tasks require evidence of qualitative and quantitative thinking. • All tasks must prompt students to make connections between observed phenomenon or evidence and reasoning underlying the observation/evidence. • Students use scientific reasoning and process skills in observational (nonexperimental) investigations. • All tasks must elicit core ideas as defined in the PE. • All tasks must include elements from at least two dimensions of the NGSS.

Task Administration

Materials and Set-up

Materials

To administer the task, educators will need:

- Task administration guide
- Student task worksheet (one per student)
- Projection screen/Smart Board

Duration

This task can be administered in approximately one class period.

Set-up

Prior to administration, print copies of the student task worksheet. Each student will receive a copy of the worksheet. Prepare a Smartboard or projector/projection screen to play a short Internet video to students as a whole class.

Directions for Administration

During administration, educators should:

1. Provide each student with a pencil and the student task worksheet.
2. Instruct students to watch the first 60 seconds of the video demonstration at https://www.youtube.com/watch?v=a08cawnJinw. (The video should be played for the whole class).
3. Introduce the task to the students. Address questions related to expectations for completing the task. However, ensure that the discussion does not include information that provides an unfair advantage for students to complete the task/items. Tell the students the task includes two questions. Remind students to check their work and to ensure that all parts of the task are completed.
4. Allow students to complete the task. While the task should take approximately one class period to complete, students can take additional time as needed to finish. While students are working, walk around and monitor student progress, noting any misconceptions or areas in which students are struggling. Follow up with individual students as needed.

Guidelines for Evaluating Student Performance

Following administration of the task, evaluate each student response using the provided rubric. Identify the evidence of what each student knows and can do with regard to each question. Assign each student a "score" in order to classify the student's performance and to inform how he or she may be grouped with other students for instruction. Consider whether the student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction (a "3"); has a partial understanding and needs additional instruction on some concepts before new instruction is provided (a "2"); or has not learned the material and/or has misconceptions and reteaching of the key concepts is required (a "1").

Collectively consider the evidence of student performance across all students. Do any patterns or trends emerge with regard to students' demonstrated knowledge, skills, and abilities related to this standard/performance expectation? Do you notice any common misconceptions or misunderstandings?

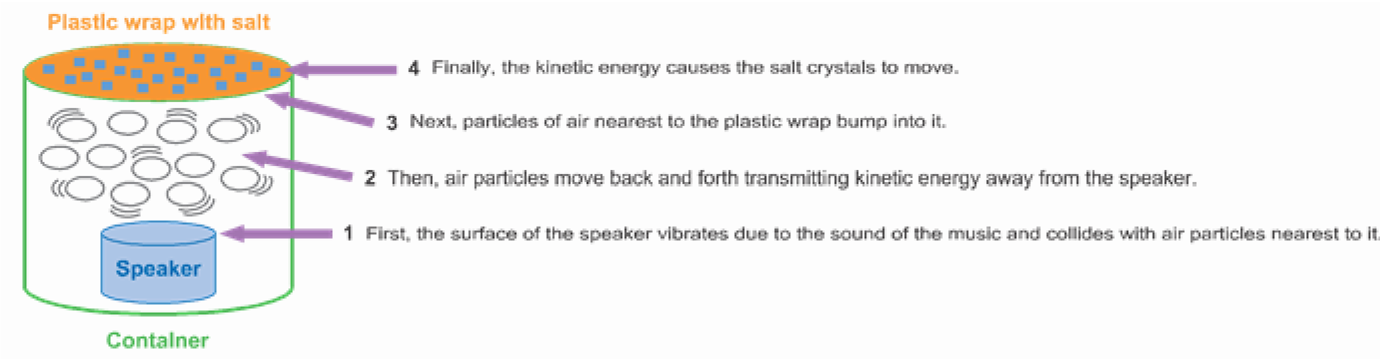
Next, consider how you might address students' needs. How will you adjust instruction based on the observed patterns and trends? Consider what aspects of the standard/performance expectation (i.e., dimensions) require additional instruction for individuals, small groups, or the class.

Rubric

Dimension Element	1	2	3
Develop and use a model to describe phenomena.	Model does not make sense of the phenomena and does not indicate relationships between components.	Model describes the phenomenon, including a limited number of relevant components and describes some of the relationships between components.	Model makes sense of the phenomenon, by describing relative components including sound waves, materials through which the waves are reflected, absorbed, or transmitted, results of the interaction of the wave and the material, and source of the wave. Model describes the relationship between components including sound waves, materials through which the waves are reflected, absorbed, or transmitted, results of the interaction of the wave and the material, and source of the wave.
Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.	Model shows misunderstanding of the properties of the materials.	Model is used to interpret part of the context.	Model is used to describe why materials with certain properties are well-suited for particular functions.
A sound wave needs a medium through which it is transmitted.	Response includes major misunderstandings or no attempt to show how sounds travels or demonstrates little understanding of how sound travels.	Response partially describes how sound travels.	Response describes how sound waves interact with different materials.

Student Exemplar(s)

Question 1: Construct a Model



Question 2: Constructed Response

"The vibrating speaker gives out sound. The sound travels through the air as longitudinal waves. The air particles next to the plastic wrap vibrate as the sound energy reaches it, making the salt crystals move. When the sound of the music is louder, it is more intense. This causes the salt crystals to move even more. The salt stops moving when the sound stops. This is why the plastic wrap is a good sound detector."

Dimension Element 1: Develop and use a model to describe phenomena, Score Point 1

SCORE POINT 1

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: Middle School

NGSS Performance Expectation: MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Task

This task is about sound waves.

1. Can you make something move by using only sound? Think about the video you just watched. Develop a model and describe this phenomenon using a bowl with plastic cling wrap as the sound detector and a radio speaker as the sound source. Be sure to label the parts of your model. Be sure your model shows:
   - what is happening at the sound source;
   - how the sound source affects the surrounding medium;
   - how the medium causes changes to the sound detector; and
   - what happens to the salt on the sound detector.

2. Based on your model, describe:
   - how sound waves are transmitted through the material;
   - why the salt appears to move differently during the song; and
   - why the plastic wrap acts as a sound detector.

Sound waves were transmitted by the sound. The sound is so powerful and it travels through all the materials causing the salt to move. The salt moves through the song because the bass of the speaker is s loud and salt is so light. The plastic wrap acts as a sound detector because it is thin and light.

Dimension Element: Develop and use a model to describe phenomena.

Score Point 1: Student has not learned the material and/or has misconceptions and reteaching of the key concepts is required.

Model: The student model is labeled. Model does not describe the phenomenon. The medium is not included in the model.

Explanation: Includes a reference to the sound being "powerful." Describes physical properties of the materials included in the model. For example, the plastic wrap is "thin and light." Describes the movement of the salt due to the "bass is loud and the salt is light."

Dimension Element 1: Develop and use a model to describe phenomena, Score Point 2

SCORE POINT 2

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

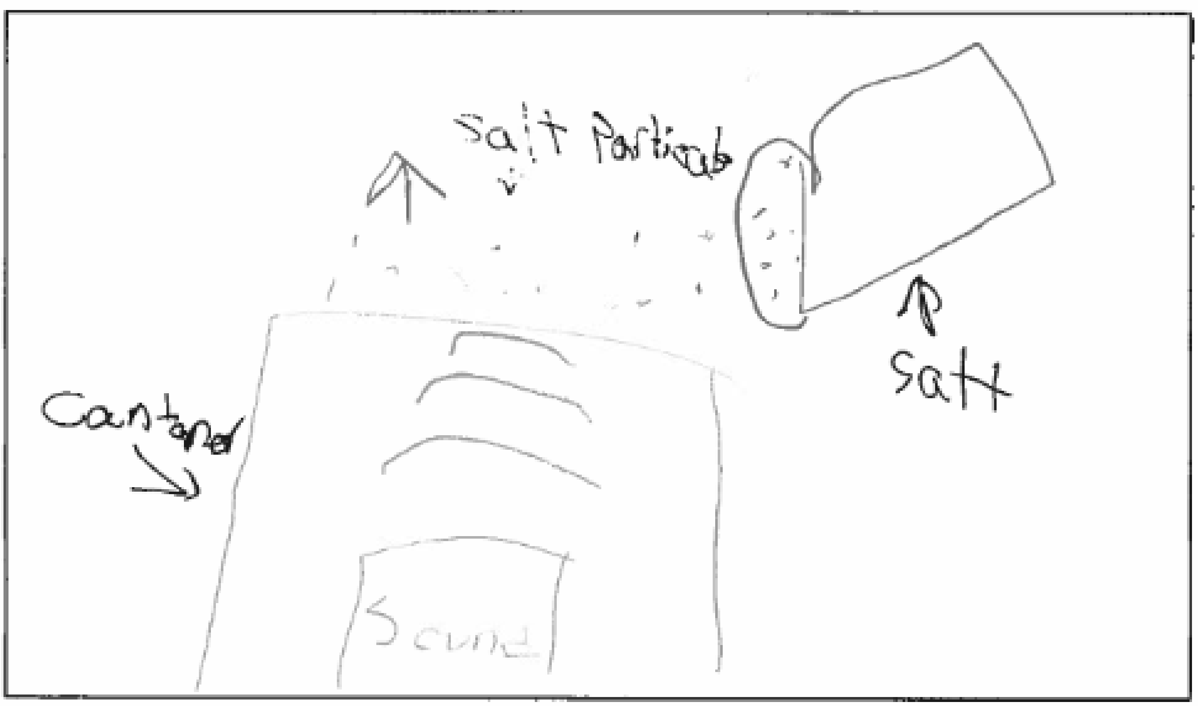
Grade: Middle School

NGSS Performance Expectation: MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Task

This task is about sound waves.

1. Can you make something move by using only sound? Think about the video you just watched. Develop a model and describe this phenomenon using a bowl with plastic cling wrap as the sound detector and a radio speaker as the sound source. Be sure to label the parts of your model. Be sure your model shows:
   - what is happening at the sound source;
   - how the sound source affects the surrounding medium;
   - how the medium causes changes to the sound detector; and
   - what happens to the salt on the sound detector.



2. Based on your model, describe:
   - how sound waves are transmitted through the material;
   - why the salt appears to move differently during the song; and
   - why the plastic wrap acts as a sound detector.

The Sownd waves hit thr cling wrap and the salt bances ↑↓. The Salt moves dePending on the rythym of the Song

Dimension Element: Develop and use a model to describe phenomena.

Score Point 2: Student has a partial understanding and needs additional instruction on some concepts before new instruction is provided.

Model: The student model is labeled. Model does not accurately describe the phenomenon. The medium is not included in the model.

Explanation: Includes a reference to the "rhythm" of the song and movement of the salt. Describes how "sound waves hit" the cling wrap and make the salt "bounce." Response does not include science-related terminology.

Dimension Element 1: Develop and use a model to describe phenomena, Score Point 3

SCORE POINT 3

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: Middle School

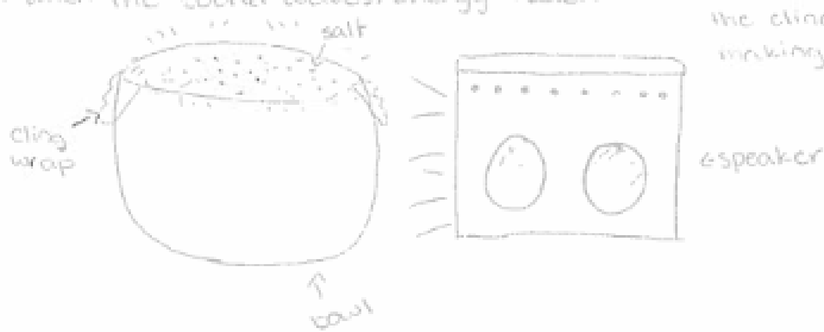
NGSS Performance Expectation: MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Task

This task is about sound waves.

1. Can you make something move by using only sound? Think about the video you just watched. Develop a model and describe this phenomenon using a bowl with plastic cling wrap as the sound detector and a radio speaker as the sound source. Be sure to label the parts of your model. Be sure your model shows:
   1 • what is happening at the sound source;
   2 • how the sound source affects the surrounding medium;
   3 • how the medium causes changes to the sound detector; and
   4 • what happens to the salt on the sound detector.

1- waves of energy are coming from the sound source, and hitting the bowl
2- the sound source doesn't really affect the surrounding medium, until it hits the bowl and makes the salt move
3- the medium (air) causes changes to the plastic wrap, because the air allows the energy to flow from the speaker to the cling wrap making it vibrate.
4- when the sound waves/energy reach the salt on the sound detector (cling wrap) the cling wrap vibrates making the salt jump/move.



2. Based on your model, describe:

- 1 • how sound waves are transmitted through the material;
- 2 • why the salt appears to move differently during the song; and
- 3 • why the plastic wrap acts as a sound detector.

1- the sound waves when transmitted through the air dont affect the air. when the soundwaves are transmitted through the bowl and the cling wrap it causes them to vibrate, because the energy causes it to vibrate.

2- there are different levels of soundwave/energy throughout the song because of the different loudnesses, which causes the salt to bounce higher when more energy/soundwave come out of the speaker, and lower when less energy is applied

3- the plastic wrap acts as a sound detector because the bowl captures the sound and causes the cling wrap to vibrate. This means that the bowl and cling wrap detect the sound and use the energy to vibrate the cling wrap/salt.

Dimension Element: Develop and use a model to describe phenomena.

Score Point 3: Student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction.

Model: The student model makes sense of the phenomenon. Model is labeled and identifies the aspects of the model, including the medium as air. Student describes the vibrations as transporting the energy of the sound waves to the plastic wrap.

Explanation: Includes a reference to the loudness of the sound and the increased movement of the salt. Describes how a speaker playing music can cause vibrations that produces sound, which causes the particles of air to move and in turn makes the plastic vibrate and the salt to "jump."

Dimension Element 3: Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used, Score Point 1

SCORE POINT 1

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

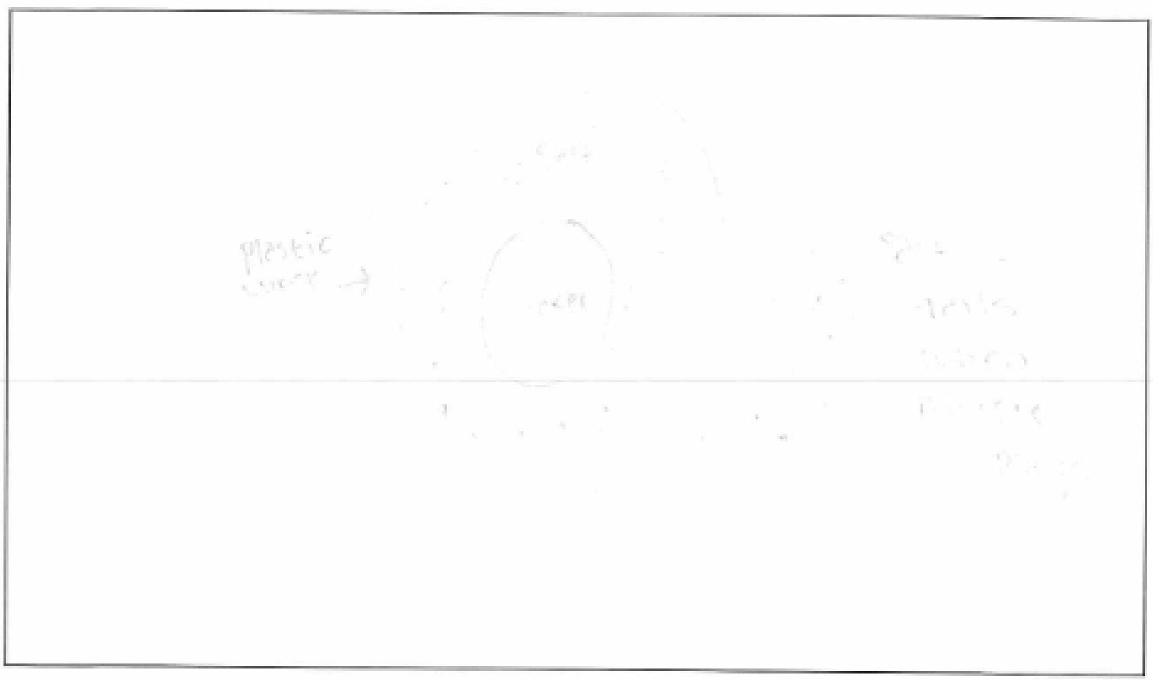
Grade: Middle School

NGSS Performance Expectation: MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Task

This task is about sound waves.

1. Can you make something move by using only sound? Think about the video you just watched. Develop a model and describe this phenomenon using a bowl with plastic cling wrap as the sound detector and a radio speaker as the sound source. Be sure to label the parts of your model. Be sure your model shows:
   - what is happening at the sound source;
   - how the sound source affects the surrounding medium;
   - how the medium causes changes to the sound detector; and
   - what happens to the salt on the sound detector.



2. Based on your model, describe:
   - how sound waves are transmitted through the material;
   - why the salt appears to move differently during the song; and
   - why the plastic wrap acts as a sound detector.

The sound echoes off of the plastic wrap which causes the salt to move. The plastic wrap acts as a sound detector because the plastic wrap is wrapped over the speaker.

Dimension Element: Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Score Point 1: Student has not learned the material and/or has misconceptions and reteaching of the key concepts is required.

Model: The student model is not referenced. Model shows some components related to the phenomenon.

Explanation: Includes a reference to the plastic wrap and salt movement being due to "echoes." Student states the plastic wrap functions as a sound detector "because it is wrapped over the speaker."

Dimension Element 3: Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used, Score Point 2

SCORE POINT 2

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

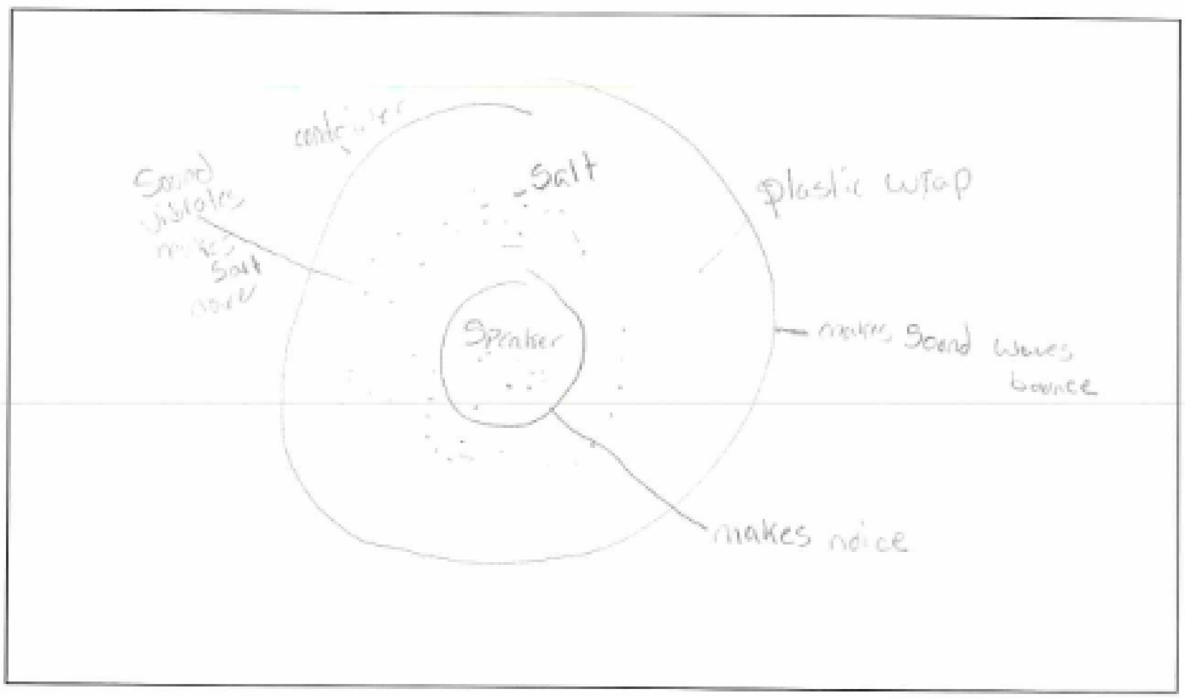
Grade: Middle School

NGSS Performance Expectation: MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Task

This task is about sound waves.

1. Can you make something move by using only sound? Think about the video you just watched. Develop a model and describe this phenomenon using a bowl with plastic cling wrap as the sound detector and a radio speaker as the sound source. Be sure to label the parts of your model. Be sure your model shows:
   - what is happening at the sound source;
   - how the sound source affects the surrounding medium;
   - how the medium causes changes to the sound detector; and
   - what happens to the salt on the sound detector.



2. Based on your model, describe:
   - how sound waves are transmitted through the material;
   - why the salt appears to move differently during the song; and
   - why the plastic wrap acts as a sound detector.

The sound bounces off the container making the sound vibrate. The Salt then moves diffrently depending on how high or low the Sound is. The plastic wrap moves to the sound waves, causing the Sand to move.

Dimension Element: Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Score Point 2: Student has a partial understanding and needs additional instruction on some concepts before new instruction is provided.

Model: The student model is labeled. Model shows components related to the phenomenon.

Explanation: Includes a reference to the container "making the sound vibrate" rather than the sound making the plastic wrap (i.e., sound detector) vibrate. Student does indicate that the "plastic wrap moves to the sound waves, causing the sand to move." Student does not describe how the properties of the materials (i.e., plastic wrap) contribute to its function as a sound detector.

Dimension Element 3: Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used, Score Point 3

SCORE POINT 3

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: Middle School

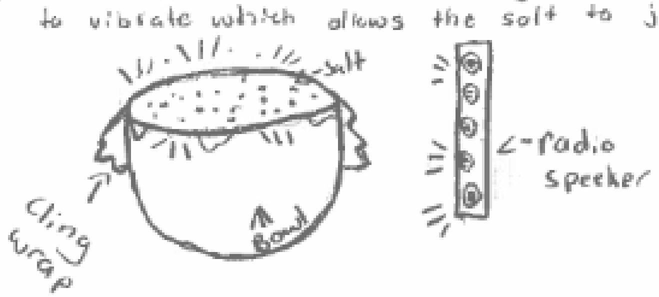
NGSS Performance Expectation: MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Task

This task is about sound waves.

1. Can you make something move by using only sound? Think about the video you just watched. Develop a model and describe this phenomenon using a bowl with plastic cling wrap as the sound detector and a radio speaker as the sound source. Be sure to label the parts of your model. Be sure your model shows:
   1 • what is happening at the sound source;
   2 • how the sound source affects the surrounding medium;
   3 • how the medium causes changes to the sound detector; and
   4 • what happens to the salt on the sound detector.

1. The sound source is letting off energy, sound, and waves. The waves are hitting the bowl
2. The sound source doesn't really affect the surrounding medium until it hits the bowl causing vibration.
3. The medium is air, so it lets the sound waves travel accross the medium to the bowl, which vibrates the sound detector. If the speaker was in water the sound detector would not be able to vibrate because the waves would not be able to travle to it.
4. The salt bounces because the cling wrap detects the sound and starts to vibrate which allows the salt to jump/vibrate.



2. Based on your model, describe:
   - how sound waves are transmitted through the material;
   - why the salt appears to move differently during the song; and
   - why the plastic wrap acts as a sound detector.

The sound waves are transmitted through the air but don't really affect the air or the sound waves. When the sound waves are transmitted through the plastic wrap it starts to vibrate because the energy from the sound causes it to vibrate. When the song changes different amounts of energy is transmitted, so the cling wrap vibrates differently. The salt jumps differently at different beats/waves. The cling wrap acts as a sound detector because the bowl captures the sound and causes the cling wrap to vibrate. This means that the bowl and cling wrap detect the sound and use the energy to vibrate the cling wrap/salt.

Dimension Element: Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Score Point 3: Student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction.

Model: The student model is used to describe why materials with certain properties are well-suited for particular functions. Model describes the phenomenon.

Explanation: Includes a reference to the three parts of the model: the source, how sound travels, and the detector. Clearly explains how their component of the model works. Explains that vibrating objects are sound sources and that different vibrations of different amounts of energy are captured by the system of the bowl and cling wrap and cause the salt to "jump."

Appendix E. Grade 11 SCILLSS Classroom-based NGSS Science Assessment Tools, Tasks, Administration Guide, and Anchor Papers for HS-ESS1-5

Unpacking the Dimensions Tool for HS-ESS1-5

Grade: 11

NGSS Performance Expectation: HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. [Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient core of the continental plate (a result of past plate interactions).]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Engaging in Argument from Evidence** Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments.	**ESS1.C: The History of Planet Earth** Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old.	**CCC: Patterns** Empirical evidence is needed to identify patterns.
Key Aspects	• Evaluate the claims behind currently accepted explanations to determine the merits of arguments. • Evaluate the claims behind currently accepted solutions to determine the merits of arguments. • Evaluate the evidence behind currently accepted explanations to determine the merits of arguments. • Evaluate the evidence behind currently accepted solutions to determine the merits of arguments. • Evaluate the reasoning behind currently accepted explanations to determine the merits of arguments. • Evaluate the reasoning behind currently accepted solutions to determine the merits of arguments.	• Active geologic processes have destroyed or altered most of the very early rock record on Earth. • Some objects in the solar system have changed very little over billions of years. • Studying these objects can help deduce the solar system's age and history.	• Identify a pattern in an observed phenomenon. • Explain the pattern in a system under study. • Support a claim about the pattern in a system under study.

Prior Knowledge	• Use linear equations and systems of linear equations to represent, analyze, and solve a variety of problems. • Analyze situations and solve problems. • Knowledge of how to recognize patterns of association in bivariate data • Write an argument.	• Rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history.	**Relationships to SEPs**	• Patterns can be used to support an argument. • Data analysis serves to identify and characterize patterns. • Patterns can be used as empirical evidence for causality in supporting explanations of phenomena.

Assessment Task Specifications Tool for HS-ESS1-5

Element	Description
Performance Expectation	**HS-ESS1-5** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
The Knowledge, Skills & Abilities (KSAs)	**KSA1**: Investigate how Earth's internal and surface processes operate at different spatial and temporal scales to explain the ages of crustal rocks. **KSA2**: Synthesize the relevant evidence to describe the relationship between the motion of continental plates and the patterns in the ages of crustal rocks. **KSA3**: Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
Student Demonstration of Learning	• Model accurately represents the observable phenomena • Model accurately captures all mechanistic features of the observable phenomena • Use a model to make an accurate prediction about a phenomenon (e.g., direction of plate movement) • Represents only the appropriate relationships and/or interactions among the elements in the model needed to explain the target phenomenon and describes why these relationships are important • Organizes data in a clear way that highlights patterns that are relevant or meaningful to a scientific question • Synthesizes relevant evidence and relevant or meaningful patterns to defend a claim or support an argument
Work Product	• Group discussion • Draw a model • Laboratory exercise • Short response • Constructed response
Task Features	• All tasks require evidence of qualitative and quantitative thinking. • All tasks must prompt students to make connections between observed phenomenon or evidence and reasoning underlying the observation/evidence. • Models provided in stimulus materials must illustrate a process or why a phenomenon exists (e.g., plate movement). • All tasks are presented in a context that revolves around movement of crustal rocks. • All phenomena for which a model is developed must be observable or fit available evidence (e.g., plate tectonics to explain the ages of crustal rocks). • Students use scientific reasoning and process skills in observational (nonexperimental) investigations. • All tasks must elicit core ideas as defined in the PE. • All tasks must include elements from at least two dimensions of the NGSS.

Aspects of an assessment task that <u>can be varied</u> to shift complexity or focus	• Complexity of empirical evidence needed to identify patterns • Format of "real-world" phenomenon presented: image, data, text, combination • What characteristics are included (given or determined by the student) • Core idea targeted in model (e.g., the degree to which nuclear processes are included) • The degree to which scientific vocabulary is required/used/scaffolded
Assessment Boundaries	• Students do not need to demonstrate comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems. • Assessment is limited to alpha, beta, and gamma radioactive decays. • Students do not need to calculate radioactive decay rates. • Students do not need to know names of supercontinents, names of fault lines, names of tectonic plates.

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: High School

NGSS PE: HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

Background Information

Alfred Wegener was a meteorologist who proposed the theory of continental drift in 1912 by proposing that the continents are in motion. Harold Hess was a geologist who confirmed Wegener's ideas by using the evidence of seafloor spreading to explain the forces that move continents.

Part 1

With your group, use the information we just discussed to build a model of seafloor spreading using the following materials:

1. 1 box lid with a slit cut in the center for the paper strip
2. 100 cm long paper strip to be folded in half, with the two ends emerging from the box lid
3. 1 box of markers
4. 1 bar magnet and 1 compass
5. Meter stick

Part 2

Work independently to answer all three questions.

1. What do the following components of the group model represent?
   a. the process of pulling the paper strips
   b. the magnet and what flipping shows
   c. the marked sections of the paper strip (e.g., A, B, C, etc.)

a)
b)
c)

2. In the space below, draw a diagram of seafloor spreading. Include and label the polar reversals, mid-ocean ridge, oceanic crust, seafloor surface, and direction of movement in the diagram.

3. Use your findings and evidence related to the theories of Hess and Wegener to develop an argument to support the following claim: "Crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and older rocks are located further away from the mid-ocean ridge."

SCILLSS Classroom-based Assessment Resources

Educator Task Administration Guide

Task Title: Continental Drift and Seafloor Spreading **Grade:** High School **PE:** HS-ESS1-5

Task Introduction

This task is about seafloor spreading (HS-ESS1-5). It requires the educator to engage students in a group discussion after viewing a video related to seafloor spreading found at https://www.youtube.com/watch?v=GyMLlLxbfa4. The video provides information about the discoveries of Harold Hess related to the process of seafloor spreading that created the oceans' seafloors. After watching the video, the educator discusses with students how Hess' theory of seafloor spreading relates to Alfred Wegener's ideas (i.e., the originator of the theory of continental drift by hypothesizing in 1912 that the continents are slowly drifting around the Earth). Note: Harry Hess' hypothesis about seafloor spreading had several pieces of evidence to support the theory. One of these is polar reversals. (Students may need clarification about polar reversal. The educator could also have students watch a video that explains this phenomenon found at http://www.youtube.com/watch?time_continue=274&v=5eka88IOJ-I). Following the group discussion, the students work in small groups to build a model of seafloor spreading. Finally, each student is presented with three questions to individually respond to, which are evaluated by the educator.

Purpose and Use

This task is intended for use at a point in instruction when the teacher wants to determine if students can evaluate and synthesize evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. The results of the tasks will be used to adjust instruction as appropriate.

Elements of the Task

This task is designed to measure students' ability to integrate the dimensions and demonstrate their knowledge, skills, and abilities (KSAs) as represented by the PE, HS-ESS1-5 "Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks."

Table 1 specifies the dimensions and the key aspects of the PE that are assessed by the task. In addition, expectations for students' prior knowledge are indicated. Table 2 specifies the KSAs, work products, and task features represented by the task.

Table 1. Specific Practices, Disciplinary Core Ideas, and Crosscutting Concepts to be Assessed

NGSS Performance Expectation: HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. [Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient core of the continental plate (a result of past plate interactions).]

	Science and Engineering Practices (SEP)	**Disciplinary Core Ideas (DCI)**	**Crosscutting Concepts (CCC)**
Foundations	**SEP: Engaging in Argument from Evidence** • Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments.	**DCI: The History of Planet Earth** • Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old.	**CCC: Patterns** • Empirical evidence is needed to identify patterns.
Key Aspects	• Evaluate the claims behind currently accepted explanations to determine the merits of arguments • Evaluate the claims behind currently accepted solutions to determine the merits of arguments • Evaluate the evidence behind currently accepted explanations to determine the merits of arguments • Evaluate the evidence behind currently accepted solutions to determine the merits of arguments • Evaluate the reasoning behind currently accepted explanations to determine the merits of arguments • Evaluate the reasoning behind currently accepted solutions to determine the merits of arguments	• Active geologic processes have destroyed or altered most of the very early rock record on Earth • Some objects in the solar system have changed very little over billions of years • Studying these objects can help deduce the solar system's age and history	• Identify a pattern in an observed phenomenon • Explain the pattern in a system under study • Support a claim about the pattern in a system under study
Prior Knowledge	• Use linear equations and systems of linear equations to represent, analyze, and solve a variety of problems • Analyze situations and solve problems. Knowledge of how to	• Rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history	**Relationships to SEPs** • Patterns can be used to support an argument • Data analysis serves to identify and characterize patterns

	recognize patterns of association in bivariate data • Write an argument			• Patterns can be used as empirical evidence for causality in supporting explanations of phenomena

Table 2. Components of the Assessment Task

Knowledge, Skills, & Abilities: • **KSA1:** Investigate how Earth's internal and surface processes operate at different spatial and temporal scales to explain the ages of crustal rocks • **KSA2:** Synthesize the relevant evidence to describe the relationship between the motion of continental plates and the patterns in the ages of crustal rocks • **KSA3:** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks
Student Demonstration of Learning: • Model accurately represents the observable phenomena • Model accurately captures all mechanistic features of the observable phenomena • Use a model to make an accurate prediction about a phenomenon (e.g., direction of plate movement) • Represents only the appropriate relationships and/or interactions among the elements in the model needed to explain the target phenomenon and describes why these relationships are important • Organizes data in a clear way that highlights patterns that are relevant or meaningful to a scientific question • Synthesizes relevant evidence and relevant or meaningful patterns to defend a claim or support an argument
Work Product: • Group discussion • Draw a model • Laboratory exercise • Short response • Constructed response
Task Features: • All tasks require evidence of qualitative and/or quantitative thinking. • All tasks must prompt students to make connections between observed phenomenon or evidence and reasoning underlying the observation/evidence. • Models provided in stimulus materials must illustrate a process or why a phenomenon exists (e.g., plate movement). • All tasks are presented in a context that revolves around movement of crustal rocks. • All phenomena for which a model is developed must be observable or fit available evidence (e.g., plate tectonics to explain the ages of crustal rocks). • Students use scientific reasoning and process skills in observational (nonexperimental) investigations. • All tasks must elicit core ideas as defined in the PE.

- All tasks must include elements from at least two dimensions of the NGSS.

Task Administration

Materials and Set-up

Materials

To administer the task, educators will need:

- Task administration guide
- Student task worksheet (one per student)
- 1 box lid with a slit cut in the center for the paper strip per group
- 100 cm long paper strip to be folded in half, with the two ends emerging from the box lid per group
- 1 box of markers per group
- 1 bar magnet and 1 compass per group
- Meter stick per group
- Laptops/Computer/projection screen/Smart Board

Duration

This task including the group project can be administered in approximately one class period.

Set-up

Prior to administration, print copies of the student task worksheet. Each student will receive a copy of the worksheet. Educators should set up the materials for the group project and either distribute student laptops or have the seafloor spreading video ready for projection. Educators could also have students watch a video that explains polar reversal, if needed: http://www.youtube.com/watch?time_continue=274&v=5eka88IOJ-I.

Directions for Administration

During administration, educators should:

1. Instruct students to take notes while viewing a seafloor spreading video at https://www.youtube.com/watch?v=GyMLlLxbfa4. (The video should be played for the whole class, or computers should be available for students).
2. If needed, instruct students to take notes while viewing the video on polar reversal at http://www.youtube.com/watch?time_continue=274&v=5eka88IOJ-I. (The video should be played for the whole class, or computers should be available for students).
3. Facilitate a group discussion after the video using the guiding questions: 1) What important discoveries did Hess and his fellow scientists make? 2) Why are models necessary for studying Earth processes?
4. Provide each student with a copy of Part 1 of the student task worksheet and read the *Background Information* section to students. Have students work in small groups to create a model, which incorporates their discussion points including seafloor spreading and the magnetic stripes that occur

in the seafloor. While students are working, walk around and monitor student progress, noting any misconceptions or areas in which students are struggling. Follow up with individual students as needed.

5. When students complete their model, provide each student with a pencil and Part 2 of the student task worksheet. Instruct students to complete Part 2 of the student task worksheet. Address questions from the students related to expectations for completing the task. However, ensure that the discussion does not include information that provides an unfair advantage for students to complete the task/items. Tell the students the task includes three questions that they will complete individually. Remind students to check their work and to ensure that all parts of the task are completed.
6. While the entire task should take approximately one class period to complete, students can take additional time as needed to finish. While students are working, walk around and monitor student progress, noting any misconceptions or areas in which students are struggling. Follow up with individual students as needed.

Guidelines for Evaluating Student Performance

Following administration of the task, evaluate each student response using the provided rubric. Identify the evidence of what each student knows and can do with regard to each question. Assign each student a "score" in order to classify the student's performance and to inform how he or she may be grouped with other students for instruction. Consider whether the student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction (a "3"); has a partial understanding and needs additional instruction on some concepts before new instruction is provided (a "2"); or has not learned the material and/or has misconceptions and reteaching of the key concepts is required (a "1").

Collectively consider the evidence of student performance across all students. Do any patterns or trends emerge with regard to students' demonstrated knowledge, skills, and abilities related to this standard/performance expectation? Do you notice any common misconceptions or misunderstandings?

Next, consider how you might address students' needs. How will you adjust instruction based on the observed patterns and trends? Consider what aspects of the standard/performance expectation (i.e., dimensions) require additional instruction for individuals, small groups, or the class.

Rubric

Dimension Element	1	2	3
Engaging in Argument from Evidence	Interpret observations from evidence and models to partially support an argument but does not link the explanation to the scenario.	Interpret observations from evidence and models to support an argument and link it to the scenario.	Interpret relevant observations from evidence and models, justifying using or not using elements of the data to support an argument that is linked to the scenario with examples.
Patterns	Incomplete explanation of the components of the model to the relationship between the motion of continental plates and the patterns in the ages of crustal rocks.	Identify aspects of the relationship between the motion of continental plates and the patterns in the ages of crustal rocks (e.g., boundaries where plates are moving apart, such as mid-ocean ridges) in the model.	Synthesize relevant evidence to describe the relationship between the motion of continental plates and the patterns in the ages of crustal rocks in the model.
The History of Planet Earth	Does not synthesize relevant evidence to describe the relationship between the seafloor, magnetic field, mid-ocean ridge, and magnetic reversals shown in the diagram.	Synthesize relevant evidence to partially describe the relationship between the seafloor, magnetic field, mid-ocean ridge, and magnetic reversals shown in the diagram.	Synthesize relevant evidence to describe the relationship between the seafloor, magnetic field, mid-ocean ridge, and magnetic reversals shown in the diagram.

Student Exemplar(s)

Question 1: Short Response

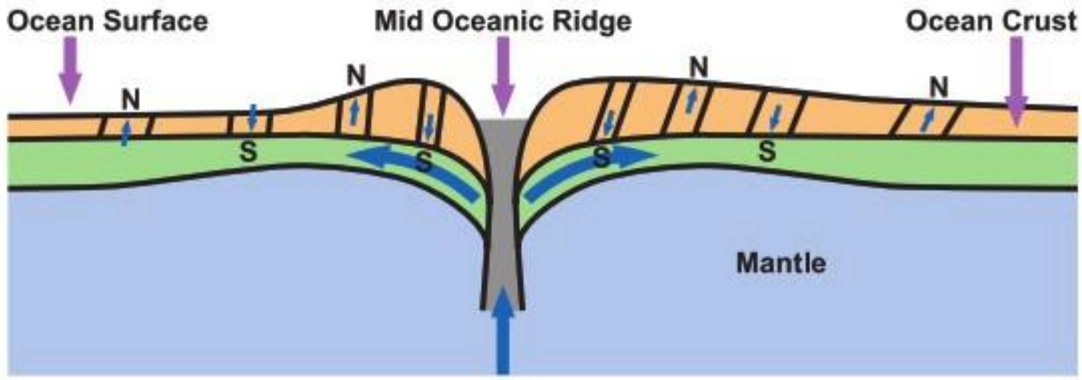
The components represent:

a. Process of seafloor spreading

b. The magnet represents Earth's magnetic field and flipping it shows Earth's magnetic reversals.

c. The different sections are the different orientations of Earth's magnetic field when the seafloor formed.

Question 2: Construct a Model



Question 3: Constructed Response

"Crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity. This is supported by data. This includes the magnetic patterns found along these ridges. Based on the north and south magnetic patterns and spacing of magnetic stripes the seafloor grows away from the ridge. So, the motion of the plates moves rocks further and further away from the ridge. This shows that because of that the older rocks are located further away from the mid-ocean ridge and newer rocks are nearer the ridge."

Dimension Element 1: Engaging in argument from evidence, Score Point 1

SCORE POINT 1

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: High School

NGSS PE: HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

Background Information

Alfred Wegener was a meteorologist who proposed the theory of continental drift in 1912 by proposing that the continents are in motion. Harold Hess was a geologist who confirmed Wegener's ideas by using the evidence of seafloor spreading to explain the forces that move continents.

Part 1

With your group, use the information we just discussed to build a model of seafloor spreading using the following materials:

1. 1 box lid with a slit cut in the center for the paper strip
2. 100 cm long paper strip to be folded in half, with the two ends emerging from the box lid
3. 1 box of markers
4. 1 bar magnet and 1 compass
5. Meter stick

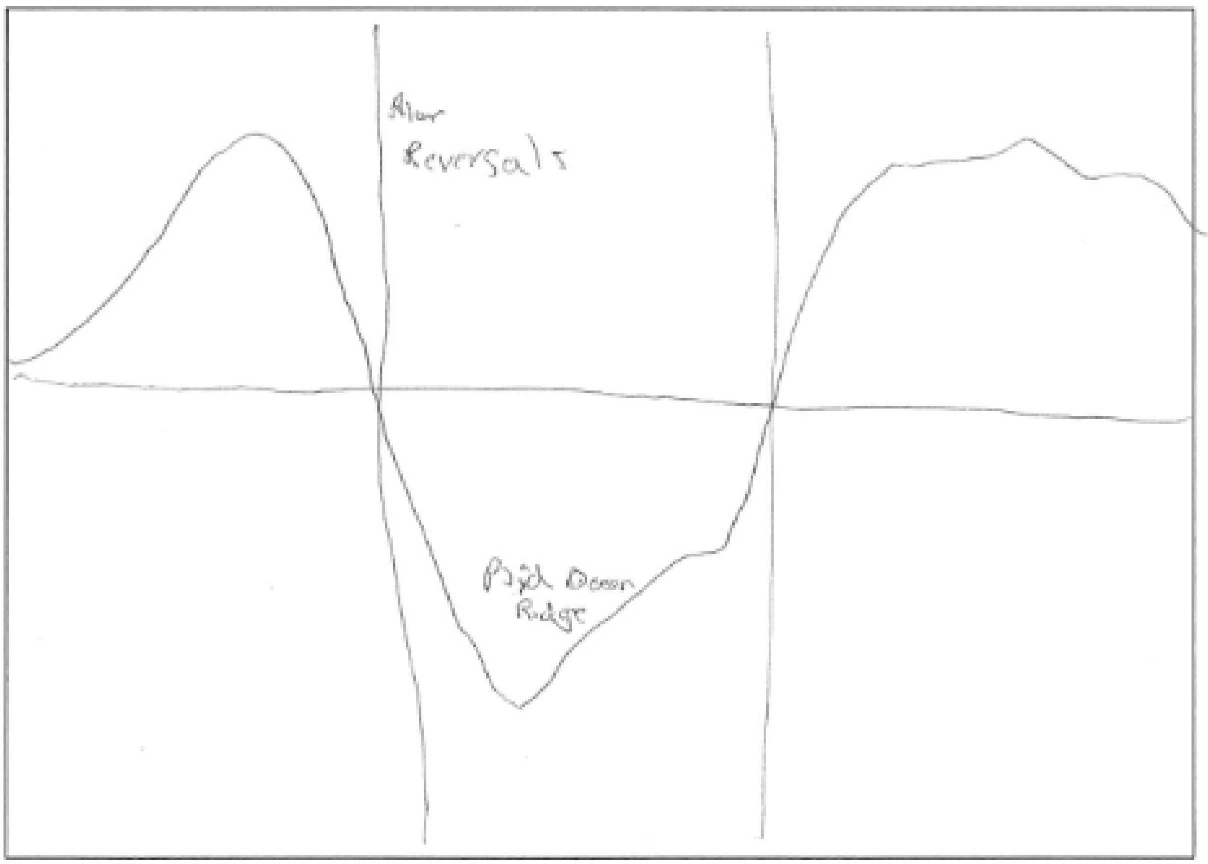
Part 2

Work independently to answer all three questions.

1. What do the following components of the group model represent?
   a. the process of pulling the paper strips
   b. the magnet and what flipping shows
   c. the marked sections of the paper strip (e.g., A, B, C, etc.)

a)	time
b)	Plate sea floor spreading
c)	movement of plate tectonics

2. In the space below, draw a diagram of seafloor spreading. Include and label the polar reversals, mid-ocean ridge, oceanic crust, seafloor surface, and direction of movement in the diagram.



3. Use your findings and evidence related to the theories of Hess and Wegener to develop an argument to support the following claim: "Crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and older rocks are located further away from the mid-ocean ridge."

This claim is true because you can identify the shape and layers of rock that are arranged in a pattern. Rocks that are older are located further away from the mid-ocean ridge because they will be deeper in the ground.

Dimension Element: Engaging in argument from evidence.

Score Point 1: Student has not learned the material and/or has misconceptions and reteaching of the key concepts is required.

Student response includes a partially labeled model that attempts to show the processes occurring at the mid-ocean ridge. The identification of the different parts of the model show a misunderstanding of the processes occurring at the mid-ocean ridge. Response includes a reference to a claim. Statements intended to support the claim are irrelevant to the task and scenario. Response includes an incorrect interpretation of the geological processes in the scenario ("rocks that are older are located further away from the mid-ocean ridge because they will be deeper in the ground").

Dimension Element 1: Engaging in argument from evidence, Score Point 2

SCORE POINT 2

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: High School

NGSS PE: HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

Background Information

Alfred Wegener was a meteorologist who proposed the theory of continental drift in 1912 by proposing that the continents are in motion. Harold Hess was a geologist who confirmed Wegener's ideas by using the evidence of seafloor spreading to explain the forces that move continents.

Part 1

With your group, use the information we just discussed to build a model of seafloor spreading using the following materials:

1. 1 box lid with a slit cut in the center for the paper strip
2. 100 cm long paper strip to be folded in half, with the two ends emerging from the box lid
3. 1 box of markers
4. 1 bar magnet and 1 compass
5. Meter stick

Part 2

Work independently to answer all three questions.

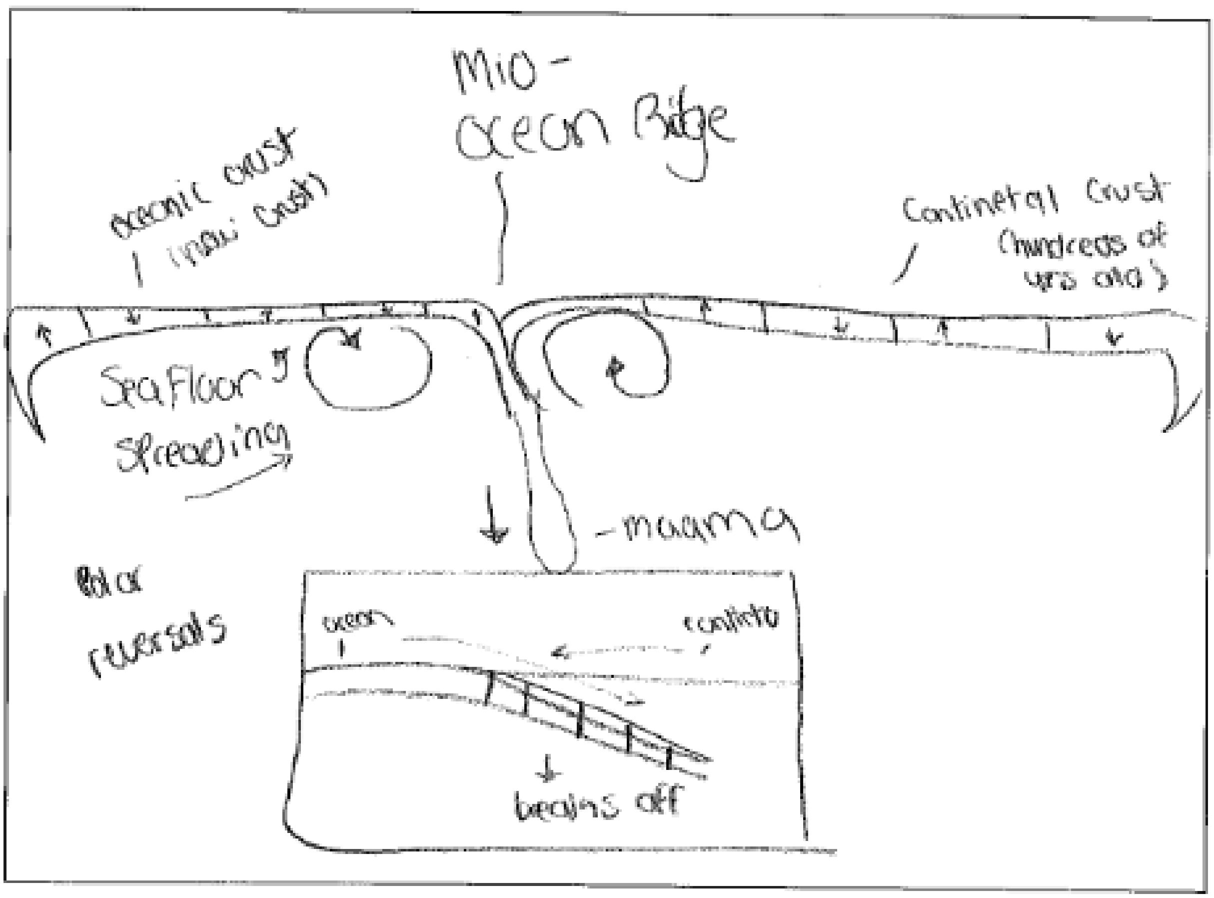
1. What do the following components of the group model represent?
    a. the process of pulling the paper strips
    b. the magnet and what flipping shows
    c. the marked sections of the paper strip (e.g., A, B, C, etc.)

a) The Proces of pulling the paper strips is sea floor spreading

b) The magnet and what flipping shows are the poles changing.

c) The marked sections of the paper are the oceanic & continental crust that are dated

2. In the space below, draw a diagram of seafloor spreading. Include and label the polar reversals, mid-ocean ridge, oceanic crust, seafloor surface, and direction of movement in the diagram.



3. Use your findings and evidence related to the theories of Hess and Wegener to develop an argument to support the following claim: "Crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and older rocks are located further away from the mid-ocean ridge."

Crustal matirials of different ages can be attributed to plate tetonic activtity and older rocks are located further away from the mide ocean ride from Hess and Wegner's theories to Prove it's truth. First we know how to tell the age of the rock. We know when evaluate a rocks age the bottom layer is the oldest similar to the farthes rocks from the ridge. While if you think about it the older curst isn't being recycled it's the oceanic crust that is more easy to break and recycled.

Dimension Element: Engaging in argument from evidence.

Score Point 2: Student has a partial understanding and needs additional instruction on some concepts before new instruction is provided.

Student response includes a partially labeled model showing the processes occurring at the mid-ocean ridge. Response includes marked sections that are incorrectly described as "oceanic and continental crust that are created." Response references Hess and Wegener with little evidence provided to support the claim. Some ideas are not clear (e.g., "oceanic crust that is more easy to break"), and there is limited usage of scientific terms or concepts to explain the phenomenon.

Dimension Element 1: Engaging in argument from evidence, Score Point 3

SCORE POINT 3

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: High School

NGSS PE: HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

Background Information

Alfred Wegener was a meteorologist who proposed the theory of continental drift in 1912 by proposing that the continents are in motion. Harold Hess was a geologist who confirmed Wegener's ideas by using the evidence of seafloor spreading to explain the forces that move continents.

Part 1

With your group, use the information we just discussed to build a model of seafloor spreading using the following materials:

1. 1 box lid with a slit cut in the center for the paper strip
2. 100 cm long paper strip to be folded in half, with the two ends emerging from the box lid
3. 1 box of markers
4. 1 bar magnet and 1 compass
5. Meter stick

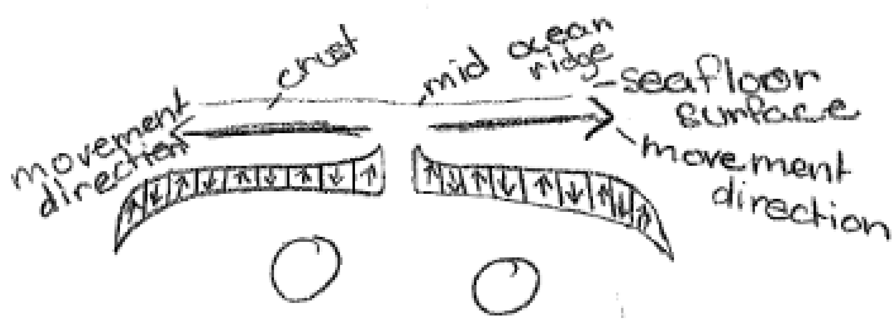
Part 2

Work independently to answer all three questions.

1. What do the following components of the group model represent?
   a. the process of pulling the paper strips
   b. the magnet and what flipping shows
   c. the marked sections of the paper strip (e.g., A, B, C, etc.)

a) The plate moving /sea floor spreading
b) The north and south pulls swiching
c) When the pull swiches

2. In the space below, draw a diagram of seafloor spreading. Include and label the polar reversals, mid-ocean ridge, oceanic crust, seafloor surface, and direction of movement in the diagram.



3. Use your findings and evidence related to the theories of Hess and Wegener to develop an argument to support the following claim: "Crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and older rocks are located further away from the mid-ocean ridge."

The rocks move because of the mantle under them. As the rock move the further they get from where it opens to the mantle. You have to remember that the rock on the other side would be the same. They would be parallel to each other. The mid ocean rid is where the two plates are going apart. The magnetic pulls are going to be the same on both plates that are parallel to the mid ocean rid. They have north and south pulls. The sea floor would also be spreding away from each other. So from this it make sense that Wegener is right. I think his theory is correct. Also the rocks by some places would be older

and I think that is because they have moved apart but once they were together

Dimension Element: Engaging in argument from evidence.

Score Point 3: Student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction.

Student response includes a model illustrating how Earth's internal processes operate at different spatial and temporal scales to form ocean-floor features. Response describes aspects of the model which illustrate how the appearance of sea-floor features are a result of both constructive forces and destructive mechanisms. Response includes an explanation of the rates of change of Earth's internal and surface processes over very long periods of time. Response references scientific evidence to support the explanation of the past movements of oceanic crust to support the claim "crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and older rocks are located further away from the mid-ocean ridge." Student evaluates evidence of plate interactions to explain the ages of crustal rocks.

Dimension Element 2: Patterns, Score Point 1

SCORE POINT 1

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: High School

NGSS PE: HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

Background Information

Alfred Wegener was a meteorologist who proposed the theory of continental drift in 1912 by proposing that the continents are in motion. Harold Hess was a geologist who confirmed Wegener's ideas by using the evidence of seafloor spreading to explain the forces that move continents.

Part 1

With your group, use the information we just discussed to build a model of seafloor spreading using the following materials:

1. 1 box lid with a slit cut in the center for the paper strip
2. 100 cm long paper strip to be folded in half, with the two ends emerging from the box lid
3. 1 box of markers
4. 1 bar magnet and 1 compass
5. Meter stick

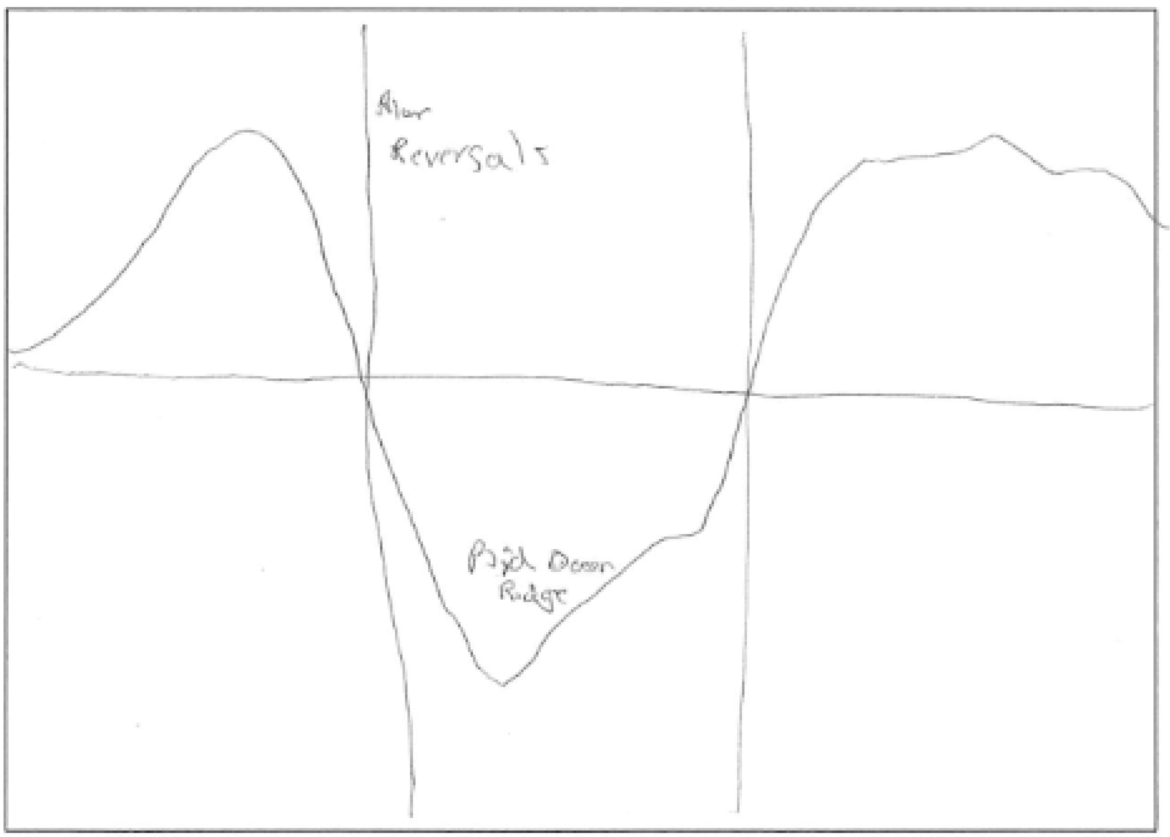
Part 2

Work independently to answer all three questions.

1. What do the following components of the group model represent?
   a. the process of pulling the paper strips
   b. the magnet and what flipping shows
   c. the marked sections of the paper strip (e.g., A, B, C, etc.)

a)	time
b)	Plate sea floor spreading
c)	movement of plate tectonics

2. In the space below, draw a diagram of seafloor spreading. Include and label the polar reversals, mid-ocean ridge, oceanic crust, seafloor surface, and direction of movement in the diagram.



3. Use your findings and evidence related to the theories of Hess and Wegener to develop an argument to support the following claim: "Crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and older rocks are located further away from the mid-ocean ridge."

This claim is true because you can identify the shape and layers of rock that are arranged in a pattern. Rocks that are older are located further away from the mid-ocean ridge because they will be deeper in the ground.

Dimension Element: Patterns.

Score Point 1: Student has not learned the material and/or has misconceptions and reteaching of the key concepts is required.

Student response includes an incorrectly labeled model with little attempts to show the patterns in the cycling of matter by thermal convection. Response includes an incorrect interpretation of what the model is intended to convey (i.e., a representation of the classroom activity). Response includes an incorrect a pattern to support the claim ("this claim is true because you can identify the shape and layers of rock that are arranged in a pattern"). Response includes a vague reference to the motion of continental plates and the patterns in the ages of crustal rocks ("rocks that are older are located further away from the mid-ocean ridge because they will be deeper in the ground").

Dimension Element 2: Patterns, Score Point 2

SCORE POINT 2

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: High School

NGSS PE: HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

Background Information

Alfred Wegener was a meteorologist who proposed the theory of continental drift in 1912 by proposing that the continents are in motion. Harold Hess was a geologist who confirmed Wegener's ideas by using the evidence of seafloor spreading to explain the forces that move continents.

Part 1

With your group, use the information we just discussed to build a model of seafloor spreading using the following materials:

1. 1 box lid with a slit cut in the center for the paper strip
2. 100 cm long paper strip to be folded in half, with the two ends emerging from the box lid
3. 1 box of markers
4. 1 bar magnet and 1 compass
5. Meter stick

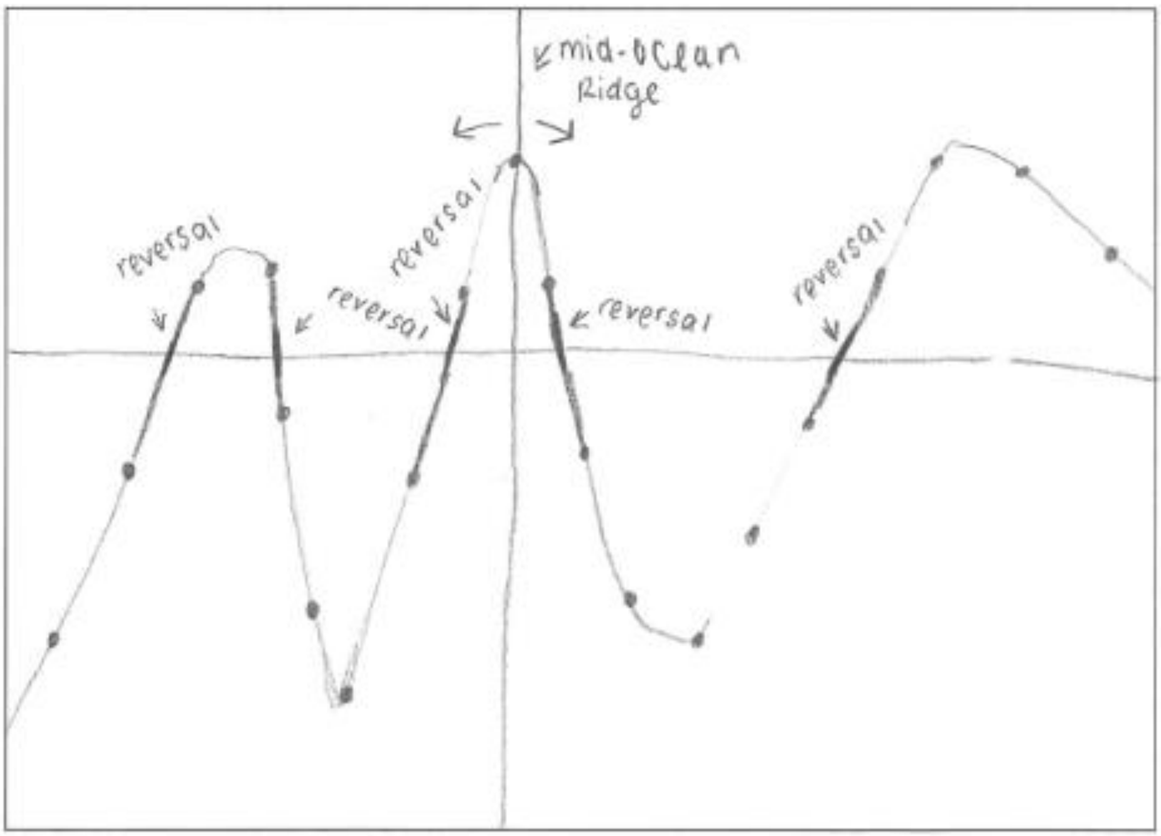
Part 2

Work independently to answer all three questions.

1. What do the following components of the group model represent?
   a. the process of pulling the paper strips
   b. the magnet and what flipping shows
   c. the marked sections of the paper strip (e.g., A, B, C, etc.)

a) changing of time	
b) symmetry	
c) magnetic reversals	

2. In the space below, draw a diagram of seafloor spreading. Include and label the polar reversals, mid-ocean ridge, oceanic crust, seafloor surface, and direction of movement in the diagram.



3. Use your findings and evidence related to the theories of Hess and Wegener to develop an argument to support the following claim: "Crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and older rocks are located further away from the mid-ocean ridge."

Younger rocks are always located above older rocks in a pattern that correlates with rock layers and plate tectonic activity. Continental drift explains the theory about how continents may have all been stuck together at one point in time, and how they all broke apart over time. Plate tectonic movement explains how plates may move away, toward, or past each other, and form earthquakes or other landforms. So, based off of these theories, the older rocks or continents may have drifted away farther and be further away from the mid-ocean ridge, while the younger land forms might be closer to the mid-ocean ridge.

Dimension Element: Patterns.

Score Point 2: Student has a partial understanding and needs additional instruction on some concepts before new instruction is provided.

Student response includes a partially labeled model that attempts to show the patterns in the cycling of matter by thermal convection. Response includes a reference to "symmetry" represented by the "reversals." Response includes an incorrect interpretation of what the model is intended to convey (i.e., a representation of the classroom activity). Student attempts to identify and describe a relevant pattern in the geological process in order to support the claim ("younger rocks are always located above older rocks in a pattern that correlates with rock layers and plate tectonic activity"). Response includes an incorrect interpretation of the geological processes in the scenario that would support the provided claim (i.e., focus is on describing/defining plate tectonics).

Dimension Element 2: Patterns, Score Point 3

SCORE POINT 3

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: High School

NGSS PE: HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

Background Information

Alfred Wegener was a meteorologist who proposed the theory of continental drift in 1912 by proposing that the continents are in motion. Harold Hess was a geologist who confirmed Wegener's ideas by using the evidence of seafloor spreading to explain the forces that move continents.

Part 1

With your group, use the information we just discussed to build a model of seafloor spreading using the following materials:

1. 1 box lid with a slit cut in the center for the paper strip
2. 100 cm long paper strip to be folded in half, with the two ends emerging from the box lid
3. 1 box of markers
4. 1 bar magnet and 1 compass
5. Meter stick

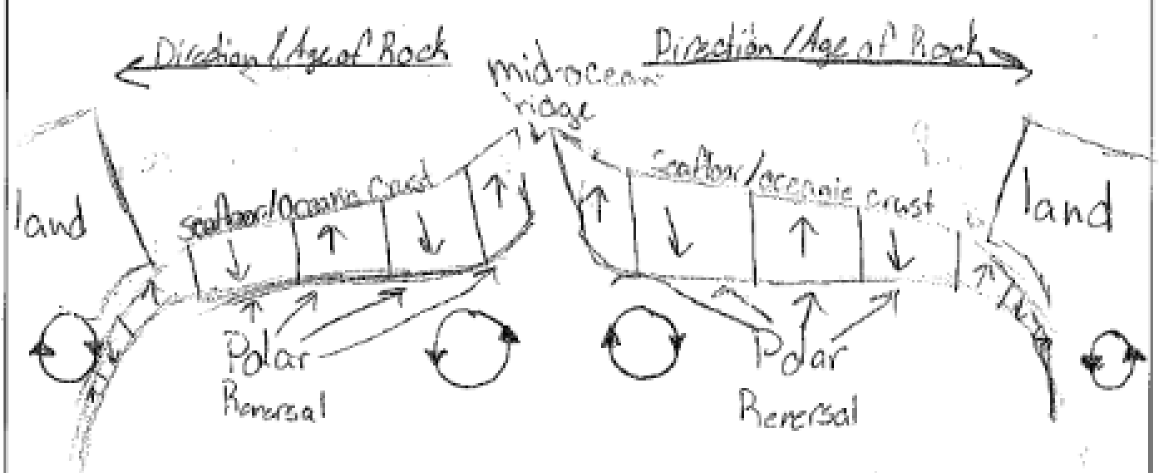
Part 2

Work independently to answer all three questions.

1. What do the following components of the group model represent?
   a. the process of pulling the paper strips
   b. the magnet and what flipping shows
   c. the marked sections of the paper strip (e.g., A, B, C, etc.)

a)	The movement of the tectonic plates
b)	The north and south pulls swiching
c)	When the pull swiches

2. In the space below, draw a diagram of seafloor spreading. Include and label the ~~polar reversals~~, mid-~~ocean ridge~~, ~~oceanic crust~~, ~~seafloor surface~~, and ~~direction of movement in the diagram.~~



3. Use your findings and evidence related to the theories of Hess and Wegener to develop an argument to support the following claim: "Crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and older rocks are located further away from the mid-ocean ridge."

The crustal materials of diffrent ages and how they are arranged is depending on how far it is from the mid-ocean ridge. Alltho the material of the rocks don't change to much the density is one way of telling if one rock is older than the other. if it is more dense it would be colder because like in the Convection currents when it is hotter the material will rise up when it is cold down it is more dense so it will sink back down. So the cooler the rock the denser it is the older it is because it has had more time to cool down. Patterns that can be attributed to plate tectonics are the swich of pulls. over a long period of time (about 1 million years) the North and South pulls swich and you can see this. In the rock the material will look diffrent compared to when the pulls were the other way around. Why older rocks are located furter away from the mid-ocean ridge is becouse the material is going out and not being pulled in so the rocks that got pushed out keep getting pushed out got away further from the mid-ocean ride.

Dimension Element: Patterns.

Score Point 3: Student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction.

Student response includes a model based on evidence of the Earth's interior to describe patterns in the cycling of matter by thermal convection. The model identifies patterns in crustal rocks attributed to plate tectonics. Response includes an explanation that coordinates patterns of evidence with current theory. Response describes the relationship between the motion of continental plates and the patterns in the ages of crustal rocks shown in the model.

Dimension Element 3: The history of planet Earth, Score Point 1

SCORE POINT 1

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: High School

NGSS PE: HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

Background Information

Alfred Wegener was a meteorologist who proposed the theory of continental drift in 1912 by proposing that the continents are in motion. Harold Hess was a geologist who confirmed Wegener's ideas by using the evidence of seafloor spreading to explain the forces that move continents.

Part 1

With your group, use the information we just discussed to build a model of seafloor spreading using the following materials:

1. 1 box lid with a slit cut in the center for the paper strip
2. 100 cm long paper strip to be folded in half, with the two ends emerging from the box lid
3. 1 box of markers
4. 1 bar magnet and 1 compass
5. Meter stick

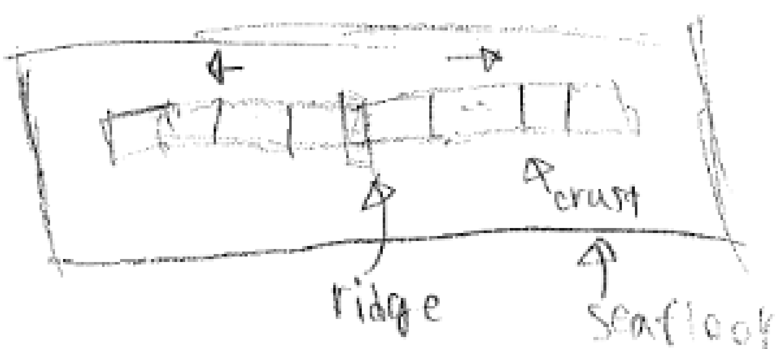
Part 2

Work independently to answer all three questions.

1. What do the following components of the group model represent?
    a. the process of pulling the paper strips
    b. the magnet and what flipping shows
    c. the marked sections of the paper strip (e.g., A, B, C, etc.)

a) The Plates moving as time goes on
b) representing the north and south Poles.
c) The aged Plates

2. In the space below, draw a diagram of seafloor spreading. Include and label the polar reversals, mid-ocean ridge, oceanic crust, seafloor surface, and direction of movement in the diagram.



3. Use your findings and evidence related to the theories of Hess and Wegener to develop an argument to support the following claim: "Crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and older rocks are located further away from the mid-ocean ridge."

as magma comes out the ridge it cools to make new rocks. The newer rocks push the older rocks which creates a pattern. The older rocks are further away from the ridge while the newer rocks are closer.

Dimension Element: The history of planet Earth.

Score Point 1: Student has not learned the material and/or has misconceptions and reteaching of the key concepts is required.

Model includes flawed reference to magnetic reversals. Response describes "newer rocks" pushing "older rocks" away which creates a pattern in an attempt to describe the fact that continental rocks are generally much older than rocks of the ocean floor. There is no relevant evidence related to what was provided in the model, and there is little to no use of scientific terminology.

Dimension Element 3: The history of planet Earth, Score Point 2

SCORE POINT 2

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: High School

NGSS PE: HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

Background Information

Alfred Wegener was a meteorologist who proposed the theory of continental drift in 1912 by proposing that the continents are in motion. Harold Hess was a geologist who confirmed Wegener's ideas by using the evidence of seafloor spreading to explain the forces that move continents.

Part 1

With your group, use the information we just discussed to build a model of seafloor spreading using the following materials:

1. 1 box lid with a slit cut in the center for the paper strip
2. 100 cm long paper strip to be folded in half, with the two ends emerging from the box lid
3. 1 box of markers
4. 1 bar magnet and 1 compass
5. Meter stick

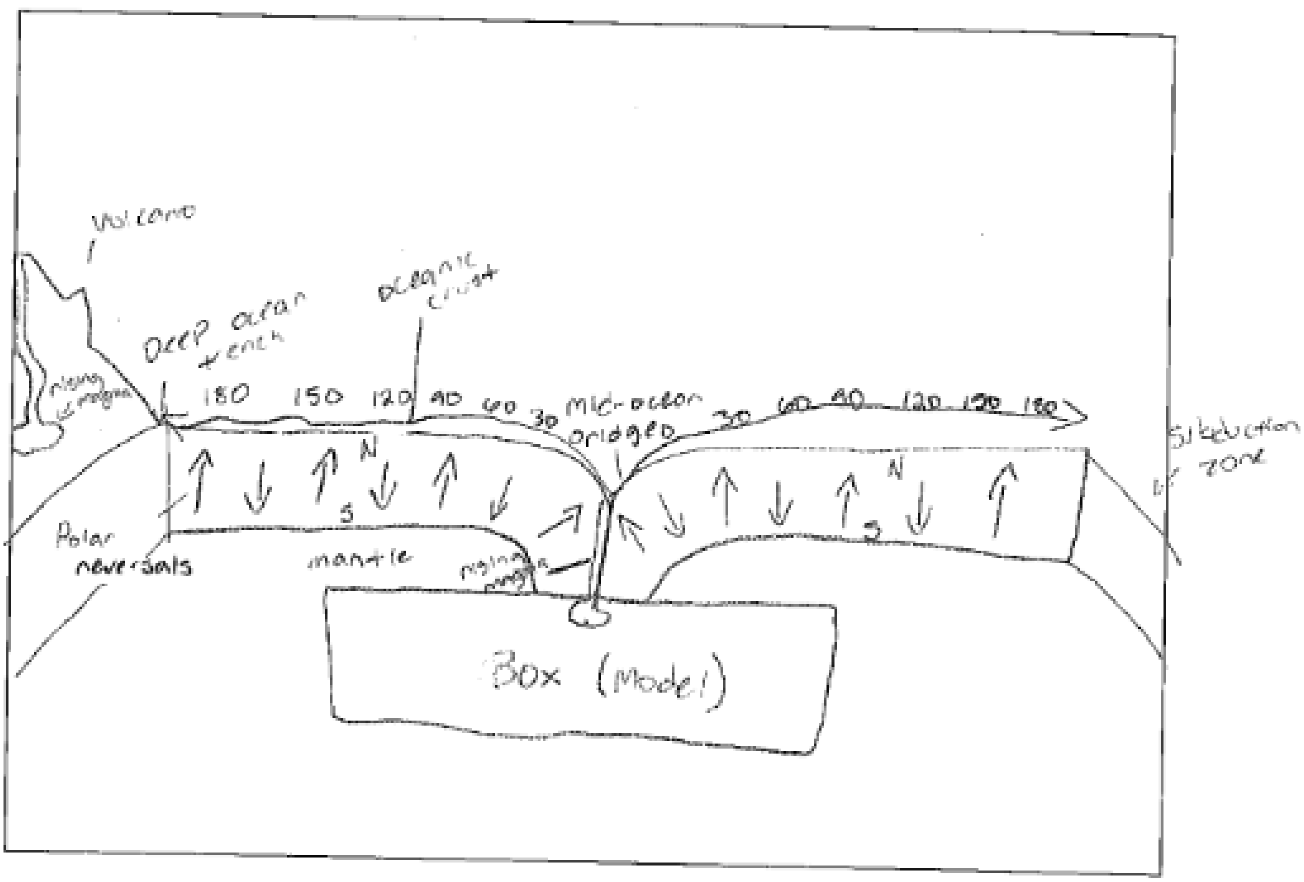
Part 2

Work independently to answer all three questions.

1. What do the following components of the group model represent?
   a. the process of pulling the paper strips
   b. the magnet and what flipping shows
   c. the marked sections of the paper strip (e.g., A, B, C, etc.)

a)	Seafloor spreading
b)	Flipping poles
c)	Time periods of the rocks

2. In the space below, draw a diagram of seafloor spreading. Include and label the polar reversals, mid-ocean ridge, oceanic crust, seafloor surface, and direction of movement in the diagram.



3. Use your findings and evidence related to the theories of Hess and Wegener to develop an argument to support the following claim: "Crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and older rocks are located further away from the mid-ocean ridge."

A mid-ocean ridge is caused by divergent plate boundaries. As the plates move away from eachother, molten seaps up through the middle to form a mid-ocean ridge. The plates continue to move apart, however, every few million years, the polar reversals switch and the movement switches from North to South. As the plates move apart, new rocks are formed at the mid-ocean ridge as older rock is pushed further out. As the plates move further and further out, they go under the continental crust to form a subduction zone which causes magma to rise. This rising magma causes volcanoes to erupt. As the plates go under the continental crust as the oceanic crust, the plates are recycled underground. Recycling plates is why the earth never gets bigger or smaller. The [illegible] zone is called a deep ocean trench. Divergent boundaries is why the continents aren't [illegible] connected anymore.

Dimension Element: The history of planet Earth.

Score Point 2: Student has a partial understanding and needs additional instruction on some concepts before new instruction is provided.

Student response cites evidence to support the provided claim; however, it does not reference the claim in the response. Student demonstrates an understanding of plate tectonics concepts and why continental rocks are generally much older than rocks of the ocean floor. Student uses knowledge of plate movements to develop explanations for the ages of crustal rocks. Response includes a reference to magnetic pole reversals without explicitly stating how the pole reversals support the pattern of arrangement of Earth's crustal materials of different ages. Response includes additional information related to plate tectonics, which is correct, yet not necessary to support the claim.

Dimension Element 3: The history of planet Earth, Score Point 3

SCORE POINT 3

Student ID:

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: High School

NGSS PE: HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

Background Information

Alfred Wegener was a meteorologist who proposed the theory of continental drift in 1912 by proposing that the continents are in motion. Harold Hess was a geologist who confirmed Wegener's ideas by using the evidence of seafloor spreading to explain the forces that move continents.

Part 1

With your group, use the information we just discussed to build a model of seafloor spreading using the following materials:

1. 1 box lid with a slit cut in the center for the paper strip
2. 100 cm long paper strip to be folded in half, with the two ends emerging from the box lid
3. 1 box of markers
4. 1 bar magnet and 1 compass
5. Meter stick

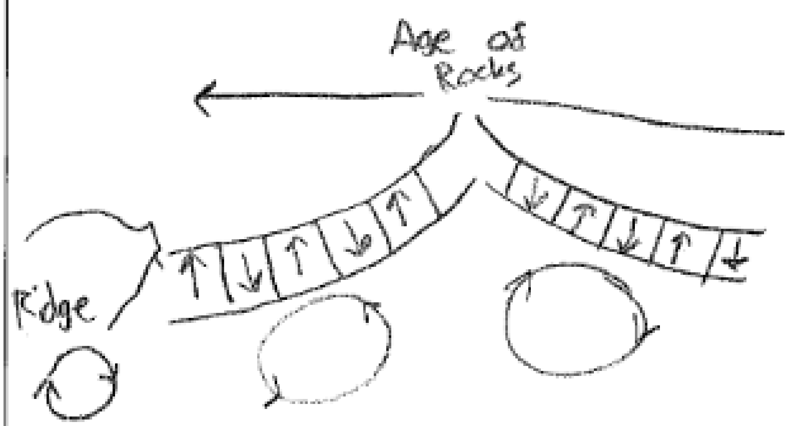
Part 2

Work independently to answer all three questions.

1. What do the following components of the group model represent?
    a. the process of pulling the paper strips
    b. the magnet and what flipping shows
    c. the marked sections of the paper strip (e.g., A, B, C, etc.)

a)	New Sediment pushing out of the mantle
b)	representing where South and north pole are located
c)	how the movement of the plates keep moving

2. In the space below, draw a diagram of seafloor spreading. Include and label the polar reversals, mid-ocean ridge, oceanic crust, seafloor surface, and direction of movement in the diagram.



3. Use your findings and evidence related to the theories of Hess and Wegener to develop an argument to support the following claim: "Crustal materials of different ages are arranged on Earth's surface in a pattern that can be attributed to plate tectonic activity and older rocks are located further away from the mid-ocean ridge."

Earth has plates in which can move in various patterns. It all starts down in the core, its heads up and moves the convection currents. This process forces magma up to the surface, which then cools down and turns to rock. After millions of years the rock pushes away (divergent) from mid-ocean ridge. This is why rock closer to mid-ocean ridge is younger because of plate movement. Magnetic poles are also a factor in plate movement. This pattern tells us that the magnetic poles switch every 2-3 million years. Lastly when new rock comes to the surface other rock needs to make room by subducting under a continential plate recycling back into the earth.

Dimension Element: The history of planet Earth.

Score Point 3: Student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction.

Student response cites evidence to support the claim and demonstrates an understanding that Earth has a hot, solid inner core, a liquid outer core, and a solid mantle and crust. Student uses knowledge of plate movements to develop explanations for the ages of crustal rocks. Response includes a reference to how magnetic pole reversals (i.e., magnetic field lines) are formed over time due to geomagnetic reversals and it includes a description of how magnetic pole reversals (i.e., magnetic field lines) can be used to plot the movement of plates over time. Response includes an evaluation of the claim, data, analysis, and a conclusion.

Appendix F. Grade 11 SCILLSS Classroom-based NGSS Science Assessment Tools, Tasks, Administration Guide, and Note on Anchor Papers for HS-ESS2-7

Unpacking the Dimensions Tool for HS-ESS2-7

Grade: 11

NGSS Performance Expectation: HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. [Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.] [*Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.*]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Engaging in Argument from Evidence** Construct an oral and written argument or counter-arguments based on data and evidence.	**ESS2.E: Biogeology** The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.	**CCC: Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable.
Key Aspects	• Construct an oral argument based on data and evidence. • Construct a written argument based on data and evidence. • Construct an oral counter-argument based on data and evidence. • Construct a written counter-argument based on data and evidence. • Identify possible weaknesses in either data or an argument and explain why their criticism is justified.	• Feedback (negative or positive) can stabilize or destabilize a system. • The feedbacks between life on Earth and the Earth's systems cause life on Earth to evolve and the surface of the Earth to undergo changes at the same time. • Examples of feedback include how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, thus reducing the amount of sunlight reflected from Earth's surface, which in turn increases surface temperatures and further reduces the amount of ice.	• Construct explanations of how things change. • Construct explanations of how things remain stable. • Evaluate models of complex systems and comprehend subtle issues of stability or of sudden or gradual change over time.

Prior Knowledge	• Use linear equations and systems of linear equations to represent, analyze, and solve a variety of problems. • Analyze situations and solve problems. • Knowledge of how to recognize patterns of association in bivariate data • Write an argument. • Use data to evaluate claims about cause and effect. • Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation	• The evolution and proliferation of living things over geological time have changed the rates of weathering and erosion of land surfaces, altered the composition of Earth's soils and atmosphere, and affected the distribution of water in the hydrosphere.	**Relationships to SEPs**	• Observations and data describe how things change. • Reasoning and data can be used to explain how things evolved to be the way they are today. • Arguments can be supported by quantifying and modeling changes in systems over very short or very long periods of time. • Explanations of how things evolved to be the way they are today involves modeling rates of change and conditions under which the system is stable or changes gradually, as well as explanations of any sudden change.

Assessment Task Specifications Tool for HS-ESS2-7

Element	Description
Performance Expectation	**HS-ESS2-7** Construct an argument based on evidence about the simultaneous co-evolution of Earth's systems and life on Earth.
The Knowledge, Skills & Abilities (KSAs)	**KSA1**: Construct an argument using causal links and feedback mechanisms between changes in the biosphere and changes in Earth's other systems, that there is simultaneous co-evolution of Earth's systems and life on Earth. **KSA2**: Construct an argument based on evidence about the simultaneous co-evolution of Earth's systems and life on Earth.
Student Demonstration of Learning	• Model accurately represents the observable phenomena • Model accurately captures all mechanistic features of the observable phenomena • Use a model to make an accurate prediction about a phenomenon (e.g., direction of plate movement) • Represents only the appropriate relationships and/or interactions among the elements in the model needed to explain the target phenomenon and describes why these relationships are important • A statement accurately describing how stability and change are related and a good model for a system must be able to offer explanations for both • Organizes data in a clear way that highlights changes observed from the evidence that are relevant or meaningful to a scientific question • Synthesizes relevant evidence related to complex systems and comprehend subtle issues of stability or of sudden or gradual change over time to defend a claim or support an argument or counter-argument
Work Product	• Constructed response • Short response • Draw a model
Task Features	• All tasks must prompt students to make connections between observed phenomenon or evidence and reasoning underlying the observation/evidence (e.g., changes in the biosphere and changes in Earth's other systems; ancient versus current atmospheric composition). • All tasks require the use of examples to support a logical argument in a context that revolves around changes in the biosphere and changes in Earth's other systems. • All tasks must elicit core ideas as defined in the PE. • All tasks must include elements from at least two dimensions of the NGSS.
Aspects of an assessment task that <u>can be varied</u> to shift complexity or focus	• Scale of mechanistic relationships in account of how things change and how they remain stable • Complexity of the scientific reasoning required to assess the extent to which the reasoning and data support the argument • Format of "real-world" phenomenon presented: image, data, text, combination
Assessment Boundaries	• Students do not need to demonstrate a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.

SCILLSS Classroom-based Assessment Resources

Student Task

Grade: High School

NGSS Performance Expectation: HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Task Introduction

This task is about the coevolution of Earth's systems and life on Earth. First, you will read and evaluate background information about gradual changes in Earth's atmosphere and interact with a computer-based animation about the geological history of oxygen. Then you will demonstrate your ability to use evidence from these sources to construct an argument to support the following claim: "Between 2.5–2.3 billion years ago, levels of oxygen on Earth began to rise."

Background Information

Early Earth would have been very different and unwelcoming to living things compared to the Earth today. Not only was early Earth covered in lava and constantly erupting, its atmosphere was choked with volcanic gases like carbon dioxide and sulfur dioxide. Volcanic eruptions on land and under the oceans released a lot of iron which, over time, dissolved into seawater. The most important feature of the ancient environment was the absence of oxygen. Therefore, the iron generally stayed dissolved in the seawater.

As Earth cooled, about 4.5 billion years ago, an atmosphere formed mainly from gases spewed from volcanoes. It included hydrogen sulfide, methane, and far greater levels of carbon dioxide than today's atmosphere.

Over millions of years, tectonic movement of the Earth's mantle thrust up the ocean floor to form coastal shallows. A few colonies of bacteria must have found successful survival conditions in these shallows. That's when blue-green algae (cyanobacteria) started the photosynthesis process. The appearance of cyanobacteria is recorded in fossils that formed roughly 3.5 billion years ago. Oxygen began to appear in the oceans. When the dissolved iron interacted with oxygen it precipitated out as iron oxide minerals.

These iron oxide materials, rust, began to form 3.0–2.0 billion years ago. This created black iron oxide minerals (like hematite and magnetite). These minerals, together with iron-poor reddish-colored shales and cherts, collected at the seafloor, and eventually turned into banded iron formations. These are common in rocks 2.8–2.0 billion years old, but do not form today.

In the interactive animation of oxygen levels over time, you will learn about the complex biological and geological factors that have influenced the changes in Earth's oxygen levels. Explore only through 2.4–1.8 billion years ago in the Proterozoic Eon.

Interactive Activity

Access the interactive graphic about the Geological History of Oxygen at https://media.hhmi.org/biointeractive/click/oxygen/. As you interact with the graphic, record evidence to use in support of the claim presented in question 1.

Task

1. Thinking like a geologist, use the background information and the evidence presented in the interactive activity to construct an argument to support the following claim.

   "Between 2.5–2.3 billion years ago, levels of oxygen on Earth began to rise."

SCILLSS Classroom-based Assessment Resources

Educator Task Administration Guide

Task Title: Changes in Earth's Oxygen Levels **Grade:** High School **PE:** HS-ESS2-7

Task Introduction

This task is about the simultaneous coevolution of Earth's systems and life on Earth (HS-ESS2-7). It requires students to use the information provided about gradual changes in Earth's atmosphere and a computer-based animation found at https://media.hhmi.org/biointeractive/click/oxygen/ to support a claim.

Purpose and Use

This task is intended for use at a point in instruction when the teacher wants to determine if students can construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. The results of the tasks will be used to adjust instruction as appropriate.

Elements of the Task

This task is designed to measure students' ability to integrate the dimensions and demonstrate their knowledge, skills, and abilities (KSAs) as represented by the PE, HS-ESS2-7 "Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth."

Table 1 specifies the dimensions and the key aspects of the PE that are assessed by the task. In addition, expectations for students' prior knowledge are indicated. Table 2 specifies the KSAs, work products, and task features represented by the task.

Table 1. Specific Practices, Disciplinary Core Ideas, and Crosscutting Concepts to be Assessed

NGSS Performance Expectation: HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. [Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.] [*Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems*.]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Engaging in Argument from Evidence**	**DCI: Biogeology** • The many dynamic and delicate feedbacks between	**CCC: Stability and Change**

	• Construct an oral and written argument or counter-arguments based on data and evidence.	the biosphere and other Earth systems cause a continual coevolution of Earth's surface and the life that exists on it.	• Much of science deals with constructing explanations of how things change and how they remain stable.
Key Aspects	• Construct an oral argument based on data and evidence • Construct a written argument based on data and evidence • Construct an oral counter-argument based on data and evidence • Construct a written counter-argument based on data and evidence • Identify possible weaknesses in either data or an argument and explain why their criticism is justified	• Feedback (negative or positive) can stabilize or destabilize a system • The feedbacks between life on Earth and the Earth's systems cause life on Earth to evolve and the surface of the Earth to undergo changes at the same time • Examples of feedback include how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, thus reducing the amount of sunlight reflected from Earth's surface, which in turn increases surface temperatures and further reduces the amount of ice	• Construct explanations of how things change • Construct explanations of how things remain stable • Evaluate models of complex systems and comprehend subtle issues of stability or of sudden or gradual change over time
Prior Knowledge	• Use linear equations and systems of linear equations to represent, analyze, and solve a variety of problems • Analyze situations and solve problems. Knowledge of how to recognize patterns of association in bivariate data • Write an argument • Use data to evaluate claims about cause and effect • Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation	• The evolution and proliferation of living things over geological time have changed the rates of weathering and erosion of land surfaces, altered the composition of Earth's soils and atmosphere, and affected the distribution of water in the hydrosphere	**Relationships to SEPs** • Observations and data describe how things change • Reasoning and data can be used to explain how things evolved to be the way they are today • Arguments can be supported by quantifying and modeling changes in systems over very short or very long periods of time • Explanations of how things evolved to be the way they are today involves modeling rates of change and conditions under which the system is stable or changes gradually, as well as explanations of any sudden change

Table 2. Components of the Assessment Task

Knowledge, Skills, & Abilities: • **KSA1:** Construct an argument using causal links and feedback mechanisms between changes in the biosphere and changes in Earth's other systems, that there is simultaneous coevolution of Earth's systems and life on Earth. • **KSA2:** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
Student Demonstration of Learning: • Model accurately represents the observable phenomena • Model accurately captures all mechanistic features of the observable phenomena • Use a model to make an accurate prediction about a phenomenon (e.g., direction of plate movement) • Represents only the appropriate relationships and/or interactions among the elements in the model needed to explain the target phenomenon and describes why these relationships are important • A statement accurately describing how stability and change are related and a good model for a system must be able to offer explanations for both • Organizes data in a clear way that highlights changes observed from the evidence that are relevant or meaningful to a scientific question • Synthesizes relevant evidence related to complex systems and comprehend subtle issues of stability or of sudden or gradual change over time to defend a claim or support an argument or counter-argument
Work Product: • Constructed response • Short response • Draw a model
Task Features: • All tasks must prompt students to make connections between observed phenomenon or evidence and reasoning underlying the observation/evidence (e.g., changes in the biosphere and changes in Earth's other systems; ancient versus current atmospheric composition). • All tasks require the use of examples to support a logical argument in a context that revolves around changes in the biosphere and changes in Earth's other systems. • All tasks must elicit core ideas as defined in the PE. • All tasks must include elements from at least two dimensions of the NGSS.

Task Administration

Materials and Set-up

Materials

To administer the task, educators will need:

- Task administration guide
- Paper (for note taking)
- Student task worksheet (one per student)

- Laptops/Computer/projection screen/Smart Board

Duration

This task can be administered in approximately one class period.

Set-up

Prior to administration, print copies of the student task worksheet. Each student will receive paper for taking notes, and a copy of the task worksheet. Student will need access to laptops or computers to interact with the biointeractive graphic.

Directions for Administration

During administration, educators should:

1. Provide each student with a pencil and the student task worksheet.
2. In the student task worksheet, read the *Task Introduction* section to students. Address questions from the students related to expectations for completing the task. However, ensure that the discussion does not include information that provides an unfair advantage for students to complete the task/items. Tell the students the task includes one question. Remind students to check their work and to ensure that all parts of the task are completed.
3. Prompt students to read the background information about gradual changes in Earth's atmosphere and, using their provided laptop, access the interactive graphic at https://media.hhmi.org/biointeractive/click/oxygen/. As students read the background information and interact with the graphic, prompt them to highlight and/or record evidence to use in support of the claim presented in question 1.
4. Allow students to complete the task. While the task should take approximately one class period to complete, students can take additional time as needed to finish. While students are working, walk around and monitor student progress, noting any misconceptions or areas in which students are struggling. Follow up with individual students as needed.

Guidelines for Evaluating Student Performance

Following administration of the task, evaluate each student response using the provided rubric. Identify the evidence of what each student knows and can do with regard to each question. Assign each student a "score" in order to classify the student's performance and to inform how he or she may be grouped with other students for instruction. Consider whether the student has mastery/an understanding of the assessed skills and is ready for new, more sophisticated instruction (a "3"); has a partial understanding and needs additional instruction on some concepts before new instruction is provided (a "2"); or has not learned the material and/or has misconceptions and reteaching of the key concepts is required (a "1").

Collectively consider the evidence of student performance across all students. Do any patterns or trends emerge with regard to students' demonstrated knowledge, skills, and abilities related to this standard/performance expectation? Do you notice any common misconceptions or misunderstandings?

Next, consider how you might address students' needs. How will you adjust instruction based on the observed patterns and trends? Consider what aspects of the standard/performance expectation (i.e., dimensions) require additional instruction for individuals, small groups, or the class.

Rubric

Dimension Element	1	2	3
Engaging in Argument from Evidence	Identify observations from evidence and/or models with little or no relationship to support the claim.	Identify observations from evidence and models to partially support a claim.	Identify relevant observations from evidence and models, justifying using or not using elements of the data, to support a claim.
Stability and Change	Does not describe changes to biological or geological factors in the context of the scenario.	Describe changes biological or geological factors in the context of the scenario.	Describe changes observed from the evidence to describe the relationship between biological and geological factors that have influenced the changes in oxygen levels during Earth's history in the context of the scenario.
Biogeology	Does not synthesize evidence to support the claim that there is continuous coevolution of Earth's systems and life.	Synthesize evidence to partially support the claim that there is continuous coevolution of Earth's systems and life.	Synthesize the relevant evidence to support the claim that there is continuous coevolution of Earth's systems and life.

Student Exemplar(s)

Question 1: Constructed Response

"There is biological and geological evidence and facts to support the claim that between 2.5–2.3 billion years ago, the levels of oxygen on Earth rose. For example, there is evidence of cyanobacteria in fossils that are approximately 3.5 billion years old. There was a lot of carbon dioxide in the atmosphere for the cyanobacteria to use for photosynthesis. Photosynthesis releases oxygen. Over millions of years, tectonic movement of the Earth's mantle thrust up the ocean floor to form coastal shallows, thus supporting the spread of more cyanobacteria colonies. This led to greater amounts of oxygen in the environment.

Banded iron formations, a type of sedimentary rock, found in many locations on Earth today, provide evidence for the increase in oxygen released by cyanobacteria. The bands of red and black iron oxides could only have formed in the presence of a lot of oxygen. Also, this phenomenon is found in rocks 2.8–2.0 billion years old. Therefore, it took about a billion years for Earth's oxygen levels to accumulate enough to cause this to occur.

These relationships between iron-rich deposits and Earth's early atmosphere support the claim that between 2.5–2.3 billion years ago, the levels of oxygen rose on Earth."

Exemplar HS-ESS2-7 High-level Student Response: Student Responses

There is biological and geological evidence and facts to support the claim that between 2.5-2.3 billion years ago, the levels of oxygen on Earth rose. For example, there is evidence of cyanobacteria in fossils that are approximately 3.5 billion years old. There was a lot of carbon dioxide in the atmosphere for the cyanobacteria to use for photosynthesis. Photosynthesis releases oxygen. Over millions of years, tectonic movement of the Earth's mantle thrust up the ocean floor to form coastal shallows, thus supporting the spread of more cyanobacteria colonies. This led to greater amounts of oxygen in the environment.

Banded iron formations, a type of sedimentary rock, found in many locations on Earth today, provide evidence for the increase in oxygen released by cyanobacteria. The bands of red and black iron oxides could only have formed in the presence of a lot of oxygen. Also, this phenomenon is found in rocks 2.8-2.0 billion years old. Therefore, it took about a billion years for Earths' oxygen levels to accumulate enough to cause this to occur.

These relationships between iron-rich deposits and Earth's early atmosphere support the claim that between 2.5-2.3 billion years ago, the levels of oxygen rose on Earth.

HS-ESS2-7 Classroom Assessment Task Anchor Student Responses

As a result of the COVID-19 epidemic, this task was not administered to students and therefore no student anchor papers are available.