3D Science Performance Assessment Tasks

4th GRADE:
WAVES

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Task Title	Let's Talk

Standards Bundle
PEs: • 4-PS4-1 Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [*Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.*] • 4-PS4-3 Generate and compare multiple solutions that use patterns to transfer information.* [Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, and using Morse code to send text.]
Practices: • Developing and Using Models • Constructing Explanations and Designing Solutions
Crosscutting Concepts: • Patterns
Core Ideas: • PS4.A: Wave Properties • PS4.C: Information Technologies and Instrumentation • ETS1.C: Optimizing The Design Solution
CCSS ELA: • 4-PS4-1 Add visual displays to presentations when appropriate to enhance the development of main ideas or themes • SL.4.5 Integrate and evaluate content presented, including visually and quantitatively, as well as in words • CCRA.R.7: Introduce a topic or text clearly, state an opinion, and create an organizational structure in which related ideas are grouped to support a purpose • 4.W.1A Engage effectively in a range of collaborative discussions(in groups) with diverse partners on a given topic. Building on others' ideas and expressing their own clearly • 4 SL.1 b Follow agreed upon rules for discussion. Pose and respond to specific questions to clarify or follow up on information. • 4.SL1C Comments to contribute to discussion and link to the remarks of others.
CCSS Mathematics: • 4.PS.04.02 Give answers to a reasonable degree of precision on the context of a given problem.

Overview / Introduction of the Assessment Task

In this task students create a communication system or device able to send a message over a distance of 100 feet. They will present their models to the group. The students will further construct an explanation of their favorite design explaining the strengths and weaknesses of the selected communication system.

Teacher Background

Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter. Light and sound are wavelike phenomena. By understanding wave properties and the interactions of electromagnetic radiation with matter, scientists and engineers can design systems for transferring information across long distances, storing information, and investigating nature on many scales—some of them far beyond direct human perception.

Whether a wave in water, a sound wave, or a light wave, all waves have some features in common. A simple wave has a repeating pattern of specific wavelength, frequency, and amplitude. The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which, for each type of wave, depends on the medium in which the wave is traveling. Waves can be combined with other waves of the same type to produce complex information-containing patterns that can be decoded at the receiving end. Waves, which transfer energy and any encoded information without the bulk motion of matter, can travel unchanged over long distances, pass through other waves undisturbed, and be detected and decoded far from where they were produced. Information can be digitized (converted into a numerical representation), sent over long distances as a series of wave pulses, and reliably stored in computer memory.

Sound is a pressure wave in air or any other material medium. The human ear and brain working together are very good at detecting and decoding patterns of information in sound (e.g., speech and music) and distinguishing them from random noise.

Resonance is a phenomenon in which waves add up in phase (i.e., matched peaks and valleys), thus growing in amplitude. Structures have particular frequencies at which they resonate when some time-varying force acting on them transfers energy to them. This phenomenon (e.g., waves in a stretched string, vibrating air in a pipe) is used in the design of all musical instruments and in the production of sound by the human voice.
When a wave passes an object that is small compared with its wavelength, the wave is not much affected; for this reason, some things are too small to see with visible light, which is a wave phenomenon with a limited range of wavelength corresponding to each color. When a wave meets the surface between two different materials or conditions (e.g., air to water), part of the wave is reflected at that surface and another part continues on, but at a different speed. The change of speed of the wave when passing from one medium to another can cause the wave to change direction or refract. These wave properties are used in many applications (e.g., lenses, seismic probing of Earth).

Grade Band Endpoints for PS4.A
By the end of grade 2. Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; it does not move in the direction of the wave—observe, for example, a bobbing cork or seabird—except when the water meets the beach. Sound can make matter vibrate, and vibrating matter can make sound.

By the end of grade 5. Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.)
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Information for Classroom Use
Connections to Instruction: This assessment should be completed in sections following each area of instruction. After learning about waves and their properties. Students will complete Task 1. Students will then continue learning about communication systems. They should focus on the recognizing patterns of sound and light (ie. Morse code) Students should further understand that sound travels on these waves. Students would then complete Task 2. Finally after learning about waves and the sounds. Students will apply this information to a new situation and use their problem solving and engineering skills to solve a "real-world" problem.
Approximate Duration for the Summative Task: (all components): • Task 1: 1-hour class period (30 minutes for exploration, then thirty minutes to answer questions with the program to give students the ability to gather specific details for their papers). • Task 2: 2 class periods - 1 to create a pattern of symbols used to create a coded message and 1 for the classmate to decode the message and send a reply. • Final Task: 3 class periods- 1 for introduction and work, 1 for work session, 1 for presentation and evaluation of favorite choice.
Assumptions: ***Students will understand the following before assessment:*** • Waves, which are regular patterns of motion, can be made in water by disturbing the surface. • When waves move across the surface of deep water, the water goes up and down in place; it does not move in the direction of the wave—observe, for example, a bobbing cork or seabird—except when the water meets the beach. • Sound can make matter vibrate, and vibrating matter can make sound. • Sound and light travel in waves • Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). • Waves can add or cancel one another as they cross.
Materials Needed: • Task 1: Computer with PHET – Sound downloaded headphones or sound capable, questions, paper and pencil. • Task 2: paper, pencil, • Final Task: Poster paper, markers for presentation posters. Additional supplies only if students are to build 3D models of communication systems
Supplementary Resources: • Photos of lighthouse: ○ Lighthouse Video: Michigan.org ○ Lighthouse examples PowerPoint • Video of Morse code: ○ Morse CODE Song ○ Rhythm of the CODE • Handout of Morse code alphabet for sample translation: ○ Sample from Crayola - any will work

Learning Performances
• Students will create a model to distinguish the frequency and amplitude of a wave. • Students will understand that waves are a transfer or movement of energy. • Students will understand that communication uses patterns to transfer information. Patterns can encode, send, receive and decode information. • Students will design and test a communication system. • Students will construct an explanation to demonstrate the benefits and constraints of their created system. • When given a problem, students will design a solution whose function is send a message a given distance successfully.

Phenomenon	Scenario
Communication by Morse code	You are stranded on an isolated island and want to be rescued. How would you signal for help? **Or** Due to a storm, the school has no power. We want to send messages from the front of the school to the back playground. (100 yards)

Performance Assessments

Student Performances		
Formative Assessment Task 1	Learning Performance: Students will create a model of sound waves. Students will change the amplitude and wavelength and will explain how the sound changes with these adjustments.	Expected Duration: 1 hour
	Description: Phet Simulation - https://phet.colorado.edu/en/simulation/legacy/sound This simulation lets you see sound waves. Adjust the frequency or volume and you can see and hear how the wave changes. Move the listener around and hear what she hears.	
	Directions: 1. Explore: using this program, the students will explore how the sound changes with several variables. Including frequency, wavelength, air pressure, and be introduced to interference. (They just see that the waves bounce off things.). 2. The students will use the first tab of the program to adjust the amplitude and frequency of the sound waves. They will adjust the toggle under the PHET symbol horizontally and will note how the tone and sound spaces changes with each adjustment. 3. The students will use test tab 4 for air pressure and will state that when there is no air pressure there is no sound. 4. The student will identify walls and other things can block sound because the sound will bounce off. This is a visual representation in the program. Audios will cause an echo.	
	Scoring / Teacher Look-For's: This will be assessed with a written summary of the student notes. Questions will include: ● Wavelength Patterns: ○ How did the LONG wavelengths LOOK and SOUND? ○ How did the SHORT wavelengths LOOK and SOUND? ■ *Students must recognize that the length of wavelength will change with the sound or frequency.* ● Amplitude Patterns: ○ How did the HIGH amplitude waves LOOK and SOUND? ○ How did the SHORT amplitude waves LOOK and SOUND? ■ *They will further identify that the amplitude effects sound volume.* ● What happened to the sound as the air pressure was REMOVED? As it was RESTORED? ● *Students must state that without air there is no sound*	

<table>
<tr><td></td><td colspan="2">and that sound waves bounce off things</td><td></td></tr>
<tr><td rowspan="4">Formative Assessment Task 2</td><td colspan="2">Learning Performance: The student will create an alphabet/ picture code with a translation key. The student will use this key to write a coded question. They will then give it to a classmate to decode and to answer in the same code used.
Patterns can encode, send, receive and decode information.</td><td rowspan="4">Expected Duration:
2 days –
One day to present and for code creation.

Day 2 – for code decoding and answering.</td></tr>
<tr><td colspan="2">Description: Phenomena: Morse code
The student will create an alphabet/ picture code with a translation key. The student will use this key to write a coded question. They will then give it to a classmate to decode and to answer in the same code used.</td></tr>
<tr><td colspan="2">Directions:
1. The teacher have the students listen to the following link: (The first time, do not let them see what it is.)
2. Ask students to write in their notebooks what they believe this to be.
3. Then show the video, have students compare to their predictions.
4. Show video- using Morse code lines, military, and sound for each letter.
5. Have students listen to the rhythm of the CODE using the following link.
6. Show the video again. Help the student to identify each of the three communication forms. (military, dots and dash, and beeps, and pictures)
7. Have students create a two-sentence message that asks a question to send to a friend. They will also need to create an alphabet key.
8. Partner will decode the message and return it to creator by answering their question using the same code.</td></tr>
<tr><td colspan="2">Scoring / Teacher Look-For's: Students should have message using a pattern of pictures, sounds, or words. The message should have a question and an answer using the same code.</td></tr>
<tr><td rowspan="3">Final Task:
(Model, Design, Explain, Argue, Investigate)</td><td colspan="2">Phenomena: Morse code (show student photo of local Michigan lighthouse)</td><td rowspan="3">Expected Duration:
3 days</td></tr>
<tr><td>Goal: The students will create a communication system to send a messages from an isolated island to rescuers</td><td>Role: A stranded engineer who needs to send a message.</td></tr>
<tr><td>Audience: Classmates act as a selection committee for new island communication system.</td><td>Situation: You are stranded on an isolated island and want to be rescued. How would you signal for help?
Or
Due to a storm, the school has</td></tr>
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		no power. We want to send messages from the front of the school to the back playground. (100 yards)	
	Product / Performance: Create a system to send a rescue message. It should have a code and a way to deliver the message. The student will create a message key and a model of the delivery system.		
	Directions: 1. Play a sound bite of a foghorn - Ask students *What is this? What is its purpose?* 2. After asking students the preceding questions, add a picture of a lighthouse along with the foghorn sound 3. Discuss with students how a lighthouse and a foghorn work. *What is the purpose of this? What forms of communication do they use?* 4. Teachers could choose to read: Lighthouses for Kids: History, Science, and Lore with 21 Activities from MEL 5. Show students photos of the Manitou islands. http://sleepingbearbirdingtrail.org/birding-sites/manitou-islands 6. Scenario: We have gone hiking on the uninhabited island. If we have no electricity, (no cell service) how do we get a message to the mainland, so the boat will come to pick us up? (see script below) a. *Day 1 Script:* i. *You are stranded on an isolated island and want to be rescued. How would you signal for help? Your team of engineers will need to create a communication system to send a message from your non-electronic island to your rescuers. You will need to include the communication system and how messages will be sent.* b. *Day 2 Script:* i. *Due to an incoming storm, we do not have time or resources to build 30 systems. Each group must present their solution to the islanders. Each of the stranded people must vote on which communication system would create a rescue most successfully. During the voting process, you will be asked to*		

	defend your selection. You must explain the pattern of communication, draw a model of your choice, and give three reasons why you feel this is the best selection. 7. Have students discuss with their team the best way to get a message to the mainland. 8. Have students determine what kind of delivery system you would use (drums, Morse code, lights, pictures) 9. Students should also create a message system. Give students a poster paper to create these. 10. Each group presents its design to the class. Along with describing how the design works, students should explain how it uses a pattern to transfer information. (see day 2 script below) 11. Individual students will listen to the rest of the groups' presentations and evaluate each one for: a. Does the design meet the constraints of distance and safety? b. Does this communication system use a pattern? c. Will the design work in the given situation? 12. Students will write an individual report recommending one design which they feel is the most successful (See outline of individual report below) 13. They will give three reasons explaining which features will be the most useful for selecting this model and draw a model of the selection. 14. Teacher will score written report/group presentations according to the checkbric (see following section)	

Outline of Individual Final Assessment Report

Student Name _____

Teacher Name _____

Which communication system do you believe will be the best for our school to purchase?

What three features do you find the most important? Why?

1.

2.

3.

What problems or limitations does this system have?

1.

2.

Draw and label a model of your choice.

CheckBric

Student Name _____

Teacher Name _____

Learning Performance: Students will create a model of their communication delivery system.					**Comments**
Evidence Statements:					
Draw and label a model of their favorite communication delivery system.	**1**	**2**	**3**	**4**	
LP Total:					
Learning Performance: Students will understand that communication uses patterns to transfer information. Patterns can encode, send, receive and decode information.					**Comments**
Evidence Statement:					
Create a code and a key to send a message	**1**	**2**	**3**	**4**	
Describe the pattern used and how that pattern can encode, send, receive, and decode information.	**1**	**2**	**3**	**4**	
LP Total:					
Learning Performance: Students will construct an explanation to demonstrate the benefits and constraints of their created system.					**Comments**
Evidence Statements:					
Choose the best system and defend their selection by explaining the three features they found to be the most important.	**1**	**2**	**3**	**4**	
LP Total:					
Checkbric Total					

4 Exemplary	Work at this level is of exceptional quality. It is both thorough and accurate. It exceeds the standard. It shows a sophisticated application of knowledge and skills.
3 Proficient	Work at this level meets the standard. It is acceptable work that demonstrates application of essential knowledge and skills. Minor errors or omissions do not detract from the overall quality.
2 Developing	Work at this level does not meet the standard. It shows basic, but inconsistent application of knowledge and skills. Minor errors or omissions detract from the overall quality. Your work needs further development.
1 Emerging	Work at this level shows a partial application of knowledge and skills. It is superficial (lacks depth), fragmented or incomplete and needs considerable development. Your work contains errors or omissions.