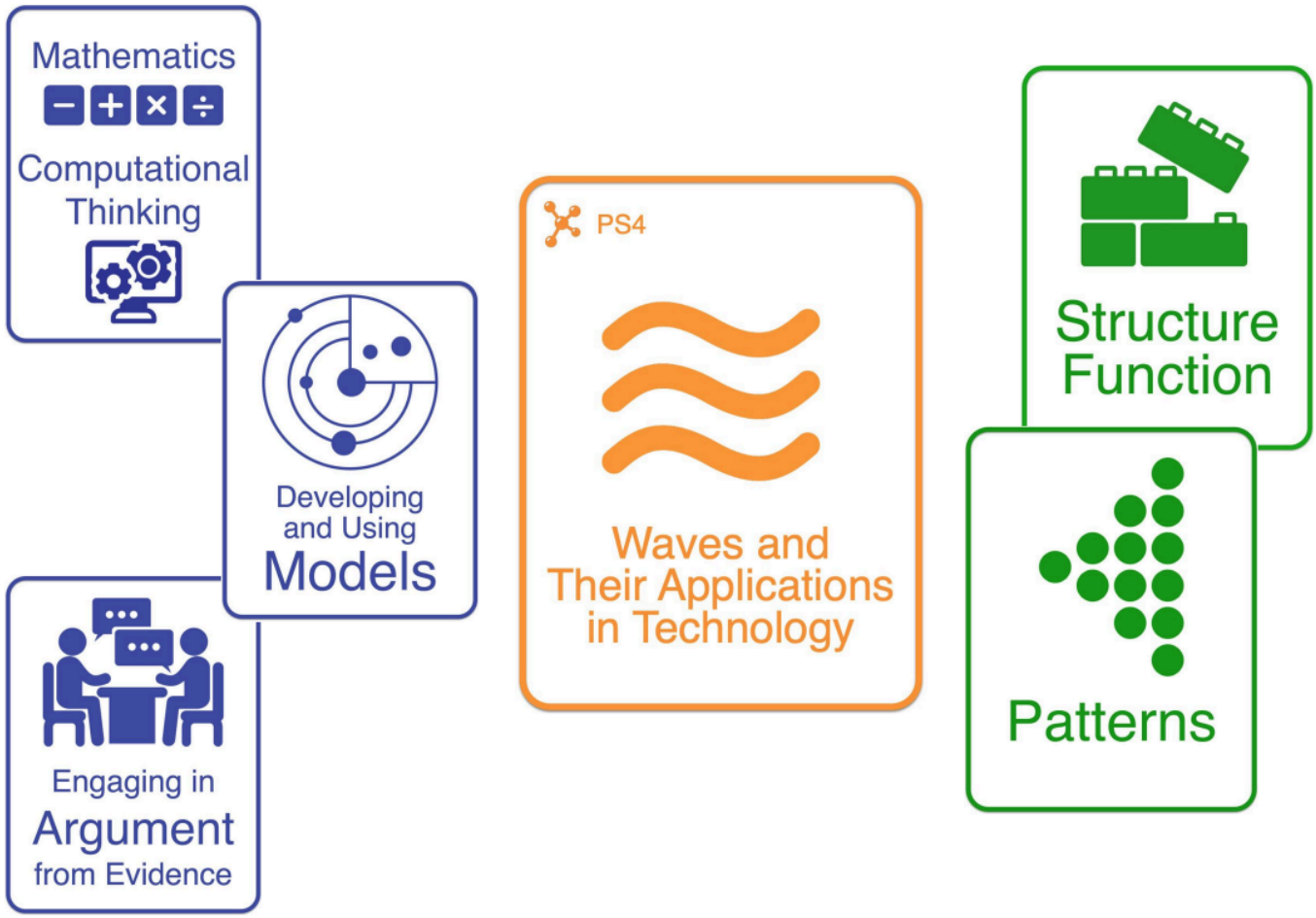
Storyline Unit Design

Understanding by Design (UbD) Template*

Unit	**Waves and Their Applications**	Course(s)	**Science 8**
Designed by	**Penkala, Helsel, Ross**	Time Frame	

Anchor Model



*UbD Unit Planner is from Wiggins, Grant and McTighe, Jay. Understanding by Design Guide to Creating High-Quality Units. Alexandria, VA: Association for Supervision and Curriculum Development. 2011.

Stage 1: Desired Results

Performance Expectations

MS-PS4-1: Wave Properties
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. (Patterns)

MS-PS4-2: Wave Reflection, Absorption, and Transmission
Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. (Structure and Function)

MS-PS4-3: Digitized Wave Signals
Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. (Structure and Function)

Anchoring Phenomenon

Communication through TikTok (How can other people watch a video you record? Uses light and matter waves with conversions from analog to digital signal).

Reflection & Refraction: Light entering the camera lens and bending to a single, smaller point

Light and sound travels through air to a camera lens and microphone. Light enters the camera lens and is refracted to hit a microchip. Information from the light wave is converted from analog to digital. Sound reaches a microphone where vibrations of the air move the speaker diaphragm, causing a magnet inside the speaker to move. This magnet is part of an electromagnet and creates an electric current. This current is converted into a digital signal. Digital signals are sent to cell towers.

A viewer's cell phone, receives a digital signal from a cell tower. Their cell phone converts the signal back to analog as the video and audio are played on TikTok.

If a person records a video on their own phone and then replays the video: *Analog signals such as audio and video travel to a cell phone where they are converted to digital signals, and back to analog as they leave the cell phone.*

Anchoring Phenomenon Worksheet

Enduring Understandings	Essential Questions

Stage 2: Assessments

MS-PS4-1 - The Cackling and Canadian Goose — MS-PS4-1 Key
MS-PS4-2 - Underwater GoPro — MS-PS4-2 Key
MS-PS4-3 - KTLA Turns Analog — MS-PS4-3 Key

Assessment Screening Tools

Backward Design Elements

What new skills (practices) will students need to learn?	What thinking concepts will students need to learn?	What science concepts will students need to learn?
-Developing and using models **MS-PS4-3: Obtaining, Evaluating, and Communicating Information** • Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. How to **model** waves and changes to waves when traveling through various media.	Energy Systems Patterns Structure and Function Patterns	Wave interactions (reflection, refraction, absorption, transmission) Properties of matter waves: Rarefaction, compression Wave properties of both Matter & Light (wavelength, frequency, amplitude, energy) Proportional relationships Digital vs analog signals

Stage 3: Learning Plan			
Phenomenon or Problem	Learning Performance - What will they do? The three dimensions woven together into a single learning performance.	Why is this important? How does this activity help build understanding of the anchoring phenomenon.	Learning Experience - How will they do it? Graphic organizers, protocols, scaffolds, labs, mini-lesson, student discourse, etc.
Communication through TikTok Day 1	Students will develop an initial system model to explain a person to person analog and digital information flow.	Modeling - See students understanding around information flow; gets at assets and taps into the students experiences and knowledge. System - this is a complex system Information flow is carried on multiple types of waves. It is light and matter waves (sound).	Mini lesson on systems - components and relationships. Draw individual models Work in group to have group model Gallery walk of group models; revisit group models. Videos of TikTok. Mini-lesson on communication - talk frames. Initial models on the wall. (Information flow diagrams)
Formative Assessment - What information are you collecting to know that they met the target?		Peer review models based on single point rubric - important components, relationships between components and does it explain the phenomenon. (criteria on back of modeling card)	
Communication through TikTok Day 2	Students will ask questions about their system model to explain a person to person analog and digital information flow.	Asking Questions - Students generate questions from their model	Questions about their model are generated as a group, then shared as a class. Use questions to transition into the next investigation. ➔ What is a wave? How does energy/information move from one place to another?
Formative Assessment - What information are you collecting to know that they met the target?			
How did the Tonga volcano eruption near Australia cause a tsunami in Santa Barbara? (Jan 16, 2022) Day 3	Students will investigate the effect of changes in energy in the structure of a matter wave.	In investigation students have an experience with wave and they are generating the wave - cause (student) and effect (wave). Energy makes the wave.	Videos - Tsunami (Vid 1) (Vid 2) Rope activity outside - making waves, waves in water - refraction, reflection (one student on each end - shake rope, shake faster, shake higher, throw down challenges with as many students as possible)

			- experience rope waves, then write about rope waves (add volcanic eruption in pacific ocean January 2022) Pdf version
Formative Assessment - What information are you collecting to know that they met the target?		Rope model waves with explanation of cause & effect relationship causing movement of energy.	
How did the Tonga volcano eruption near Australia cause a tsunami in Santa Barbara? (Jan 16, 2022) Day 4	Students will investigate the effect of changes in energy in the structure of a matter wave.	In this investigation students have an experience with wave and they are generating the wave - cause (student) and effect (wave). Students notice that waves can have differences in height and wavelength. Energy makes the wave.	Slinky & Water Activity Students drop corks in a tub of water and observe changes in surface waves that are created ➔ when parts of the slinky are closer together, this is an area of higher compression. Vs when slinky is spread apart, we have a lower area of pressure, rarefaction. Introduce Vocabulary after students have explored and noticed these terms: - waves with different heights have different **amplitudes** - waves that are closer together or farther apart have different **wavelengths**
Formative Assessment - What information are you collecting to know that they met the target?		Exit Ticket: Explain how an eruption near Australia caused a tsunami in Santa Barbara. ie: *Energy from an eruption traveled through the water, and made the tsunami in SB.*	
How does sound travel? Day 5	Students will investigate the effect of changes in energy in the structure of a matter wave.	Students investigate how changing amplitude and frequency of waves affect the amount of energy transferred. Students explain explicit relationships between amplitude, frequency, and energy.	Sound waves simulation - and cup phones ** Edit to prompt students to explicitly explain how changing amplitude and frequency affect energy Give students time to *play* with simulation **Cup phones** - make and explore - make model of energy transfer through medium. Can signals cross (party line with 4 people)? * lines must have enough tension Materials: Cup phones, different size containers/different sounds

Formative Assessment - What information are you collecting to know that they met the target?		Student models comparing effects of changing amplitude and frequency on energy	
Why are sound and water waves both called waves? Day 6	Students obtain, evaluate, and communicate information on patterns (similarities and differences) in matter wave properties.	Students describe similarities and differences in mechanical waves using accurate scientific vocabulary All waves have these same fundamental properties	Reading about three types of **mechanical waves** with graphic organizer comparing the three types: Reading: Matter Wave Sound Wave Surface Wave Summary (lower level reading) ➜ Jigsaw in a group of 4 * might want to find readings more specifically about water/sound/surface waves Graphic organizer: In groups: Use the diagram to compare the three types of mechanical waves ➜ add examples of types of waves in each category ➜ center should have all properties in common (amplitude, wavelength, frequency, transfer energy)
Formative Assessment - What information are you collecting to know that they met the target?		Graphic organizer with common wave properties in the center	
How do waves transfer energy? Day 7	Students will investigate the effect of changes in the structure of a matter wave.	Computational Focus: How does constant energy input affect wavelength and amplitude?	String Wave generators - explore factors that affect waves ** Add: Prediction -- what will happen if you shorten the string, loosen the string...) (evidence statement 3b)
Formative Assessment - What information are you collecting to know that they met the target?		Student prediction	
Which wave transfers more energy - a single wave at Mavericks or a day's worth of waves hitting the beach? Day 8	Students will use mathematical and computational thinking to describe the patterns in the energy of a matter wave.	Students investigate the relationship between amplitude and volume, and frequency and pitch. Students create 2 graphs: amplitude vs. energy and frequency vs. energy and communicate the results	**Mavericks Waves:** https://www.kqed.org/quest/17358/science-of-big-waves ➜ Start with mavericks video as an intro to the day **Leadbetter Waves:** https://www.youtube.com/watch?v=UR5wbHk0C-M **Waves Intro (Phet Explore)**: wavelength, amplitude, frequency

			https://docs.google.com/presentation/d/1laKVenzsftfaYaIDJQrhx7FryBXpprnKfrD8LFfJ2CA/edit?usp=sharing
Formative Assessment - What information are you collecting to know that they met the target?		Conclusion section at the end of each of the 3 sections in the pHet investigation.	
Which wave transfers more energy - a single wave at Mavericks or a day's worth of waves hitting the beach? Day 9	Students will use mathematical and computational thinking to describe the patterns in the energy of a matter wave.	What is the relationship between wavelength, amplitude, and frequency? Students identify waves that transfer more energy using their understanding of amplitude having a greater effect on energy than frequency	**Making Waves:** drawing models Use grid paper to draw waves with the following parameters (label all parts): * give students slips of paper to draw a different wave on each paper * as a group, students arrange waves in order of increasing energy * gallery walk to see work from different groups 1. one wave with wavelength of 4 cm, amplitude of 2 cm 2. three waves with wavelength of 2 cm, amplitude of 3 cm 3. four waves with wavelength of 3 cm, amplitude of 1 cm Determine the frequency of each model - assume the waves are generated in one second. Arrange wave models in order of most to least energy.
Formative Assessment - What information are you collecting to know that they met the target?		Explain that a single maverick's wave transfers more energy because the amplitude is much larger, and energy is the square of a wave's amplitude.	

How can we represent sound waves? Day 10	Students will use mathematical and computational thinking to describe the patterns in the energy of a matter wave.	Students will make models to show sound waves.	**Sound Waves Model - particle to transverse:** **Info/Activity/Practice:** https://docs.google.com/presentation/d/17KQ7IPXC8wVFPht_c8sy2-5ZizUKe_jaZkMGVRY73SE/edit?usp=sharing See notes for edits in the slides above Waves tone (pitch), wavelength, amplitude, frequency, and energy practice:
Formative Assessment - What information are you collecting to know that they met the target?		Students explain their thinking throughout the investigation	
Day 10+	Students will obtain information to describe a model that includes how the amplitude of a wave is related to the energy in a wave.	Students read for review if they have time prior to the assessment.	STEMscopedia or Reading Science A/B/C
Formative Assessment - What information are you collecting to know that they met the target?			
Communication through TikTok Day 11	Students will revise their system model to explain a person to person analog and digital information flow.	Students apply what they have learned about matter waves to revise their initial model.	Students use a different color to update their model and explanation
Summative Assessment What information are you collecting to know that they met the target? Day 12		MS-PS4-1 - The Cackling and Canadian Goose MS-PS4-1 Key	
MS-PS4-2 Info video about fiber optic cables and internet: Optical fiber cables, how do they work? | ICT #3			
Burning Leaf Day 1	Students will develop an initial system model to explain how light transmitted through a magnifying glass causes a leaf to burn.	Use a magnifying lens to collect light and focus light on the leaf - leaf starts smoldering - students make a model to show what is happening Start thinking: What does the lens do that causes the leaf to burn?	Burning leaf - hook Communicating on Earth and in space (just a thought) Class brainstorms ideas about what might be similar to what we learned about matter waves, and what might be different (patterns).

Formative Assessment - What information are you collecting to know that they met the target?			
How do electromagnetic waves behave in matter? Day 2	Students will develop models to observe patterns of electromagnetic waves interacting with various matter.	Students will gain an understanding of how light waves behave in various matter.	Introduction to the Electromagnetic SpectrumPencil in water, fiber optic demonstration, cell phone w/wo aluminum foil, etc Fiber optic demo: shine laser through curved bar that shows internal reflection
Formative Assessment - What information are you collecting to know that they met the target?		Models of obsservations	
How do animals interact with light? Why do we see colors? Day 3	Students will investigate how changes in structure and energy affects the brightness and color of light waves.	Phet: Students investigate how wave amplitude affects light brightness	**Compare/contrast mechanical and electromagnetic waves** Hook: Sharks eat the internet ➜ What is different about electromagnetic waves that attract sharks? Phet waves - light amplitude = brightness, wavelength = color
How do animals interact with light? Why do we see colors? Day 4			**Compare/contrast mechanical and electromagnetic waves (cont)** EM Spectrum Documents: 1. Wave Characteristics reading - highlight how EM and Mechanical waves are similar in green, different in pink 2. https://drive.google.com/file/d/1_Fk4SmVgguUZFzEuyGWv3v-TTYMu5WcE/view?usp=sharing 3. https://drive.google.com/file/d/1nIYk2F-pvfBcKHfxiUlDOPp9Krxtto6E/view?usp=sharing
Formative Assessment - What information are you collecting to know that they met the target?		Students complete a venn diagram to compare and contrast mechanical waves with EM waves	
How do scientists track	Students create a model to explain how the structure of	Students explore a real-world application of	Visit this Shark Tracking Website and adopt a shark.

sharks? Day 5	EM and mechanical waves are transmitted through different materials.	waves. Different types of waves are used intentionally due to their properties.	Build engagement with sharks: Introduction to sharks How do we learn about sharks? By following them on a boat. How do we follow sharks on a boat? Using an acoustic tracker: Acoustic Shark Tracking (REMUS)
How do scientists track sharks? Day 6	Students create a model to explain how the structure of EM and mechanical waves are transmitted through different materials.	Component of Student Models: - draw sound waves from acoustic tag to underwater receiver on REMUS - draw radio waves from shark to satellite, to receiver with scientist - explain different applications of waves	How do scientists track sharks without following them? How do we get updates for your adopted shark? Video: CSULB Video putting together different types of shark trackers Create a model to show how mechanical and electromagnetic waves are used to collect information about sharks.
Formative Assessment - What information are you collecting to know that they met the target?		Students create a model and explain how properties of EM vs. mechanical waves allow trackers to send information to receivers	
How does matter affect light? Day 7	Students will obtain information about the structure and function of matter on light.	Students change incident angle, measure the reflection angle as light travels from one material to another.	Phet Bending Light - reflection/refraction https://drive.google.com/file/d/1sWHWvOI1y2JEdy2S1Mj0Cc9qXjPuxe_K/view?usp=sharing
Formative Assessment - What information are you collecting to know that they met the target?			
Day 8			The Electromagnetic Spectrum Reading: https://drive.google.com/file/d/18p0msextibChnr2li5Pi_VH7ikLkZdZx/view?usp=sharing Update TikTok model - radio waves, visible light/camera.

Day 9			Taking Apart the Light (use spectroscopes before doing this activity): https://drive.google.com/file/d/1-xurfdDMl97bNVlTZe3ELMa6B1_dkwMS/view?usp=sharing Uses gas tubes at GV to look at emission spectra of different materials
Remove this activity			EM Spectrum and Molecular Interaction: Make an organized chart from the simulation (linked below) about how parts of the EM spectrum affect various molecules.https://phet.colorado.edu/sims/html/molecules-and-light/latest/molecules-and-light_en.html Ozone article: https://drive.google.com/file/d/1LtBpFxel7uRknwuEZGCd920UB5JKQ3_M/view?usp=sharing
			Two options: Energy Absorption lab with different colors paper in sun and temp measured with IR thermometers. Color addition: Use color sheets to explore color addition Visit this simulation to explore color addition of visible light: https://phet.colorado.edu/sims/html/color-vision/latest/color-vision_en.html Read and highlight key concepts about color addition in the article.

			https://www.physicsclassroom.com/class/light/Lesson-2/Color-Addition Here is a pdf you can use to highlight: /files/1153174/color_addition.pdf Write a brief summary of visible light and color addition (in the "Prepare answer" section of this assignment - you do not need to submit the highlighted document).
			Modeling the disappearing light: https://docs.google.com/document/d/1H5_HdOwOrAfjWIT_B6XwsQmDmhTQKPPZd7WGGIhOFVA/edit?usp=sharing
			STEMScopedia:https://drive.google.com/file/d/1YqyzAI_a2jSuHAvjTe5l91ihMIQFB7Jq/view?usp=sharing EM: https://drive.google.com/file/d/1vcExeWw4yiulMnKez2R-RE_5uWkrQ5e_/view?usp=sharing STEMScopedia Digital/Analog: https://drive.google.com/file/d/1o-jh_BrOjagEU5mOsBWJMjCrWwbTDmOg/view?usp=sharing
Digital vs. Analog Brain Dump Video we watched with Nellie Records vs. CDs: • The grooves on a record create an analog signal through vibrations • CDs are played by a laser that reflects off the surface. The laser either reflects off the CD, or doesn't. This is a digital signal			

- Idea: have students do the exploratorium Groovy Sounds snack, then compare with a CD
- DIY phonograph?

Summative Assessment What information are you collecting to know that they met the target?	Create a model explaining how someone can record a video on their phone and play it back later. Model and explanation should include wave types, wave properties, and digital/analog signals

Materials / Resources

Vocabulary

MS-PS4-1
Wave
Wave properties
- Wavelength
- Frequency
- Amplitude

Patterns
Wave energy

MS-PS4-2
Mechanical wave (e.g. sound and water waves)
Medium
Light waves (amplitude is brightness and frequency is color)
Materials
Reflection
Absorption
Transmission
Structure and Function

MS-PS4-3
Digitized signal
Analog signal
Information
- Transmission
- Encoding

Information technology (e.g. fiber optic, wifi devices, binary signal)
Structure and Function

Mini Lessons

Patterns Level 4 - Patterns in Data Mini-Lesson
Patterns Level 4 - Patterns in Data Thinking Slides
Structure and Function Level 3 - Material Properties
Structure and Function Level 3 - Material Properties Thinking Slides

Graphic Organizers

Phenomena Observation Graphic Organizer
Questioning Graphic Organizer
Modeling Graphic Organizer
Planning an Investigation Organizer - Experimental
Planning an Investigation Organizer - Observational
Investigation Evidence Organizer
Engaging in Argumentation Organizer

Differentiation / Modifications

Phenomenon Worksheet

Back to **Stage 1**

◁ **MS-PS4-1 - Wave Properties**
◁ **MS-PS4-2 - Wave Reflection, Absorption and Transmission**
◁ **MS-PS4-3 - Digitized Wave Signals**
◁ **Local and Relevant**
◁ **Favorite**
◁

Beach erosion from waves ◁
Point break ◁◁
Giant waves at Mavericks
Sound Waves shaking windows◁ ◁
Ocean waves ◁◁
Shark tracking / Sonar ◁◁◁
Green flash sunsets◁
Bird calls◁◁
Optic fibers (total internal reflection) ◁ ◁◁
Musical wine/water glasses ◁◁
Musical road (intentional bumps along freeway to make music) ◁◁
Earthquakes creating tsunamis & traveling across oceans◁◁◁
Soprano vs baritone ◁
Arecibo Message ◁◁
Rainbows ◁◁
Air Pods (bluetooth)◁◁◁
Urban Heat Island / Solar energy ◁
Video game resolution ◁◁
Light pollution◁ ◁
Artificial reef to dissipate wave energy (local in Carp?)◁◁
AM/PM vs satellite radio ◁◁◁
Northern lights Aurora ◁◁
Morse code/telegraph vs iMessage ◁◁
Records vs spotify/apple music ◁◁
Sonar ◁◁◁
PBS Newshour: Immersive Van Gogh ◁
Digital Locks on Classroom Doors-Santa Cruz ◁

Overarching phenomena
- Communication through oceans
- Ocean's impact on humans

Screening Tools

Back to **Stage 2**

MS-PS4-1: Wave Properties

Evidence Statement

Assessment: The Cackling and Canadian Goose (Google Template)

Reflections: *Question 1 no units for amplitude*
Wavelength is not mentioned - add to table in question 2
We question correctness of the graph in question 4 - should it be pressure not amplitude with negative numbers below rest.
Question 6 should graphs be above response?
No prediction requested as per PE 3b

	No	Partial	Yes
1. The assessment contains a **phenomenon** (science) or a **problem** (engineering)			x
2. The **prompts** match the Science and Engineering Practice (SEP) and engage students in sense making.			x
3. The **stimuli** have multiple and sufficient information needed to utilize the SEP. (e.g. multiple data sets to analyze)			x
4. The **prompts** elicit observable understanding of the Disciplinary Core Idea (DCI).			x
5. The **prompts** explicitly mention the Crosscutting Concept (CCC).			x
6. The **prompts** include language (i.e. bullets) from grade appropriate progressions. (SEP)(DCI)(CCC)			x
7. The **graphic organizers** provide space for the observable features (e.g. 1, 2, 3...) in the evidence statement. (e.g. claim, evidence and reasoning)			x
8. The **entire assessment** contains information that is scientifically accurate and properly attributed. (e.g. don't make up data and include the source)			x
9. The **prompts** point in the direction of explaining a phenomenon (science) or designing a solution (engineering).			x
10. The **phenomenon** or **problem** is authentic, interesting, and requires students to figure something out.			x
11. The **phenomenon** or **problem** is novel to show the transfer of knowledge. (i.e. not in the unit)			x

Screening Tools

Back to Stage 2

MS-PS4-2: Wave Reflection, Absorption and Transmission

Evidence Statement

Assessment: Underwater GoPro (Google Template)

Reflections:			
	No	**Partial**	**Yes**
1. The assessment contains a **phenomenon** (science) or a **problem** (engineering)			
2. The **prompts** match the Science and Engineering Practice (SEP) and engage students in sense making.			
3. The **stimuli** have multiple and sufficient information needed to utilize the SEP. (e.g. multiple data sets to analyze)			
4. The **prompts** elicit observable understanding of the Disciplinary Core Idea (DCI).			
5. The **prompts** explicitly mention the Crosscutting Concept (CCC).			
6. The **prompts** include language (i.e. bullets) from grade appropriate progressions. (SEP)(DCI)(CCC)			
7. The **graphic organizers** provide space for the observable features (e.g. 1, 2, 3...) in the evidence statement. (e.g. claim, evidence and reasoning)			
8. The **entire assessment** contains information that is scientifically accurate and properly attributed. (e.g. don't make up data and include the source)			
9. The **prompts** point in the direction of explaining a phenomenon (science) or designing a solution (engineering).			
10. The **phenomenon** or **problem** is authentic, interesting, and requires students to figure something out.			
11. The **phenomenon** or **problem** is novel to show the transfer of knowledge. (i.e. not in the unit)			

Screening Tools

Back to Stage 2

MS-PS4-3: Digitized Wave Signals

Evidence Statement

Assessment: KTLA Turns of Analog (Google Template)

Reflections:			
	No	**Partial**	**Yes**
1. The assessment contains a **phenomenon** (science) or a **problem** (engineering)			
2. The **prompts** match the Science and Engineering Practice (SEP) and engage students in sense making.			
3. The **stimuli** have multiple and sufficient information needed to utilize the SEP. (e.g. multiple data sets to analyze)			
4. The **prompts** elicit observable understanding of the Disciplinary Core Idea (DCI).			
5. The **prompts** explicitly mention the Crosscutting Concept (CCC).			
6. The **prompts** include language (i.e. bullets) from grade appropriate progressions. (SEP)(DCI)(CCC)			
7. The **graphic organizers** provide space for the observable features (e.g. 1, 2, 3...) in the evidence statement. (e.g. claim, evidence and reasoning)			
8. The **entire assessment** contains information that is scientifically accurate and properly attributed. (e.g. don't make up data and include the source)			
9. The **prompts** point in the direction of explaining a phenomenon (science) or designing a solution (engineering).			
10. The **phenomenon** or **problem** is authentic, interesting, and requires students to figure something out.			
11. The **phenomenon** or **problem** is novel to show the transfer of knowledge. (i.e. not in the unit)			